Journal of Cardiovascular Disease Research

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

A Robotic Device design for safety Guidance to Nursing Care

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Abstract - Using a physical helper robot might possibly enhance the quality of life for those who use it. Because of this, in the worst-case scenario, physical helper robots are utilised instead of standard industrial robots and machinery. The physical assistance robot will be developed with the help of a safety document. Using the "V-model," which includes concept design, risk assessment, safety validation, and user testing as the foundation, this advice establishes the core idea. This is how we're going to make things more secure and easier to use. It was for this reason that we devised a danger scenario for the physical helper robot, a human safety measure, and a mechanism for validating human safety. It is our hope that this book will serve as a guide for conventional robot manufacturers looking to get into the physical helper robot industry.

I. Introduction

Using a physical helper robot might possibly enhance the quality of life for those who use it. These robots are employed in everyday life and assist untrained humans as one of their qualities. In certain cases, they are even closer to the user than the robots employed in factories. Physical helper robots are utilised instead of standard industrial robots and machinery where safety is a concern. As a "personal care robot that physically supports a user to execute essential duties by providing supplementation or augmentation of human skills," the physical assistance robot is defined. ISO 13482 is the worldwide standard that governs such robots. [2] and [3] are two examples of Japanese industrial standards that cover this international standard. Personal care robots have a different design idea than regular industrial robots, which necessitates the development of new safety requirements.

As a result, it is difficult for manufacturers to produce the physical helper robot, despite the fact that such criteria have been set. As a result, we drafted out some guidelines for creating the actual robot assistance. To accomplish this, a danger scenario for the physical helper robot, a human safety measure, and a safety validation test technique were created.

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

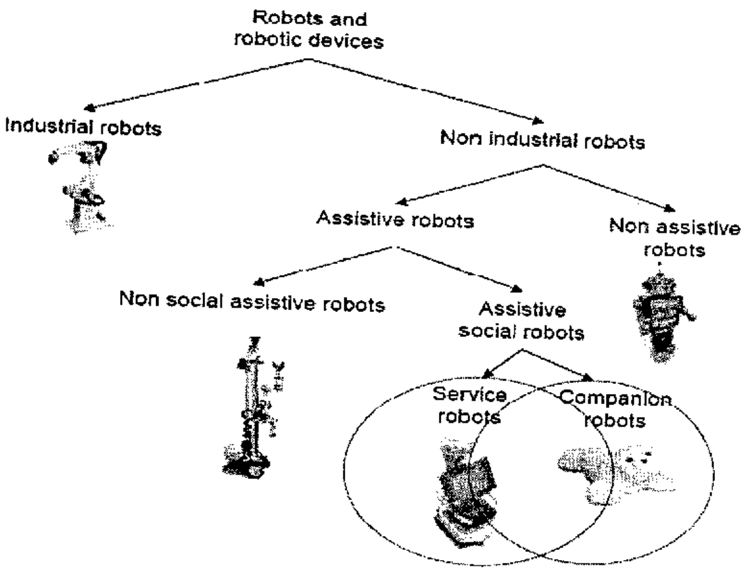

Figure. 1. Physical assistant robot classification

II. Concept Of Safety Guidance

Depending on the sort of support they provide, physical assistant robots may be categorised. Figure 1 depicts the categorization of Japan's Ministry of Economy, Trade, and Industry's physical helper robots. A robot's safety may be greatly impacted by its situational, physical, and functional characteristics. This categorization helps to account for these differences. For each class in this guide, the level of robot safety has been assessed.

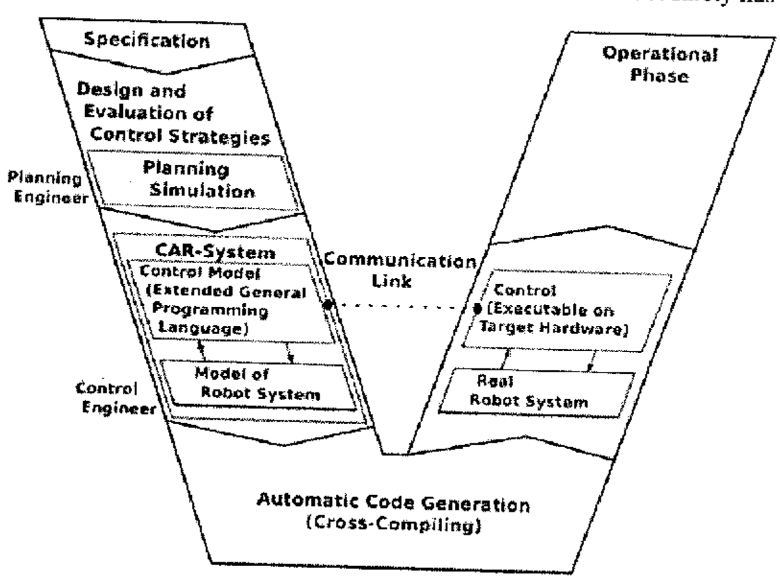

Figure. 2. Design and development of a physical helper robot (V-model)

The "V-model" in Figure 2 summarises the basic principle of this guideline. This is a visual representation of the method through which the physical assistance robot is designed and developed. The process moves in the same direction as the vector, from left to right. The vertical axis represents the conceptual level. The V-model is a way of thinking about system development that is universal. It was widened and tailored to the creation of a physical helper robot in this investigation.

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

The usability and target layer is at the top. Contrary to industrial robots, the physical helper robot's operator does not have any formal training in using the device. As a result, it is impossible to create a disciplined work environment, unlike in a factory. In this stage, the robot's impact on the user's quality of life should be evaluated and documented. As a concrete engineering system, this layer includes both robot hardware and software. The robot system should be equipped at this level for both function and safety.

Design is the subject of the first part. The robot's idea is embodied in the robot's hardware and software components. The robot's safety should be evaluated and its architecture updated throughout this step. The risk evaluation is necessary for this step. The idea and example of \sthis method is presented in section III. Validation takes place in the second half. If the safety standard is met, the robot should be tested. In the guideline paper for mechanical, electrical, and electromagnetic safety, many safety test techniques were created and presented. Section IV goes into detail about this procedure.

III. Safety Design

A *Risk assessment*

The robot's safety should be considered in the first part of the V-model. It is necessary to do a risk assessment for this aim. ISO 12100 and ISO 14121 [4] and [5] define risk assessment as a fundamental part of machine safety design. Danger scenario consideration is critical in the risk assessment process. As a result, such standards detail the most common types of hazards, such as vibration and electric shorts. The physical helper robot, on the other hand, may have additional risks that were not previously considered because of the unique circumstances in which it is being used. For example, the danger of skin damage or overpower must be addressed since the robot must approach near to or touch the person.

TABLE I : EXAMPLE OF RISK ASSESSMENT (NON-WEARABLE TRANSFER ASSIST)

Hazardous conditions				Risk estimation		
Phases	Origin	Injury scenario	Potential conse-quences	Severity	Avoidability	Risk in-dex
Setting	Collision of sup-port bar	The support bar hits the head when inserting sheet under the care taker	Head injury	3	7	21
	Unnatural posture caused by over as-sist	The care taker is inclined owing to the difference of bar heights	Low back pain	2	7	14
Care	Hand pinch	The hand of the care taker was pinched between descend-ing support arm and bed	Bone fracture	4	8	32
	Over assist caused by error of limiter	The error of limiter makes height of arms unbalanced. The care taker drops from sheet	Head injury	3	8	24

As a result, the risk assessment was conducted for both the usual and virtual physical assistance robots in this guideline document Table I provides an illustration of risk assessment in action. For each robot in the series of instances of risk assessment, a list of typical dangers is provided. Consider the human's capacity to withstand a danger when determining the severity of that threat. As a result, the robustness of the human body is examined and put to the test in a variety of settings. Such a study's findings may be found in the accompanying paper.

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B Related standards

It is helpful to look at standards for similar machines while building the physical helper robot's safety features. However, surveying the standards of comparable items isn't something that the average maker can do. Thus, in this advice, the corresponding standards \swere examined. They are classified depending on the category of \shazard and kind of robot as indicated.

For example, the physical assistance robot must take into account risks common to all machines, such as mechanical, electrical, and electromagnetic danger. Physical helper robots, on the other hand, provide a distinct danger that is not covered by any of the relevant standards. As a result, this advice establishes new risk areas.

IV. Safety Validation

V-safety model's measures should be checked in the latter stages. Safety testing methodologies that were created for this purpose are discussed in this safety advice. Such validation techniques and human endurance are discussed in this work.

A Contact stress

The repeated friction and distortion of the skin tissue acting on the fixation section of the robot to the user causes the skin damage that is specific to the physical helper robot. This necessitates the development of a safety validation test technique. Use of pig skin, as depicted in Figure 3, is introduced in this safety recommendation. Detailed information on the testing procedure is provided in ISO 13482.

Bone fracture risk must also be taken into account. ISO 15066 [6] is a standard for determining the contact safety threshold, however it does not account for the intensity of the contact in proportion to the degree of contact stress. However, when the physical helper robot is in close proximity to the human, the stress that surpasses the ISO 15066 standard should be taken into consideration. Artificial bone and finite element modelling were used to evaluate the fracture risk of bone under various stress conditions.

B Posture

The caregiver's low back discomfort is the primary symptom. Exoskeletons, for example, are physical assistance robots designed to aid the user in lifting the caregiver. A physical helper robot's effectiveness or safety cannot be tested since there is no test technique or threshold.

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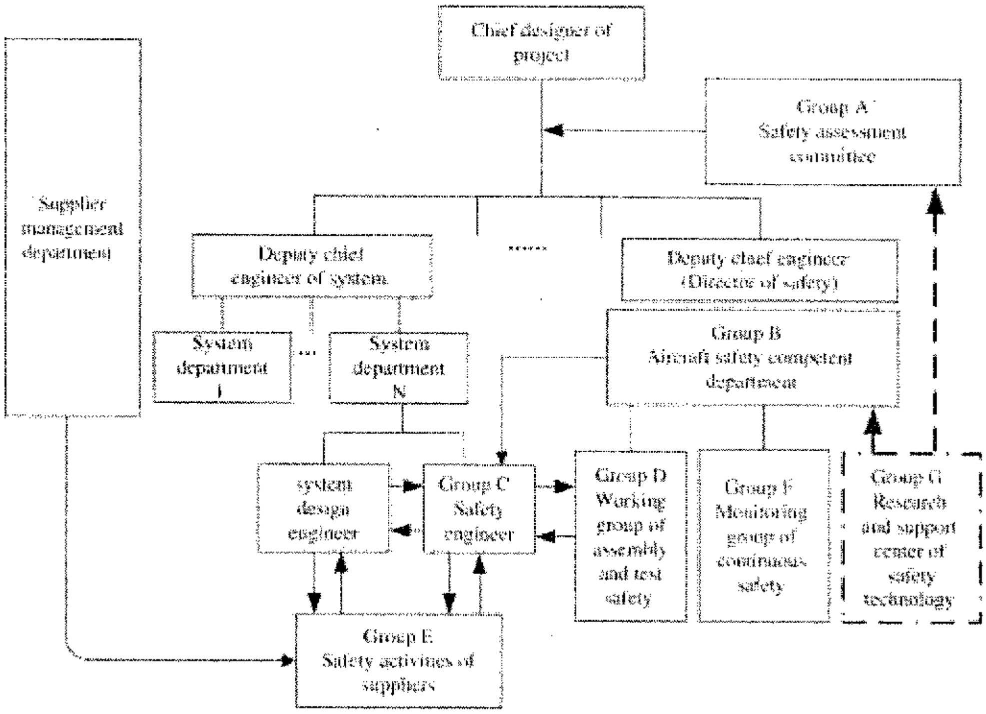

Figure. 3. Process of skin injury safety validation [1]

Due to the mechanism of low back pain, the compression stress acting on the lumbar spine may be used as a measure of pain. Previously documented compression strengths of the lumbar spine were gathered and grouped in this advice. Figure 4 depicts the lumbar spine fracture risk curve.

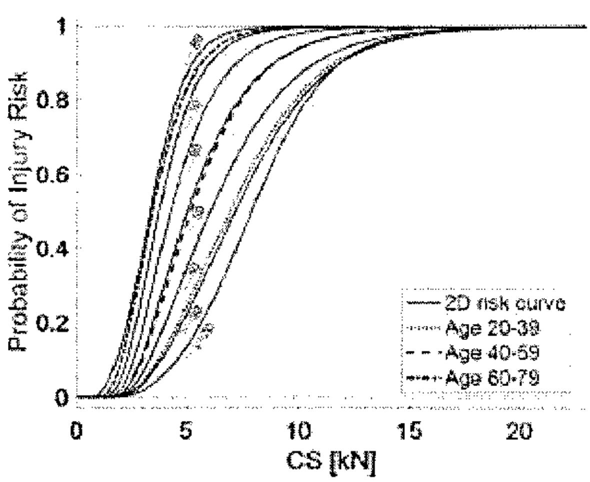

Figure. 4. Lumbar spine compression strength

V. Conclusions

The safety guideline document was published to aid the conventional robot firm in the development of the physical assistance robot. The "V-model," a development path from design idea to user test, was presented to increase the

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

safety and usefulness of the robot. In addition to mechanical, electric, and electromagnetic safety, this manual covers the issue of touch safety, which is specific to physical helper robots. We created a physical helper robot danger scenario, a human safety measure, and a safety validation test technique to help with this. As a result of this advice, it was recommended that users' biomechanical limitations be taken into account while creating a robot personal assistant.

References

[1] Peng, Z., & Huang, J. (2019). Soft rehabilitation and nursing-care robots: A review and future outlook. Applied Sciences, 9(15), 3102.

[2] Yasuhara, Y., Tanioka, T., Kai, Y., Tsujigami, Y., Uematsu, K., Dino, M. J. S., ... & Schoenhofer, S. O. (2020). Potential legal issues when caring healthcare robot with communication in caring functions are used for older adult care. Enfermeria Clinica, 30, 54-59.

[3] Mukai, T., Hirano, S., Nakashima, H., Kato, Y., Sakaida, Y., Guo, S., & Hosoe, S. (2010, October). Development of a nursing-care assistant robot RIBA that can lift a human in its arms. In 2010 IEEE/RSJ International Conference on Intelligent Robots and Systems (pp. 5996-6001). IEEE.

[4] Rothrock, J. C. (2018). Alexander's care of the patient in surgery-E-Book. Elsevier Health Sciences.

[5] Patton, J., Brown, D. A., Peshkin, M., Santos-Munné, J. J., Makhlin, A., Lewis, E., ... & Schwandt, D. (2008). KineAssist: design and development of a robotic overground gait and balance therapy device. Topics in stroke rehabilitation, 15(2), 131-139.

[6] Beyl, P., Knaepen, K., Duerinck, S., Van Damme, M., Vanderborght, B., Meeusen, R., & Lefeber, D. (2011). Safe and compliant guidance by a powered knee exoskeleton for robot-assisted rehabilitation of gait. Advanced Robotics, 25(5), 513-535.

[7] Servaty, R., Kersten, A., Brukamp, K., Möhler, R., & Mueller, M. (2020). Implementation of robotic devices in nursing care. Barriers and facilitators: an integrative review. BMJ open, 10(9), e038650.

[8] Ren, Y., Wu, Y. N., Yang, C. Y., Xu, T., Harvey, R. L., & Zhang, L. Q. (2016). Developing a wearable ankle rehabilitation robotic device for in-bed acute stroke rehabilitation. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 25(6), 589-596.

[9] Chu, C. Y., & Patterson, R. M. (2018). Soft robotic devices for hand rehabilitation and assistance: a narrative review. Journal of neuroengineering and rehabilitation, 15(1), 1-14.

[10] Somashekhar, S. P., Acharya, R., Manjiri, S., Talwar, S., Ashwin, K. R., & Rohit Kumar, C. (2021). Adaptations and safety modifications to perform safe minimal access surgery (Minimally invasive surgery: Laparoscopy and Robotic) during the COVID-19 pandemic. Surgical Innovation, 28(1), 123-133.

A 3D printing face protection shield design for nursing homes at COVID-19

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Abstract- the COVID-19 pandemic of 2020 is the subject of this research, which examines how it will affect Slovakia. Voluntary cooperation was prompted by the shortage of protective equipment provided by State Material Reserves. One thousand 3D face shields were printed in two months by our civic association Slovak Python User Group, while many others assisted by sewing face masks and printing 3D face shields for hospitals. During the last two months, we have optimised all of our 3D printers and 3D models in order to boost productivity. Patients at nursing homes around the country received all face shields.

Keywords- 3D printing; COVID-19; 3D face shield; Slovakia

I. INTRODUCTION

Coronavirus disease outbreak COVID-19 has become a global pandemic because of its rapid dissemination and high death rate [1]. More people are becoming ill with COVID-19's causal agent, acute respiratory syndrome coronavirus 2 (SARSCoV-2), which is spreading worldwide. Acute respiratory distress syndrome (ARDS) and multiple organ failure may occur in patients with COVID-19.

23 states in the United States have gathered statistics on the number of fatalities in nursing homes [2]. COVID-19 was shown to be responsible for 27% of all fatalities. This data shows that 50,000 people have died from COVID-19-caused fatalities through 23rd April 2020, which accounts for 11% of all coronavirus cases in 29 states. Over 50% of fatalities in nursing homes and long-term care facilities have been linked to COVID19 in Delaware, Massachusetts, Oregon, Pennsylvania, Utah, and Colorado. This shows that any nation that was badly impacted by COVID-19 may have experienced a similar predicament.

Of the 181,000,000 recorded COVID-19 cases, 166,000,000 individuals have recovered and approximately four million people have died [3]. [1]. Most fatalities occur in the United States, India, or Brazil. Slovakia ranked 54th out of 222 nations. Due to disparities in population, it is impossible to compare the absolute number of cases each nation. Slovakia ranks 11th out of 190 nations based on the total number of cases per one million people. According on the number of tests performed per one million people, Slovakia ranks 78th in the world with 545,297 tests.

At the beginning of spring in 2020, the first cases of coronavirus illness were reported.

[4] It resulted in a decrease in public transportation as well as the closure of businesses and educational institutions.

ISSN- 2394-5125 VOL 08, ISSUE 02,

Almost all public institutions, such as schools and nursing facilities, have moved away from a physical location to a virtual one. Many of them, on the other hand, were unprepared.

Because of the elderly population, nursing institutions were particularly vulnerable. First Slovak nursing home with proven COVID-19 instances was Nursing Home Pezinok, which opened its doors for patients in April 2020. (Domov v Pezinku). More than 60 senior citizens were tested, and 16 of them died as a result. There were also 27 people who tested positive, but none of them died as a result of the test. A crisis manager has taken over as director of the company.

A 15-year term is expected to be handed down to the current Chairman of State Material Reserves, who is presently serving a 15-year sentence in jail for managing bids for the procurement of medical items such as respirators [5]. He is accused of causing the state up to five million euros in harm and receiving bribes of 220 680.

II. THE SHIELD CALL

Founded in 2015, the SPy (Slovak Python User Group) aims to educate the public about the Python programming language, educational technologies, and open-source resources. In our opinion, [6]: PyCon SK and regular Bratislava Python meetups, the We Teach with Hardware project aimed at increasing digital skills, an EduSummit section at PyCon and the SPy Cup competition, and the Open Education community by publishing openly licenced materials and spreading awareness about open education among teachers are all examples of our efforts to serve the Python and education communities.We have to postpone PyCon 2020 as a result.

This was a terrible time, and we wanted to be a part of the solution. Although no instances of COVID-19 had been found in Slovakian nursing homes at the time, we had read about coronavirus cases in other countries, notably Spain. The death toll among the elderly was consistently high. In the following months, investigators made even more horrific findings, such as the discovery of two dozen murders at a single nursing home in Madrid. 24 people have been confirmed dead in a Madrid nursing facility that was cleaned by the army on Sunday, according to local media reports. The average age of the people who died in Spain was above 65 percent.

[7]. At the time, Slovakia had volunteers who printed 3D face shields, such as those from the Department of Informatics at Constantine The Philosopher University in Nitra or the Faculty of Management Science and Informatics at the University of [8, 9]. Many of the volunteers chose to work at medical facilities. We couldn't find anybody in Slovakia who helps nursing homes when we did a search. As a result, we have made the executive decision to begin producing 3D face shields for nursing homes right now! We had previously printed face shields for physicians at that point, and they provided us with great input on how to make the design even better.

To be clear, we did not endorse the use of a face shield in isolation. A face shield by itself does not provide enough protection, as has been shown in earlier studies. When compared to just donning face masks, however, wearing a face shield was shown to be more effective [10]. When caring for the elderly in nursing facilities, nurses are unable to maintain the necessary 2 metre social distance. Face shields may help minimise transmission, according to some physicians [11]. When a person sneezes or coughs, the face shield is designed to reduce the distance the aerosol travels, so reducing the danger of spreading the illness to people around. In addition, wearing a face shield may reduce the likelihood of the wearer touching his or her face with dirty, unwashed hands.

TABLE I SUITABILITY OF USING FACE SHIELD IN NURSING HOMES

ISSN- 2394-5125 VOL 08, ISSUE 02,

Attributes of face shield	Occurrence in nursing homes
Suitable as an additional stuff while wearing a face mask	Yes
Sneezing or coughing (large particles)	Yes
Touching relatively contaminated objects	Yes

In order to pay the cost of materials and provide face shields to nursing homes for free, we have sought for grant money in different grant programmes. Both the Orange and the Henkel grant programmes were awarded to us. For the first wave of the epidemic, we've opted to use a courier service to get the face shields out to as many people as possible while still keeping ourselves safe. Grant funds also covered the cost of courier services. Our goal of producing 500 face shields was finally accomplished.

With people from all around Slovakia, we wanted to be a resource for anybody in need, no matter where they lived inside the country. For lack of Slovak nursing facility contacts, we created a scraper in Python to collect data in the form of nursing home email addresses. Other national entities (such as municipal councils and regional governments) were also on our list because we believed they could know someone who might help us locate local nursing facilities.

How many personnel (nurses) were in each team?

How many seniors?

How many face shields were requested?

We couldn't foresee how many nursing facilities would respond to the questionnaire.

Every nursing facility was required to have a crisis team in place in case of an emergency. Isolated or COVID-19 seniors at a nursing home were cared for by a group of nurses. We got 93 forms with a total of 1841 face shield requests.

This country is also split into three primary areas based on location: Western (BA), Central (BB), and Eastern (PO). There were fewer applications and requests for face shields in Eastern Slovakia due to the fact that many nursing facilities lack websites or email addresses. A phone call was made to them, but the number of applications in Slovakia was still low in contrast. When compared to Western Slovakia or the Middle Slovakia, Eastern Slovakia is by far the most impoverished area.

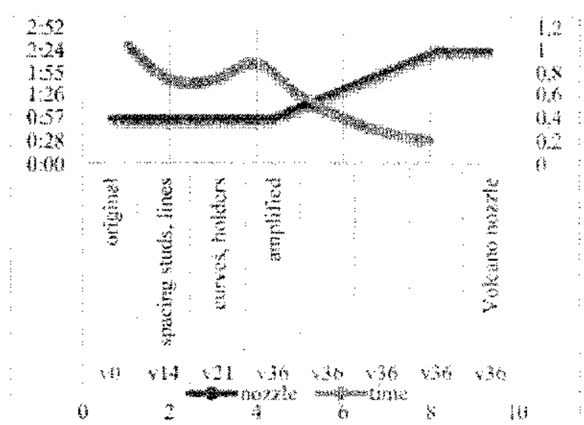

Figure 3 Face shield optimization

III. METHODOLOGY

In order to print and optimise our 3D printers for the Shield grant, we had to choose or design a model of a face shield.

ISSN- 2394-5125 VOL 08, ISSUE 02.

A. Modelling the Face Shield

Many of the models we looked at for printing didn't enable us to wear glasses or goggles with a face shield while we tested them on ourselves. First and foremost, there was this. Screwless models were very popular due to the ease with which they could be assembled.

In the beginning, we used Prusa RC2, which we eventually upgraded to RC3. It has fulfilled both of our requirements. Quality and speed of printing were two areas where we hoped to improve the product. We began by focusing on the product's quality. The side plastics of the Prusa model sometimes snapped and the studs were spaced irregularly. To accommodate the use of goggles, we shifted the front portion (which houses the studs) forward. After moving and increasing the portion where rubber is fitted, we also reworked the overall design. We designed a holder for the PET-G sheet's tail end. A new feature was the curvature of the side front, which connected to the rear. The primary portions of the front and rear were connected in more locations. In order to maintain the standard spacing, the studs were shifted. Finally, we came up with 36 alternative variations of the same design.

B. Prusa i3MK3

When the Prusa i3MK3 printer's printing speed was first increased, the nozzle size could be increased from 0.4 mm to 0.6 mm, then to 0.8 mm, and eventually to 1 mm.

Aside from expanding the breadth of the print, the larger nozzle also increased the height of one printed layer, which reduced the number of nozzle transitions required. Increases in printing speed were made feasible because to this change. (With a mainline print width of 2.4 mm, the number of transitions needed were as follows: - 6 transitions for 0.4 mm nozzle, - 4 transitions for 0.6 mm nozzle, - 3 transitions for 0.8 mm nozzle, - 2 transitions for 1 mm nozzle.)

Despite the fact that this adjustment doubled printing speed, the filament did not have enough time to overheat. Step skipping and printing errors were caused mostly by overheating the extruder's stepper motor. This necessitated the use of a separate fan to cool this engine. We were also able to raise the temperature of the nozzle to 250 degrees, but we ran into the limitations of the PTFE tube, which degrades and becomes hazardous at this temperature. We were able to aid in this instance by switching out the PTFE tube with PTFE Capricorn, which can withstand temperatures up to 300 degrees.

C. Creality ENDER-3-PRO

In light of the demand for face shields, we decided to purchase and customise an Ender 3 Pro 3D printer. Due to its low cost, additional changes were required; nevertheless, this printer also allowed for a greater amount of customization.

Although the Bowden tube approach proved unsuccessful, the whole extruder system was modified to the Direct Drive method for incredibly rapid printing. The slider mechanism, which used just one driving wheel to move the filament, was also found to be unreliable, resulting in filament jamming on a regular basis. We chose to employ the Bondtech BMG extruder system since it used two driving wheels to move the filament and also conveyed it in a 3:1 ratio (Fig. 4). It was also able to employ a less powerful stepper motor because of this gearbox. The ability to swap the X-axis and extruder motors was excellent in this case. With the Direct Drive technology, the extruder's weight and inertial forces have been lowered, but the X-axis motor power needed has risen. As the extruder weighed more, the Z-axis lift was moved to the right side of the gear wheel shift from the original stepper motor on the left, owing to the increased weight. Additionally, a substantial improvement was made to the design of the extruder stepper motor, which resulted in reduced wear on the guide carriage, as well as increased printing accuracy at higher speeds, compared to solutions published on the Internet.

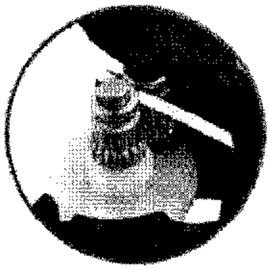

Figure 4 Bondtech BMG extruder system

E3D's hotend system, which is more widely used and has a greater choice of accessories, was also replaced with the BMG extruder.. Due to the increased temperatures, the Capricorn tube was utilised in this modification, as well as in the Prusa printer modification. Extruder stepper motor cooling was essential even in this situation. It turned out that switching to more dependable and even quieter Noctua fans was a good idea for fixing printer problems that cropped up when the printer was running continuously. Despite the fact that it had no effect on print speed, this source-side change made the office considerably more peaceful.

To boost print speed after making all of these modifications, inadequate nozzle heating time was the main stumbling block. The Volcano nozzle from E3D was able to be used with a heating cube because of a prior printer modification to the E3D system (Fig. 5). This adjustment allowed the filament to remain in the nozzle for a longer period of time, resulting in a better and quicker transmission of heat from the heating cube to the filament.

This change dramatically raised the filament heating rate limit and enabled for an even faster print speed to be achieved once it was made.

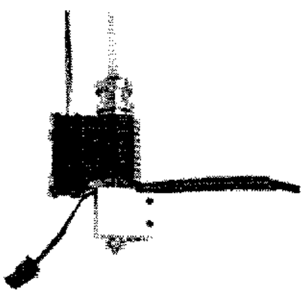

Figure 5 E3D Volcano

D. Constructing Face Shields

This is why we choose with PETG for printing a face shield - it offers a noteworthy tensile toughness, flexibility and good processability [12]. After that, we had to clean and warm up the surface so that the connections between the layers would be stronger. Foam cushioning for comfort was added and a perforated (adjustable) rubber band was connected to the shield after this step. Finally, we attached the Polycasa HIPEX PETG translucent shield. In spite of being twisted and bent, it remains robust and translucent. Even at lesser thicknesses, it possesses a high level of impact resistance.

IV. CONCLUSION

One thousand face shields were printed by the SPy civic organisation and distributed to nursing homes in Slovakia. We arranged a programme in which nursing homes filled out an application for a face shield requirement thanks to Slovenku and Accenture. With 93 applications and 1941 needed face shields, we were able to start the process.

Based on the Prusa RC2 face shield model, we were able to develop our own face shield model thanks to input from healthcare workers. We produced 36 different iterations, each with a different set of studs, stud spacing, Polycasa PETG holders, and the curves that joined the various components together. Prusa i3MK3 and Creality ENDER-3-Pro 3D printers were also fine-tuned for improved printing. We were able to manufacture an amplified face shield in 30 minutes thanks to model and printer optimizations. In the end, we distributed 1000 face shields to 93 care facilities.

References

[1] Lemarteleur, V., Fouquet, V., Le Goff, S., Tapie, L., Morenton, P., Benoit, A., ... & Dursun, E. (2021). 3D-printed protected face shields for health care workers in Covid-19 pandemic. American Journal of Infection Control, 49(3), 389-391.

[2] Lichtenberger, J. P., Tatum, P. S., Gada, S., Wyn, M., Ho, V. B., & Liacouras, P. (2018). Using 3D printing (additive manufacturing) to produce low-cost simulation models for medical training. Military medicine, 183(suppl_1), 73-77.

[3] Attaran, M. (2020). 3D printing role in filling the critical gap in the medical supply chain during COVID-19 pandemic. American Journal of Industrial and Business Management, 10(05), 988.

[4] Universities, U. K. (2020). How universities are helping fight Covid-19.

[5] Dutt, A., Khare, A., & Shukla, N. K. (2017). HOW TECHNOLOGY &NEW MEDICAL SYSTEM HELPS IN THE FIGHT AGAINST COVID-19 ERA. VINDHYA BHARTI.

[6] De Sio, L., Ding, B., Focsan, M., Kogermann, K., Pascoal-Faria, P., Petronela, F., ... & Pierini, F. (2021). Personalized Reusable Face Masks with Smart Nano-Assisted Destruction of Pathogens for COVID-19: A Visionary Road. Chemistry–A European Journal, 27(20), 6112-6130.

[7] Dalziel, B. D., Kissler, S., Gog, J. R., Viboud, C., Bjørnstad, O. N., Metcalf, C. J. E., & Grenfell, B. T. (2018). Urbanization and humidity shape the intensity of influenza epidemics in US cities. Science, 362(6410), 75-79.

[8] Anwari, V., Ng, W. C., Mbadjeu Hondjeu, A. R., Xiao, Z., Afenu, E., Trac, J., ... & Mashari, A. (2021). Development, manufacturing, and preliminary validation of a reusable half-face respirator during the COVID-19 pandemic. PloS one, 16(3), e0247575.

[9] Skowronski, D. M., Chambers, C., De Serres, G., Sabaiduc, S., Winter, A. L., Dickinson, J. A., ... & Smith, D. J. (2017). Serial vaccination and the antigenic distance hypothesis: effects on influenza vaccine effectiveness during A (H3N2) epidemics in Canada, 2010–2011 to 2014–2015. The Journal of infectious diseases, 215(7), 1059-1099.

[10] Achanta, A., Yang, H., Cramer, A. K., Freake, J., Sinha, M. S., Sherry, H. Y., ... & Sorger, P. K. (2022). A Crisis-Responsive Framework for Medical Device Development Applied to the COVID-19 Pandemic. Health Technologies and Innovations to Effectively Respond to the COVID-19 Pandemic.

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

Nursing Care Activity Identification Using Mutual Information with Feature Selection

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Abstract - Recognition of human activities is a tough undertaking since they vary greatly amongst individuals. Human activity may be detected using sensor data in numerous ways that have been developed in recent years. Several research have been carried out effectively to far in order to find basic activities and various commercial applications have also been created. Research is currently ongoing in the field of accurate identification of complicated actions. Nurse care activity data may be viewed as an activity recognition dataset with a high level of complexity. Spatio-temporal graph convolution and various custom characteristics have been suggested by researchers to detect nurse care activities. A few of these characteristics may actually detract from the classifier's performance because they are too noisy, redundant, or redundant. A feature selection approach is proposed in this research to identify the most essential aspects of the handmade characteristics. A basic classifier may perform well if the most significant characteristics are picked and noise is minimised, according to our assertion. To evaluate our suggested technique, we conducted experiments that found it to be 87% accurate in terms of accuracy and 87% accurate in terms of f1-score. These results are far better than previous techniques on this benchmark dataset, which supports the assertion we made before.

Index Terms—Activity Recognition, Nurse Care Activity, Mutual Information, Feature Selection.

I. Introduction

Recognition of human behaviour in computer vision, smart settings, and healthcare research is critical. Electronics (such as cellphones, sensors, and cameras) have grown so prevalent and advanced in recent years that human behaviour is now a hot topic of study. In fields including human-computer interface (HCI), health care, surveillance, and security, recent advances in automated human activity detection have opened up new possibilities [1], [2]. A person's daily routine may be better tracked with the help of human activity recognition.

External, wearable sensors [3] and computer vision-based approaches [4] may be used to detect activity. It is difficult to distinguish human activities because of their complexity and variety. Performing the same task in a different way by various people, changing the pace at which sensors gather data, or moving sensors are just a few examples [2]. To solve the difficulty of supervised categorization, researchers have used several machine learning and deep learning algorithms to extract features from sensor inputs and detect these behaviours [3]. There has been great development in this subject in the last decade thanks to the availability of trustworthy sensors and benchmark data. Simple actions (e.g., running, walking, and sitting) are easily recognised by existing models [6], [7]. These basic behaviours are recognised by a slew of commercial items.

Applications that seek to identify complicated tasks (such as cooking or nursing care) do less well than those that aim to recognise basic activities. One possible explanation is the absence of data that may be accessed by the general population. Nursing activities may be regarded difficult in the health care industry since the motions that go along with them are dependent not only on the nurses themselves but also on the patients' actions. When it comes to

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

healthcare, there are several uses for this nurse care activity recognition (such as nursing training, verifying compliance with care routines for a certain patient, creating automated documents). There is a benchmark dataset for nurse activity recognition in [8]. Deep learning and machine learning techniques have both been presented [9] to help solve this issue.

An technique that relies on the use of gated recurrent units was proposed by Haque and colleagues [10]. Here, [11] makes use of a spatio-temporal graph convolution approach. The strategy presented by Kadir et al. [12] involves collecting features from raw data, grouping the features manually, and then using basic machine learning models to learn these categories. According to them, it is possible to accurately classify complicated nurse tasks using this basic categorization method.

When it comes to recognizing an activity, we've found that not all of the characteristics used by the authors contribute equally to its accuracy. It's also a good idea to delete any aspects that aren't relevant, redundant, or just plain annoying throughout the categorization process. We suggest JMI as a feature selection approach to improve performance. This technique selects meaningful and non-redundant features using information-theoretic criteria and a Chi-Square (2) test-based filter strategy. The remaining sections of the document were arranged as follows. Section II discusses related works. Section III explains how the dataset on nursing care activities was compiled and includes additional information about the data gathering method. Section IV provides a quick primer on feature extraction. Section V explains how we went about choosing the features we wanted to include. Section VI explains the general method for recognising nurse activities. Section VII explains the experiments and the findings they produced. Section VIII is where the paper comes to a close.

II. Related Work

Vision-based techniques were the only ones that could recognise human activities at first. Template matching was employed in the early stages of human activity identification. The difficulty in dependably obtaining high-level human body representations is a fundamental drawback of such techniques. Optical flow features and local features, which address this issue, are becoming popular. Using a dynamic programming method, video sequences were recognized. Human activity was detected from video sequences in the previous systems, but the everyday life of a person was not well captured. Using wearable sensors to track everyday activities has become commonplace. First, the notion of utilising wearable sensors to track an individual's activities was developed in the context of home automation.

There are several ways to incorporate wearable sensors onto a user's clothing or body. Sensor information may be used to categorise human behaviours depending on the nature of the activity, according to a study. Accelerometer sensors, for example, are very useful in monitoring activities that involve repeated body monitoring, such as walking and running. Typical sensor data gathered from a user's movements and interactions with objects in ubiquitous and pervasive computing is noisy. Using a pre-process to turn the raw sensor data into features, a model is then trained to categorise the various actions. It is possible to categorise human activity recognition models into two major categories: logic-based and probabilistic. A series of first-order assertions is used to describe activities in logic-based techniques. The main drawback of such techniques is their sensitivity to noise. A probabilistic strategy is more suited for dealing with sensor data noise.

Probabilistic techniques categorise human actions in a non-deterministic way. Various characteristics are initially collected from the sensor data before employing probabilistic techniques. Models such as K-Nearest Neighbor (KNN), Decision Tree, and Support Vector Machine may be used to identify sequential activities in various locations, such as a restaurant, a library, or a museum, for example. Among the other methods used to identify human activity are hidden Markov models, dynamic belief networks, and conditional random fields. Research in this field has seen a rise in the use of deep learning techniques. Describes a neural network model based on self-awareness. In this model, recurrent architectures are utilized to learn higher dimensional feature representations to categorise activities by using various attention processes.

For the classification of six distinct nursing care tasks using deep learning, researchers have developed a gated recurrent unit with an attention mechanism [10]. It is possible to extract characteristics from location and mobility data using this strategy. Data overfitting and reduced classification accuracy in the test data are also problems with this strategy. For the same nursing care tasks, a spatial-temporal graph convolutional network was reported.

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

With a 10-second overlap, they break the data into 20-second chunks and use the spatial-temporal graph to analyze the 3D motion capture data. Finally, each segment's output is used to forecast the activity's label. Kadir et al. have retrieved some useful and suitable characteristics from location and motion capture data in order to detect the same nursing care actions. In this research, the authors provide an ensemble of KNNs for predicting the activity label based on the characteristics they collected into four distinct categories.

Authors classified the collected characteristics into four categories based on their own intuition, which makes this technique less generalizable. These constructed traits are also not examined to see whether they are essential for categorization. This is required since there may be traits that reduce categorization performance.

III. Dataset Overview

Recognition of nursing care activities The Smart Life Care Society Creation Unit at Kyutech, Japan, has recorded the dataset. A total of three days were needed to gather data from eight professional nurses. Desk, bed, and rolling cart were all part of the set up in the test room. Nurses were given drips, gauze, diapers, and other supplies they needed to carry out their duties as nurses throughout the data collection period. Measurement of vital signs, collection of blood, measurement of blood glucose, retention and connection of indwelling drip, oral care, and diaper replacement and cleaning of the region are all included in the dataset. Each exercise was repeated five times by eight nurses, resulting in a total of 40 samples.

As a result, 240 different activity patterns have been recorded. There are 60 second segments in each activity sequence.

Three sensors, including motion capture, location, and accelerometer sensor, were used to gather the data. The motion capture system uses 29 body markers situated in various regions of the body monitored by 16 infrared cameras to collect data. A sampling rate of 100 samples per second was used to capture tri-axial data. Bluetooth-based Meditag sensors were used to collect the location information. Each nurse's right breast pocket had been equipped with a Bluetooth beacon.

Four receivers, one for each axis of movement (x and y) and one for air pressure, had been installed in the lab to receive data from the beacon. The accelerometer sensor data is captured by a smartphone. To measure the triaxial (horizontal, forward, backward movement) acceleration in m=s2, it had been inserted in the right chest pocket of a nurse in the upright posture, with a data collecting rate of 4 Hz.

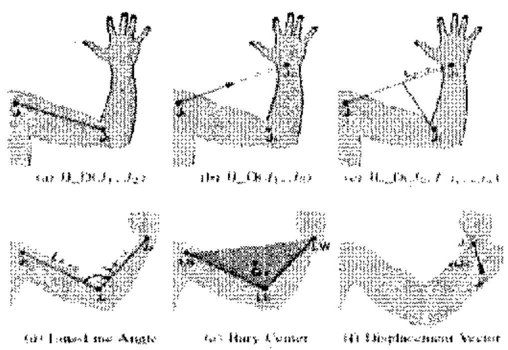


Figure. 1: Extracted features from different joints

IV. Feature Extraction

A person's activity is made up of a variety of little movements. The movement of bones, joints, and muscles may be used to identify these movements. The human motion system is comprised of skeletal muscle. From the human body, geometric characteristics (e.g. angles, positions and orientations) may be retrieved. It has been proposed in literature to extract geometric characteristics from various joints in the human body. The following sections discuss some of these geometric aspects.

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

1) Joint Coordinate (J C): J C(J1) represents the position of joint J1 in a 3D coordinate system.

2) Joint-Joint Distance (JJ D): The distance between joint J1 and J2 is represented by JJ D(J1; J2).

3) Joint-Joint Orientation (JJ O): JJ O(J1; J2) denotes the unit vector directed from J1 to J2.

The use of human kinematics and action aspects, in addition to geometrical ones, might be helpful when attempting to describe human movements. The action characteristics were extracted using a two-level hierarchical model. The activity of a human body is taken into account when extracting the first level characteristics (e.g. the action of the left hand as a unit). The action features are extracted from a barycenter in each unit. As an example, we may use Eq. (1) to get the barycenter of the left hand, and the 3D coordinates of its elbow, wrist, and shoulder can be found by plugging in the values for LE;LW;LS appropriately.

$$C_{LH} = \frac{LE + LW - 2 \times LS}{2} \qquad (1)$$

Range (R(CLH)), Mean (M(CLH)), Variance (V(CLH)), and Skewness (S(CLH)) are all calculated as first-level action characteristics from the barycenter of a unit (for example, the left hand).

Local relative offset distance (v(J)) on each axis is calculated using Eq. (2) where J C(J),t denotes the position of joint J at that time in the current frame. The second-level features are derived using this information.

$$\overrightarrow{v(J)} = J\_C(J)^{(t+1)} - J\_C(J)^{(t)} \qquad (2)$$

A greater amount of information regarding human mobility may be gleaned from sensor data if action and geometric aspects are retrieved.

V. Feature Selection

There are several characteristics collected from sensor signals that are used for activity recognition. Each activity has its own unique set of characteristics that must be considered. For example, when categorising activities such as walking, running, and swimming, action elements play a vital role, but similar qualities may not be relevant for other activities (e.g. sleeping, standing, sitting). When a classifier is trying to figure out what an object is doing, it might be thrown off by characteristics that aren't relevant. Feature selection is critical in this sense.

Algorithm 1: Feature Selection

Input : Set of features, F
Output: Selected subset of features, F_S

for $f_i \in F$ **do**
  Calculate MI for f_i with respect to C using Eq. (4)
end
$F \leftarrow$ Sort F in decreasing order based on their MI
$F_S \leftarrow f_1$
for $i = 2$ *to* $|F|$ **do**
  Calculate J_{JMI} for f_i using Eq. (3)
  if $J_{JMI} > \chi^2_{\alpha}$ **then**
    $F_S \leftarrow F_S \cup f_i$
  end
end
return F_S

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

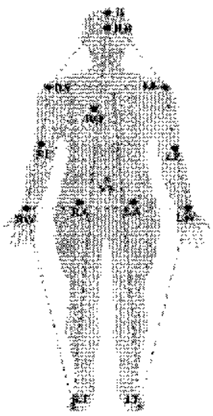


Figure. 2: Feature extraction body markers

Filtering approaches based on information theory have been presented to choose the best characteristics. Various criteria, such as correlation and mutual information (MI), have been used to pick a characteristic. The use of MI-based feature selection approaches is on the rise among these techniques. A method to feature selection based on Joint Mutual Information (JMI) has been given. On the basis of mutual information between the previously chosen characteristics and the class, JMI calculates a feature's relevance level. Eq. may be used to determine the relevance of a feature (fi) (3).

$$J_{JMI} = I(f_i; C) - \frac{1}{|S|} \sum_{f_j \epsilon F_S} I(f_i; f_j) + \frac{1}{|S|} \sum_{f_j \epsilon F_S} I(f_i; f_j|C) \quad (3)$$

where C stands for the class label, FS stands for the feature set picked, and I(X; Y) stands for the mutual information between X and Y, which may be expressed in the following way.

$$I(X;Y) = \sum_{y \in Y} \sum_{x \in X} P(x,y) \times \log \frac{P(x,y)}{P(x)P(y)} \qquad (4)$$

All features are ranked according to relevance, but no features are removed from the feature set. It is important to keep in mind that there are three concepts in Eq. that refer to relevance, redundancy, or complementarity (3). These three terms are distributed by the factor of two. We provide an automated threshold for determining if a feature is picked or not, inspired by that article. Eq. may be used to determine the critical value of 2c (g) when g = I(X; Y) follows the 2 distribution (5).

$$\chi_c^2(g) = 2N \ln(2) \times I(X;Y) \qquad (5)$$

In this case, N represents the total number of samples that were taken. In the same way, we may calculate the critical value of Eq. (3). Our suggested feature selection strategy, called JMI in Algorithm 1, is described in that algorithm. Line 8 of Algorithm 1 illustrates the process of selecting features by comparing each JJMI with its associated critical value (2c).

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

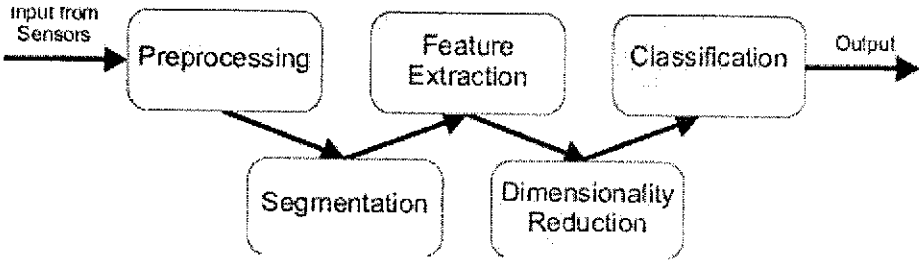


Figure. 3: Overall activity recognition method overview

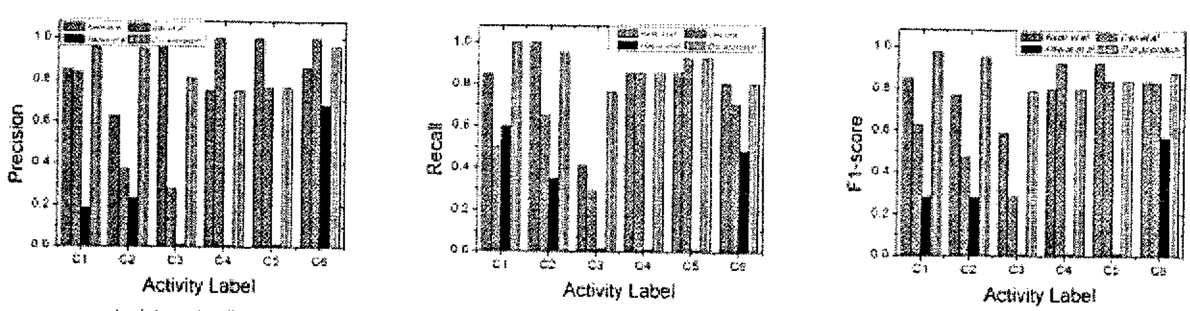
VI. Nurse Activity Recognition

Three kinds of sensor data were included in the nurse activity recognition dataset. Sensor readings are missing from this dataset. Simply interpolating the data is what has been done to get around this problem. The skeleton of a human being may be constructed from a single frame's worth of sensor data. An activity may be represented by a series of such frames arranged in a certain order. A 60-second segment is used to represent an activity in the given dataset. Each 60-second section is divided into 30 windows of 2 seconds each using the windowing method.

We extract sensor data characteristics after addressing missing values and use the windowing technique. We use motion capture and GPS data to derive elements that help us pinpoint nurse care tasks. A nurse's 2-dimensional position (x; y) and air pressure may be determined using location sensors. We extract a number of features for a window, including Mean position (Mean(x);Mean(y), SD(x);SD(y), Maximum (Mmax(x);Mmax(y), Minimum (Mmin(x);Mmin(y), Block ID where the nurse is staying in that window, Spatial and angular distance for x and y coordinates between first and last samples of a window, and Block ID. However, using just the information gleaned from location sensors is insufficient for identifying a particular action. Motion capture sensor data are used for this purpose.

These 29 body indicators were carefully reviewed when extracting features from motion capture data. As a result, the following 14 body markers are utilised: There are four joints in the human body: J1 is the head, which includes the front and back, J2 is the rear head, which includes the rear and front, and J3 is the right shoulder, which includes the right elbow, which includes the right wrist and the right wrist, and J4 is the left shoulder, which includes the left elbow, which includes the left wrist and the left wrist (LT). From these 14 critical body indicators, we choose 11 joints, 12 lines, and 3 planes for feature extraction that are useful for identifying nurse care tasks. Figure 2 depicts the selected joints and lines (indicated by an asterisk (*)).

11C2 = 55 joint-joint distances are calculated from the selected 11 joints. The joint-joint orientations for the same combination are also gathered. 12C2 = 66 line-to-line angles are taken from the selected 12 lines. A total of 132 lengths are derived by combining the joint-line distances of 11 joints and 12 lines. In order to get the most accurate information, we employ three planes: PJ3!J4; PJ6; and PJ2!J9!J12. These three planes are used to extract 33 joint-plane distances, which are used to extract action characteristics from each plane individually. All eleven joints have their displacement vectors extracted as well.



(a) Activity-wise Precision (b) Activity-wise Recall (c) Activity-wise F1-score

Figure. 4: Comparison of approach performance by activity

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

Our suggested feature selection method, JMI, is used to focus on the most significant attributes and reject the rest. We execute equal-width discretization for all features while applying JMI. This probability vector Q(i) = [P(i) C1 P(i) C2 :::] P(i) C6] for the ith window of an activity segment is obtained by applying KNN to our features. A continuous series of some windows, we eventually combine the outcomes of all windows constituting an activity segment and forecast the activity label using Eq. (6), where C is the window size for an activity segment.

$$Y' = arg \max_{C_j \in C} \sum_{i=1}^{m} P_{C_j}^{(i)} \qquad (6)$$

VII. Experimental Results

In this part, we compare and contrast our suggested strategy to existing ways and show and discuss the experimental findings.

Six nurses recorded their train activities, while two additional nurses recorded their test activities for the data in the dataset. Models are built using the training data and their classification accuracy is measured using test data. In this experimental set-up, we choose K = 10 since KNN is used in our suggested technique.

Overall accuracy and f1-scores are shown in Table I. Table I shows that our suggested method surpasses other methods in terms of overall accuracy and f1-score. Table I additionally shows that our suggested method's overall accuracy and f1-score are 87.93% and 87.97%, respectively. Even with the same set of features, our suggested strategy beats the method given in [12]. This is due to the correct selection of features and the incorrect reduction of features. We even outperform the ensemble of KNNs in [12] with only a single KNN.

TABLE I: Comparison among different approaches in terms of overall accuracy and f1-score

Method	Accuracy(%)	F1-score(%)
Kadir et al. [12]	80.17	79.53
Cao et al. [11]	64.66	66.56
Haque et al. [10]	29.31	24.88
Our approach	87.93	87.97

Figures 4a and 4b, which exhibit the activity-based precision and recall, were generated similarly. Although our suggested strategy delivers an acceptable precision score for all activities, it performs better in terms of accuracy for activity C1 and C2 than other approaches. As can be shown in Fig. 4b, our technique has a respectable performance in terms of activity-wise recall.

We also compute the f1-score for each action in addition to accuracy and recall. Precision and recall measurements are averaged geometrically to provide the F1 score. For an unbalanced dataset, this statistic is critical. Figure 4c shows the activity-wise f1-score of several techniques.

Table II shows the confusion matrix, which helps illustrate how well our strategy performs. Table II shows that the technique we suggest effectively classifies almost all activities. Our technique becomes muddled while trying to figure out what C3 and C6 are. A few C3 activity segments have been recognised as C4, whereas a few C6 activity segments have been anticipated to be C5. It's possible that this is due to the motions of activity groups (such as C5 and C6) being almost identical. However, this is still a significant and commendable effort.

TABLE II: Confusion matrix of our proposed approach

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

		Predicted Label					
		C_1	C_2	C_3	C_4	C_5	C_6
Actual Label	C_1	20	0	0	0	0	0
	C_2	0	19	1	0	0	0
	C_3	0	0	13	4	0	0
	C_4	0	0	1	12	0	1
	C_5	0	1	0	0	13	0
	C_6	1	0	1	0	4	25

VIII. Conclusion

In this research, we provide a feature selection technique based on mutual information. This research also presents a feature selection technique for activity identification. We use sensor data to extract a large number of characteristics and choose the most significant ones. We then use a basic classifier (KNN) to identify complicated nursing actions.. The performance of nurse activity recognition is enhanced by using the KNN algorithm, followed by feature selection. It is our goal to expand our suggested technique to more complicated tasks in the future by using this future selection process.

References

[1] Haque, M. N., Mahbub, M., Tarek, M. H., Lota, L. N., & Ali, A. A. (2019, September). Nurse Care Activity Recognition: A GRU-based approach with attention mechanism. In Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers (pp. 719-723).

[2] Faisal, M. A. A., Siraj, M. S., Abdullah, M. T., Shahid, O., Abir, F. F., & Ahad, M. A. R. (2020, September). A pragmatic signal processing approach for nurse care activity recognition using classical machine learning. In Adjunct Proceedings of the 2020 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2020 ACM International Symposium on Wearable Computers (pp. 396-401).

[3] Bulling, A., Blanke, U., & Schiele, B. (2014). A tutorial on human activity recognition using body-worn inertial sensors. ACM Computing Surveys (CSUR), 46(3), 1-33.

[4] Kadir, M. E., Akash, P. S., Sharmin, S., Ali, A. A., & Shoyaib, M. (2019, September). Can a simple approach identify complex nurse care activity?. In Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers (pp. 736-740).

[5] Alia, S. S., Adachi, K., Hossain, T., Le, N. T., Kaneko, H., Lago, P., ... & Inoue, S. (2021, September). Summary of the Third Nurse Care Activity Recognition Challenge-Can We Do from the Field Data?. In Adjunct Proceedings of the 2021 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2021 ACM International Symposium on Wearable Computers (pp. 428-433).

[6] Ambu Saidi, M. A. S. (2015). Feature selection using mutual information in network intrusion detection system (Doctoral dissertation).

[7] Maheshwar Reddy, V., Ravi Prakash Reddy, I., & Adi Narayana Reddy, K. (2019). Mutual Information-Based Intrusion Detection System Using Multilayer Neural Network. In First International Conference on Artificial Intelligence and Cognitive Computing (pp. 529-537). Springer, Singapore.

[8] Hosseini, R. (2018). Proposing a Sparse Weighted Directed Network Construction Method and a Novel Mutual-Information based Sparse Feature Selection Algorithm for Multivariate Time-series Analysis and Its Application in Medical Diagnostic Problems (Doctoral dissertation, The University of Texas at Arlington).

[9] Ahad, M. A. R., Antar, A. D., & Ahmed, M. (2020). IoT sensor-based activity recognition. IoT Sensor-based Activity Recognition. Springer.

ISSN:0975-3583,0976-2833 VOL12, ISSUE07,2021

[10] Ghojogh, B., Samad, M. N., Mashhadi, S. A., Kapoor, T., Ali, W., Karray, F., & Crowley, M. (2019). Feature selection and feature extraction in pattern analysis: A literature review. arXiv preprint arXiv:1905.02845.

[11] Wang, Z., Yang, Z., & Dong, T. (2017). A review of wearable technologies for elderly care that can accurately track indoor position, recognize physical activities and monitor vital signs in real time. Sensors, 17(2), 341.

[12] Nanda, M. (2014). FETAL ECG ANALYSIS BY REDUCTION OF MUTUAL INFORMATION. International Journal of Research, 2(1).

Vol. 24, No. 01, 2018
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2018.24.01.009

Clinical Nursing Risk Assessment and Early Warning System based on Support Vector Machine

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Abstract—Clinical nursing entails several hazards. When the early warning system is really functioning, the threshold that the system sets for assessment is too imprecise, resulting in an excessively lengthy reaction time. Support vector machine-powered clinical nursing is aimed to address this problem. An early warning system and risk assessment. Combine the requirements of the early warning system, design the hardware connection circuit, use the C/S network architecture to obtain clinical care risk data, calculate the clinical care risk value, use support vector machines to set different levels of early warning thresholds, and finally design the risk evaluation signal formation hardware. The system's design has been completed. To conduct experiments, two risk assessment and early warning systems, as well as an experimental system, are employed. The planned early warning system has the fastest reaction time, according to the findings.
Keywords—*Support vector machine; Clinical nursing; Riskassessment;Early warning(keywords).*

I. INTRODUCTION

Researchers have studied the risk factors for UEX in ICU patients over the last several years and have categorised them into the following: patients, catheters, medical treatment, management and the environment. " Self-extubation by patients is the most common cause of UEX, accounting for 50% to 100% of all UEX instances. UEX is triggered by a person's inability to calm down. ICU patients' emotional state, comfort level, and illness circumstances also have a significant role in UEX's incidence. Current study findings are inconsistent, and no conclusions can be drawn. The majority of the UEX risk variables are based on retrospective study or summaries of academics' experience, thus the findings of the analysis and the real situation are congruent and reliable. There is a certain difference [11], and there is no uniform standard of

Vol. 24, No. 01, 2018
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2018.24.01.009

UEX risk assessment index system for ICU patients, thus it is required to develop a scientific, objective and specific UEX risk assessment index system for ICU patients.

Preventing injury without prior knowledge or preparation is the goal of early warning, which involves implementing dynamic monitoring during an activity and making real-time assessments and predictions about harmful occurrences. Research objects serve as the basis for an early warning system that gathers relevant data and information and keeps tabs on risk indicators to detect harmful situations before they arise. This system then sends warning signals to those who can make decisions so that preventative steps may be taken. When it comes to responsiveness and responsiveness, the system excels [2-3]. When compared to China's early warning information system, other nations' early warning information management began sooner. Nursing risk early warning systems in the United States and Great Britain are considered to be among the most effective in the world because of their extensive experience with risk early warning systems in other high-risk sectors. Many nations in the 1970s created early warning systems for nursing risk management. These systems included early warning systems for infusion safety, early warning systems for nursing professional risk management and early warning systems for assessing nursing risk. Medical order data extraction, adjuvant medicine and integrated health education are all examples of advanced clinical early warning systems in industrialised nations. Nursing information was first used in China in the late 1980s, and nurse workstation systems were implemented in the 1990s, resulting in continued growth. A number of pioneering and exploratory studies on the building of hospital nursing informatization have since been conducted.

II. RISK ASSESSMENT AND EARLY WARNING HARDWAREDESIGN

A. Hardwaredesignofrisksignalformation

According to the signal flow of the clinical care riskinformation chain, the information storage hardware adopts89C51 single-chip microcomputer, 74HC573 latch, memoryandclockchip.Thecircuitdiagramoftheinformationstoragemoduleis shown in the figurebelow:

Vol. 24, No. 01, 2018
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2018.24.01.009

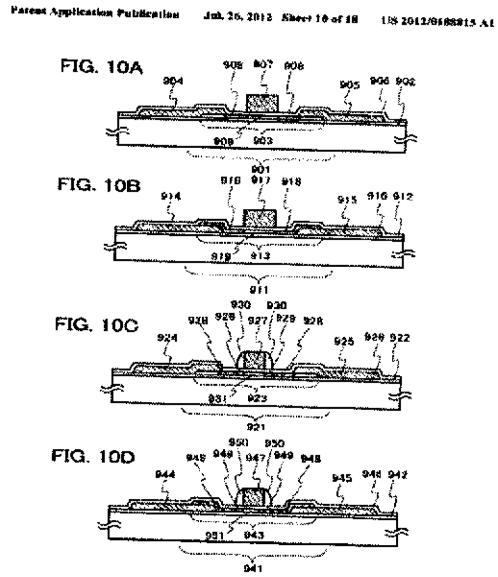

Fig.1. Signal storage hardware schematic

The information storage hardware uses an 89C51 single-chip microcomputer, 74HC573 latch, memory and clock chip, in accordance with the clinical care risk information chain's signal flow. The information storage module's circuit diagram is given in the following figure:
It is clear from the hardware circuit diagram given above that the single-chip microcomputer's external data line is linked to the address line bus in order to implement the dual transmission of scheduling address and scheduling instruction data owing to the constraint of the number of pins employed. The address bus is paralleled with the latch and the latch clock period is set to 5.0 s to guarantee that the scheduling information is effective in various situations.. Continuous input from an effectiveness assessment information source may be managed by a latch control output grounded to maintain constant output state of the latch. A microcontroller's 8-bit data line connects to the data line of the memory to retain the effective position of the geological line at various places. An inverter may be used for connection to the memory's CS terminal, and using the CS signal as the signal source, control a single-chip microcomputer to be in a high-level condition to verify that the memory is being properly stored. The clock chip is operated at a low level to boost the chip's rapid read-write function in order to achieve real-time interchange between single-chip microcomputer and clock chip.
Switch 2 is switched on in the image above, indicating that the formation circuit is in transmission mode and the related information link transmission channels 1 and 2 are disconnected. The level converter then travels via the serial port. The evaluation signal output circuit is switched on, the relay is closed, and pins 1 and 2 produce high potentials when connected to the evaluation system processor.

B. Connection circuit design

Accordingtothehardwarerequirementsoftheevaluationearlywarningsystem,atwo-stagemethodisused to design an amplification gate. The gate has a built-indual operational

Vol. 24, No. 01, 2018
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2018.24.01.009

amplifier and a low-noise amplifier. Thebandwidth of the dual operational amplifier is set to 30MHz.Eachamplifierisconstantlydebugged,andtheamplification factor of the first-stage amplifier circuit iscontrolledtobe10.Theconnectioncircuitoftheamplifierisshownin thefollowingfigure:

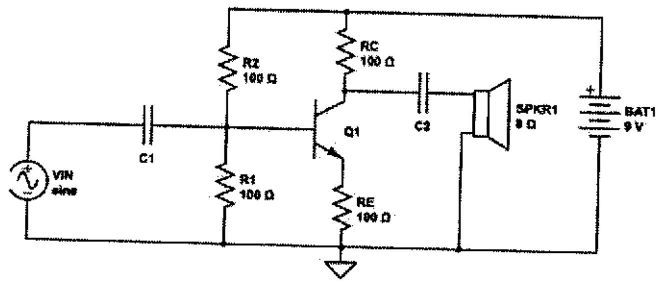

Fig.2. Amplifiercircuit

The evaluation early warning system's amplification gate was designed using a two-stage process, which was dictated by the system's hardware limitations. Dual operational amplifiers and a low-noise amplifier are incorporated within the gate. The dual operating amplifier's bandwidth has been set to 30MHz. One of the most important aspects of the first-stage amplifier circuit is that the amplification factor is set at 10. The following diagram depicts the amplifier's wiring:

Pin 3 of the control dual operational amplifier is connected to pin 5 in the amplifier circuit described above to enhance the amplifier's gain. To prevent amplifier damage from transiently high power, a 5.5 fine resistor is attached to Pin 7. A gating circuit structure with a built-in four-channel two-way switch is employed to limit the interference of the effectiveness assessment system, and a wave gate setting circuit is constructed. The information link signal controls the circuit gating, and control pins 1 and 2 are shorted. A single-chip timer is then connected.

III. RISK ASSESSMENT AND EARLY WARNING SOFTWARE DESIGN

A. Calculationof clinicalnursingrisk value

When the clinical nursing event is poised to undergo a qualitative shift, the monitoring mechanism begins to act. A dynamic game may be used to establish acceptable thresholds for other emergency mechanisms in the following stage and prepare for the continuing development of an event by monitoring the event and using the necessary information gathered [10-11]. A two-tier C/S architecture is employed to communicate with the clinical data monitoring centre during risk detection. The data monitoring centre now operates in two distinct modes. The ZigBee WiFi gateway may be linked to the data monitoring centre as a client, and the data monitoring centre and the ZigBee WiFi gateway can interact with each other to collect and store clinical risk data.

Based on the wireless sensor network's clinical nursing risk assessment data, the application calculates the evaluation coefficient. Client gathers risk data set X based on received assessment data using the architecture described in the figure above, builds a risk analysis model using a risk

Vol. 24, No. 01, 2018
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2018.24.01.009

matrix and generates a risk matrix for security incidents in which risks lead to different security events. Assign 16 to each of the six possible degrees of probability and effect. This method may be used to calculate risk in a security risk matrix by multiplying the likelihood and impact degree of different security events by the risk's quantitative value:

$$F = \frac{X}{g \times h} \quad (1)$$

Among them, F represents the risk's value, g represents the risk's potential to cause different safety events, and h represents the risk's degree of effect on the likelihood that various incidents of safety will occur. After doing a risk assessment, the following are the results:

Table 1 SECURITY RISK LEVEL

SYSTEM: Research Data Server with HIPAA-protected data			
Threat Event	Likelihood	Impact	Risk Level
1. Loss of Confidentiality	Likely	Severe	HIGH
2. Loss of Integrity	Possible	Significant	MODERATE
3. Loss of Availability	Unlikely	Minor	LOW
		OVERALL RISK:	HIGH

IV. SIMULATION EXPERIMENT

A. Experiment preparation

As stated in the table below, you should set up your system's operating environment using the software and hardware setup described there.

Table 2TEST ENVIRONMENT DATA

Tap	Channel A		Channel B		Doppler
	Relative Delay (ns)	Average Power (dB)	Relative Delay (ns)	Average Power (dB)	Spectrum
1	0	0.0	0	−2.5	Classic
2	310	−1.0	300	0	Classic
3	710	−9.0	8900	−12.8	Classic
4	1090	−10.0	12,900	−10.0	Classic
5	1730	−15.0	17,100	−25.2	Classic
6	2510	−20.0	20,000	−16.0	Classic

NLB has been chosen for network deployment to assist the clinical nursing risk assessment and early warning system, as depicted in the accompanying diagram:.

Vol. 24, No. 01, 2018
P-ISSN: 2204-1990; E-ISSN: 1323-6903
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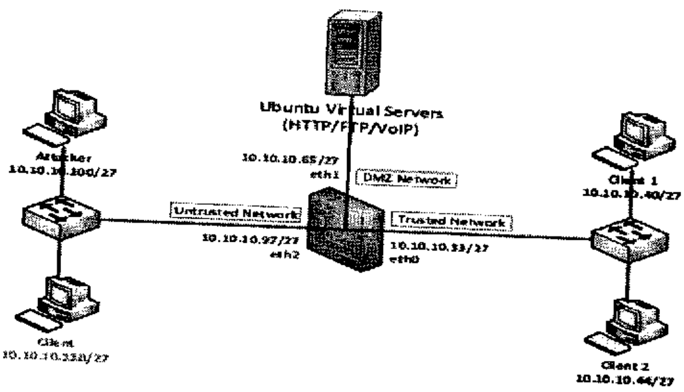

Fig.3. Network topology test

NLB has been chosen for network deployment to assist the clinical nursing risk assessment and early warning system, as depicted in the accompanying diagram:.

B. Experimental results and analysis

These three early warning systems all had lengthier reaction times than one another at various degrees of danger for a single early warning operation, as can be seen from the above table, which compares the three systems' responses to the same alert operation. The reaction time is the longest when the conventional nurse risk early warning system 1 has a danger rating of 4, clocking in at 6.1 seconds. It takes the longest time to respond to early warning instructions when all danger levels are taken into account (on average 5.1s). In terms of reaction time, the conventional nurse risk assessment and early warning system 2 is the worst at risk level 1. The average reaction time to early warning activities in the whole early warning process is roughly 3.7 seconds, which is a comparatively low response time. The reaction time of the article's nursing risk early warning system is the longest at risk level 5, and the average response time for all operations is roughly 1.4s. The risk assessment early warning system described in the article is superior than the two classic risk assessment early warning methods. Early warning operations have the shortest reaction times, making this system ideal for use in clinical care risk assessments and early warning.

The typical early warning system 1 has a throughput rate of around 100 kggs / s at various times, according to the experimental findings of the aforesaid warning system, and the rate value is tiny. A shift in the tiny rate value's direction occurs at around 1.0 s, which is too late to improve the early warning risk level. It is impractical to do an assessment based on data that is both more extensive and more complex. Traditional early warning system 2 has a variable throughput rate at various periods. Average throughput is 150ks per second. Large fluctuations in the system's throughput rate will lead to instability and jamming during assessment and early warning. There are around 350ks/s of throughput in the risk assessment and early warning system described in the article. In the real application process, there is a considerable value rate shift in the direction of improved early warning and assessment of clinical care documents with more data and more practicality.

V. CONCLUSION

Vol. 24, No. 01, 2018
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2018.24.01.009

Patients, medical treatment, organisation and administration, and equipment all play a role in ensuring patient safety. To ensure patient safety, researchers have shown that the use of early warning systems and early warning information may enhance early warning and quick reaction, as well as save money. Patients' nursing risks may be discovered in a timely way thanks to the use of human and material resources, enabling medical staff to "know, inform, and avoid" these risks, which is to say, "know."

Acknowledgment

Conflicts of Interest: The authors declare no conflict of interest.

Funding: The authors receive no funding for this work

Ethical approval: This paper has not submitted to anywhere and published anywhere. It doesnot contain any studies with human participants or animals performed by any one ofthe authors

REFERENCES

[1] Yang, B., Gong, R., Wang, L., & Yang, S. (2020). Support vector machine in image recognition of nursing methods for critically ill blood purification. Microprocessors and Microsystems, 103398.

[2] Diker, A., Cömert, Z., Avci, E., &Velappan, S. (2018, May). Intelligent system based on Genetic Algorithm and support vector machine for detection of myocardial infarction from ECG signals. In 2018 26th Signal Processing and Communications Applications Conference (SIU) (pp. 1-4). Ieee.

[3] Xiong, J., Li, J., Cheng, W., Wang, N., & Guo, L. (2019). A GIS-based support vector machine model for flash flood vulnerability assessment and mapping in China. ISPRS International Journal of Geo-Information, 8(7), 297.

[4] Anton, N., Dragoi, E. N., Tarcoveanu, F., Ciuntu, R. E., Lisa, C., Curteanu, S., ... &Bogdănici, C. M. (2021). Assessing changes in diabetic retinopathy caused by diabetes mellitus and glaucoma using support vector machines in combination with differential evolution algorithm. Applied Sciences, 11(9), 3944.

[5] Prabakaran, G., Vaithiyanathan, D., & Ganesan, M. (2021). FPGA based effective agriculture productivity prediction system using fuzzy support vector machine. Mathematics and Computers in Simulation, 185, 1-16.

[6] Czabanski, R., Horoba, K., Wrobel, J., Matonia, A., Martinek, R., Kupka, T., ... &Leski, J. M. (2020). Detection of atrial fibrillation episodes in long-term heart rhythm signals using a support vector machine. Sensors, 20(3), 765.

[7] Mahdavi, M., Choubdar, H., Zabeh, E., Rieder, M., Safavi-Naeini, S., Jobbagy, Z., ... &Kamrani, E. (2021). A machine learning based exploration of COVID-19 mortality risk. Plos one, 16(7), e0252384.

[8] Shams, M. Y., Elzeki, O. M., Abd Elfattah, M., Abouelmagd, L. M., Darwish, A.,

Vol. 24, No. 01, 2018
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2018.24.01.009

&Hassanien, A. E. (2021, March). Impact of COVID-19 Pandemic on Diet Prediction and Patient Health Based on Support Vector Machine. In International Conference on Advanced Machine Learning Technologies and Applications (pp. 64-76). Springer, Cham.

JOURNAL OF CRITICAL REVIEWS

ISSN- 2394-5125 VOL 09, ISSUE 02,

A Real time Nursing Care Assistance in Intelligent Space using Task Activity Recognition

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Abstract - There is a lack of careers in Japan because of the rising ageing of the population. Thus, the itch has become a serious societal concern. "Information and communication technology (ICT) solutions have been developed in response to this to aid caretakers. Because of this, there are only so many tasks that can be supported. Caregivers must also devise a nursing strategy that takes into account the diverse health conditions of those they are caring for. This necessitates highly trained careers, which in turn raises the cognitive strain on them. Our goal in this project is to develop an assistance technology that will lessen carers' cognitive load and boost their productivity. For the most part, we use the iSpace (intelligent Space) idea to implement help that is based on observations made by caregivers and recipients of that help. The first step is to identify the current state of a task. Task activity recognition is the topic of this research. We believe that the tasks performed by nursing home staff are closely linked to their physical locations. To this end, we've devised an approach that uses a caregiver's current location and orientation in relation to predefined workspaces to estimate their current job activity. In addition, the prospective workspaces should be automatically extracted to broaden the applicability of this technique. In addition, we offer a technique to extract caregiver workspaces based on hierarchical clustering of caregiver movement trajectories. Experiments have shown that the caregiver's job activity may be reliably detected, as well as the possible workspace of the caregiver.

I. INTRODUCTION

In the developed world, an ageing population has emerged as a major social issue in recent years. This is due to the fact that as living standards and medical technology have improved, so has life expectancy and the ageing process. As one of the world's most developed nations, Japan has been dubbed a "super-aging society." This equates to a 65+ population of at least one in four people, or 27.7% of the total population. Elderly people over the age of 65 are expected to make up about 40% of the population by 2065 [1].

As the number of people over the age of 65 continues to rise, so does the need for elder health care. A chronic shortage of caregivers plagues the country's more than 45,000 facilities dedicated to caring for the elderly. With so many elderly people living in the facility, there's a lot of work to be done, including caring for each one's individual needs, cleaning, and completing daily reports. To put it another way, as a result, many caregivers experience stress as a result of working conditions and interpersonal relationships [2]. In addition, caregivers are under a lot of pressure because of the amount of work they have to do.

Research on information and communication technology (ICT) systems has been performed in an effort to ameliorate this situation. Several ICT systems utilise cameras and wearable sensors to monitor the behaviour of old people and identify accidents and odd circumstances, which helps reduce senior mishaps such as falls [3] [4]. The results of these earlier research, however, only apply to a small subset of activities and cannot be generalised to cover a broader variety of tasks. Therefore, it is not a basic answer to concerns such as a growth in the amount of duties that a caregiver is expected to do.

Nursing responsibilities must be arranged in accordance with the needs of patients in different stages of health. As a result, the cognitive strain on caretakers is increased. As a result, a system is required to assist caretakers with a variety of activities.

In this research, we want to develop a system that will ease the cognitive load on caregivers while also increasing the effectiveness of nursing care. Consequently, we concentrated on the intelligent space (iSpace) [5] (Fig. 1) notion. Human actions are supported by sensors and actuators dispersed throughout the iSpace. Information in the area may be measured using sensors like cameras, laser sensors, RFID tags, and actuators like displays and mobile robots [6] [7]. Robots are anticipated to offer knowledge and physical assistance to carers and care receivers in accordance with their current conditions. Caregiver productivity is projected to increase as a result of this.

Task recognition is necessary for the implementation of such a system.

Caregiver tasks may be described as a series of acts relating to the job at hand. As an example, a caregiver may aid in moving a patient from a bed to a wheelchair by doing such things as holding the patient in their arms, shifting them from the bed to the wheelchair, and then releasing them from the wheelchair again. A task activity and a task action are defined in this article as a complete task and a specific task action, respectively.

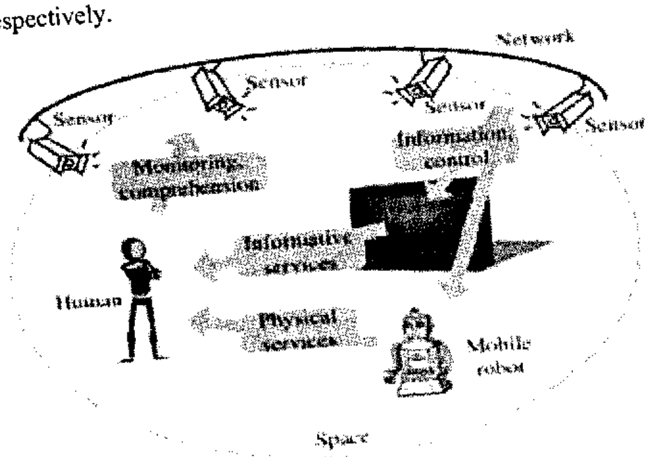

Figure 1. Intelligent Space Design [5]

A number of experiments have shown that deep learning can accurately identify human behaviours [10] [11]. There are a few issues with applying these strategies to support systems in this case. Individual variations in physique and task skill may affect the efficacy of these strategies. Furthermore, these systems are unable to execute real-time support operations because of their high processing costs. An appropriate task activity recognition approach for caregiver support systems is thus required..

In this case, we're going to suppose that the tasks performed by the caregiver are tied to a specific location in the care facility. Based on how the caregiver's position and orientation are defined in advance, we propose an algorithm to determine the caregiver's task activity based on their position and orientation. A spatial memory system is introduced in the iSpace platform to describe and identify task activity in an actual environment.

Adding automatic extraction of potential workspaces would broaden the applicability of this strategy. In order to deal with this, we also propose an approach based on the hierarchical clustering of the movement trajectories of caregivers to extract the potential workspaces of caregivers. We test the efficacy of all of the approaches we've come up with.

The following is the outline for this document. A caregiver's task activity is determined depending on his or her location and orientation in section II. Using hierarchical clustering of caregivers' movement trajectories, we describe an approach to extracting potential workspaces in section III. Our suggested methodologies were tested in parts IV and V. In Section VI, the findings of this research are summarized.

II. SPATIAL MEMORY

A *Overview of Spatial Memory*

Caregivers should be able to use the care support system's ability to understand their current task status and deliver support activities tailored to their requirements. For this reason, we used a spatial memory as the care support system.

Users may control a variety of digital information and networked devices via a single interface provided by a spatial memory. In order to handle digital information in real-world context, the system associates the information with a 3D location.

By moving their bodies, users may indicate their location in real time to access digital information. To put it another way, the spatial memory allows users to physically interact with digital information or transmit orders to different devices by moving their bodies. In this way, a spatial memory is likewise considered a cyber-physical system. The activity record of users in the environments is recognised as an access log for the spatial memory.

Spatial-Knowledge-Tag is the term given to digital information stored in the spatial memory (SKT). Space-related data may be stored in an SKT. The user's movement is recognised by the spatial memory, which then delivers information about the space when the user touches an SKT.

For the purpose of supporting human activities, numerous facilities (such as retail shops and parts assembly factories) have been used in research on the spatial memory system [13][14]. Sales and productivity have been improved as a result of using spatial memory systems. As a result, the use of the system is anticipated to lessen carers' cognitive load and enhance the effectiveness of their job.

As seen in Fig. 2, the spatial memory is used in this investigation. The positional link between the SKT and the caregiver is used to identify the caregiver's task activity. An SKT positioned near a bed, for instance, may detect when a caregiver is executing a task activity associated with that area since it is within range of the SKT. It is quite likely that the caregiver's task activity will be mistakenly identified if task activity detection relies only on the caregiver's location. As a result, we pay special attention to the carers' direction throughout the work.

We may infer that the caregiver's interest in the job was strongly tied to the actions performed on the job. Based on the location and orientation of carers in an SKT, we present a task activity recognition approach that may be used to identify the activities of caregivers.

JOURNAL OF CRITICAL REVIEWS

ISSN- 2394-5125 VOL 09, ISSUE 02,

B *Task activity recognition*

This section explains how the SKT may be used to identify task activity. The two requirements of the suggested technique are as follows: The caregiver's role plays a role in one of the illnesses. Another factor to consider is the direction in which the caregiver is looking. Using mathematics, we shall describe each task activity recognition condition.

The variable accessp, which can be derived from the equation, is required for the determination of task activity recognition criteria based on location (1). The caregiver's location coordinates (xc, yc, zc) are checked to see whether they fall within the parameters of SKT I (xi,min, xi,max, yi,min, yi,max, zi,min, zi,max). Caregiver proximity to SKT I is taken into account when $access_p$ is substituted for SKT id I when a caregiver is within the SKT i's range.

$$access_p = \begin{cases} i, \text{ if } x_{i,min} \leq x_c \leq x_{i,max} \text{ and } y_{i,min} \leq y_c \leq y_{i,max} \\ \quad \text{and } z_{i,min} \leq z_c \leq z_{i,max}, \\ 0, \text{ otherwise.} \end{cases} \quad (1)$$

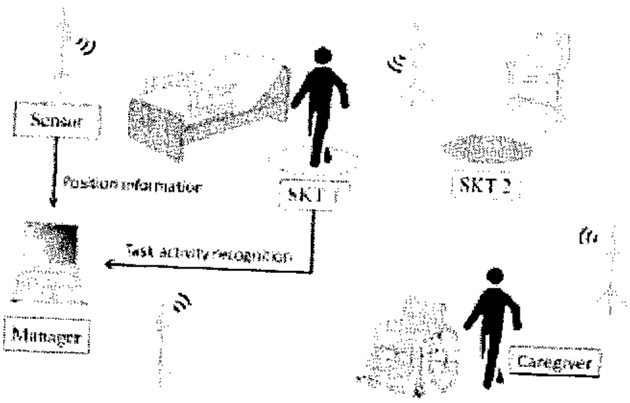

Figure 2. Proposed system overview

In contrast, the variable accessd, which can be derived from the equation, is required to identify the task activity recognition depending on the caregiver's orientation (2). Caregiver angle ac is measured in this situation to assess if it falls within a range (ai,min – max) for entering or exiting the SKT I. The term "angular area" refers to this range of angles. If the caregiver's orientation is inside the angular region, the system decides that the task activity has been begun or finished in that space and assigns the SKT id I to $access_d$.

$$access_d = \begin{cases} i, \text{ if } a_{i,min} \leq a_c \leq a_{i,max}, \\ 0, \text{ otherwise.} \end{cases} \quad (2)$$

Each of these situations has a specific time and place. In order to determine a caregiver's task status, the system employs the task activity recognition based on the following conditions: When the caregiver enters and departs the SKT, the system employs task activity recognition based on condition (2) to determine the state of the caregiver's task activity.

Accessp and accessd are used to identify the caregiver's task activity in the suggested technique. First, the system compares the variables a and b. The system looks for an SKT whose ID number matches the value of these variables if they are the same. A task may be connected with an SKT if they are found to match. As an alternative, if all of these conditions are not satisfied, the system determines that the caregiver was conducting an unrelated activity. Even in the same working environments, the suggested technique allows for the identification of various task activities.

III. EXTRACTION OF WORKSPACE

Task activity recognition may be applied to a broader variety of scenarios using our technology. In order to identify the caregiver's task activities, it is important to designate the workspace as SKT in preparation. Because of this, we have developed a technique for automatically extracting caregiver workspaces based on the clustering of caregiver movement trajectories.

Using hierarchical clustering, this research was able to identify a large number of prospective workplaces (clusters). Hierarchical clustering may be approached from the bottom up or the top down. We employ a bottom-up approach in our work, which allows us to quickly discover the whole structure. Furthermore, the Euclidean distance, which is often employed to express the dissimilarity across individual datasets, is utilized. When two points I (xI, yI, and zi) are separated by the Euclidean distance diJ from one other, the distance is represented as (3).

$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2 + (z_i - z_j)^2} \quad (3)$$

The shortest distance technique is used to compute the distance between groups of different data using a cheap computing cost. W is the new cluster formed by merging the two clusters u and v into one. As a result, we may represent the difference Dwt between the cluster w and any other cluster t in terms of their differences, which are stated as follows:

$$D_{wt} = \min(D_{ut}, D_{vt}) \quad (4)$$

If an integrated cluster has more than three points, it isn't worth considering as a possible workplace. Using this method, the caregiver's possible workplaces are removed from the rest of the prospective workspace clusters. In statistics, a filter variable is a numerical value used to limit the amount of data points that are included in a certain statistical cluster. The number of points in a cluster has little bearing on the usefulness of a cluster as a workspace, but this filter variable does.

IV. Results and discussion

For this experiment, we are testing the accuracy of the suggested approach for recognising task activity in the real world. Fig. 3 depicts a test setup resembling a nursing facility room where we performed the experiment.

A *Dataset*

Fig. 3 illustrates the location of the caregiver during the transfer task, and this dataset includes the caregiver's position and orientation. In the experiment, the cared-for individual was transferred from their bed to a wheelchair and then back to their bed. motion analysis corporation MAC3D System was used to collect this data. "Osprey" and "Raptor" cameras from Motion Analysis Corp. are employed in this system. A sample period of 0.01 s and a measurement inaccuracy of 1.0 mm are the specifications of this system. In

ISSN- 2394-5125 VOL 09, ISSUE 02,

addition, the experimenter labels each observed caregiver's position coordinate and orientation according to Table I. Ten datasets collected under these conditions are used in this experiment.

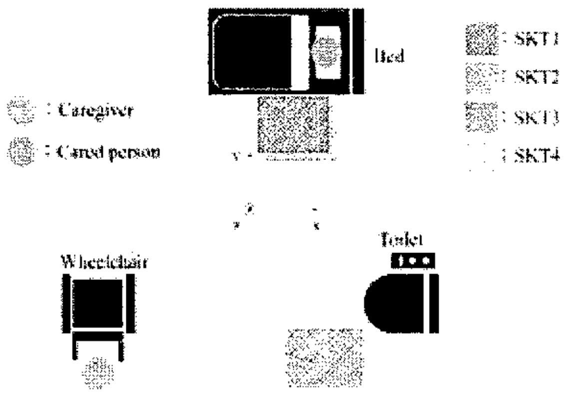

Figure 4. Experimental environment

TABLE I. TASK LABELS

Task Labels	Assisting the transfer of elderly people	SKT ID
Task 1	from a bed to a wheelchair	SKT 1
Task 2	from a wheelchair to a bed	SKT2
Task 3	from a wheelchair to a toilet	SKT3
Task 4	from a toilet to a wheelchair	SKT4
Task 5	Other operations	

B *Conditions of the experiment*

This system's utility is tested by comparing it to four different task activity recognition situations (A through D). SKTs and angular areas are determined in this experiment by referring to the location and direction of each measurement. The SKTs are set up in the manner seen in Fig. 3. Also indicated in Table I, each SKT is paired with a task label that identifies the task activity. Evaluation items in this experiment include task activity recognitions, labelled task activity times, and system-determined task activity times.

The caregiver's position coordinates and orientation were the two kinds of datasets utilised in this experiment, comparable to the dataset used in Section IV. Section IV's dataset is utilised in one of the datasets in Section V. This dataset is referred to as group I, whereas group II is referred to as group II. Group II was seen to begin the task activity at a different place.

C *Conditions of the experiment*

Two kinds of data sets are employed in this experiment to test the applicability of the suggested strategy. Experimentation is used to determine the values of the threshold and the filter. Variables for threshold and filter are 5.0 mm and 400, respectively.

A caregiver's prospective workstations at the institution were discovered as a consequence of the study. Additionally, prospective workstations and non-task-related locations were separated.

V. CONCLUSION

As part of the caregiver support system, this article developed a task activity identification technique and a workspace extraction technique. Tests were performed to see whether these two approaches were effective. The findings of the task activity recognition experiment reveal that the caregiver's position and orientation may be used to identify the task activity. It was found that the suggested strategy of locating prospective carers' workspaces was successful in the workspace extraction experiment, however.

Each suggested solution will be improved in the future in order to produce a support system that reduces the cognitive load of carers and improves job efficiency. For example, the workspace extraction technique will be enhanced such that prospective workspaces may be inserted as SKT and the angular area can be determined automatically from the angle of each SKT. In contrast, the approach for identifying work activities will be upgraded in order to better identify work activities and to recognise more specific work actions. These two technologies will eventually be integrated into a care support system that uses spatial memory.

REFERENCES

[1] Osmani, V., Balasubramaniam, S., & Botvich, D. (2008). Human activity recognition in pervasive health-care: Supporting efficient remote collaboration. Journal of network and computer applications, 31(4), 628-655.

[2] Lin, F., Song, C., Xu, X., Cavuoto, L., & Xu, W. (2016, June). Sensing from the bottom: Smart insole enabled patient handling activity recognition through manifold learning. In 2016 IEEE first international conference on connected health: applications, systems and engineering technologies (CHASE) (pp. 254-263). IEEE.

[3] Hussain, Z., Sheng, M., & Zhang, W. E. (2019). Different approaches for human activity recognition: A survey. arXiv preprint arXiv:1906.05074.

[4] Kato, S., Niitsuma, M., & Tanaka, T. (2021, January). Pose Identification for Task Recognition in Care Work. In 2021 IEEE/SICE International Symposium on System Integration (SII) (pp. 315-319). IEEE.

[5] Lea, C., Facker, J., Hager, G., Taylor, R., & Saria, S. (2013). 3D sensing algorithms towards building an intelligent intensive care unit. AMIA summits on translational science proceedings, 2013, 136.

[6] Pineau, J., Montemerlo, M., Pollack, M., Roy, N., & Thrun, S. (2003). Towards robotic assistants in nursing homes: Challenges and results. Robotics and autonomous systems, 42(3-4), 271-281.

[7] Wang, Y., Cang, S., & Yu, H. (2019). A survey on wearable sensor modality centred human activity recognition in health care. Expert Systems with Applications, 137, 167-190.

[8] Ghayvat, H., Mukhopadhyay, S., Gui, X., & Suryadevara, N. (2015). WSN-and IOT-based smart homes and their extension to smart buildings. Sensors, 15(5), 10350-10379.

[9] Chan, E. A., Jones, A., & Wong, K. (2013). The relationships between communication, care and time are intertwined: a narrative inquiry exploring the impact of time on registered nurses' work. Journal of Advanced Nursing, 69(9), 2020-2029.

ISSN- 2394-5125 VOL 09, ISSUE 02.

[10] Feo, R., Kitson, A., & Conroy, T. (2018). How fundamental aspects of nursing care are defined in the literature: A scoping review. Journal of Clinical Nursing, 27(11-12), 2189-2229.
[11] Huber, D. (2017). Leadership and nursing care management-e-book. Elsevier Health Sciences.

International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 01, 2020
ISSN: 1475-7192

Analysis of Nurse's Reflection on Success or Failure of Blood ithdrawal by Vein Types

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Abstract - We'll put this information to good use in nursing school. We thus requested 19 clinical nurses to perform a blood withdrawal procedure using four distinct kinds of blood vein simulator models, each with varying degrees of difficulty. In this research, we questioned nurses to learn about their thoughts on the elements that determine whether or not a patient is able to draw blood successfully. In light of the findings, we qualitatively assessed their mental state while using the approach.

Keywords— Blood Withdrawal Technique, Nurse, Reflection, Tacit Knowledge

I. Introduction

Practical nursing skills include "tacit knowledge" such as "proficient art" and "knacks." This research visualises this information from numerous data points, including brain waves, cerebral blood flow, line of sight, blood vein extension pressure upon injection, and nurses' awareness. Nursing students will benefit from the visual representations of information we provide. Nineteen clinical nurses were requested to perform a blood withdrawal method on five different kinds of simulator models for blood vessels with varying degrees of difficulty in order to get various data points. In order to have a better understanding of the reflections of nurses, we conducted an interview with each nurse to get their take on what makes blood draws successful or unsuccessful. In light of the findings, we qualitatively assessed their mental state while using the approach.

II. Course Of Study On Tacit Knowledge Of Nursing Skills And ICT

Since 2008, Majima and colleagues have been doing research on tacit knowledge of nursing skills and ICT-based learning assistance systems. Recently, Wu Y and colleagues [1] have published findings on tacit knowledge relevant to clinical nursing practise in Korea [1]. Only the possible application of modern ICT tools for the nursing community was outlined by Skiba D.J.[2] (2017) and Stephen K.[3](2016).

Research on tacit strategies in nursing abilities has been undertaken by Majima and others to date. Many nurses believe that once they have found a vein, they can administer an intravenous injection. This is based on interviews with nurses. "A sensation like entering a blood vessel fast (kukutto) or smoothly (sutto)" is a common way for them to describe the sense of a job well done.

Despite this, many believe that expressing how they really feel is tough. Novice nursing students, on the other hand, believe that the aptitude for methods is just the ability to recall procedures. When it comes to learning assistance, it is critical that beginners understand processes before they are brought closer to expert qualities.

III. Experiment Overview

Everyone agreed to participate in the study. Here is a breakdown of the steps involved in the experiment:

1) The first step is to inform the participants of the experiment's protocols and acquire their agreement.
2) During the experiment, participants extract blood from a simulated arm model of a blood artery five times each, totaling 20 times. When blood is drawn, the model of blood artery is not disclosed to the subjects.
3) About an hour is needed for each participant.
4) In an interview once all of the measurements have been completed, urge the participants to reflect on their findings.

A simulation arm model is shown in Fig. 1 connected to a human being for the experiment environment. According to Fig. 2, this experiment employed an arm simulation model that included several kinds of blood vessels.

Figure.1: Experiment setting and simulation arm model

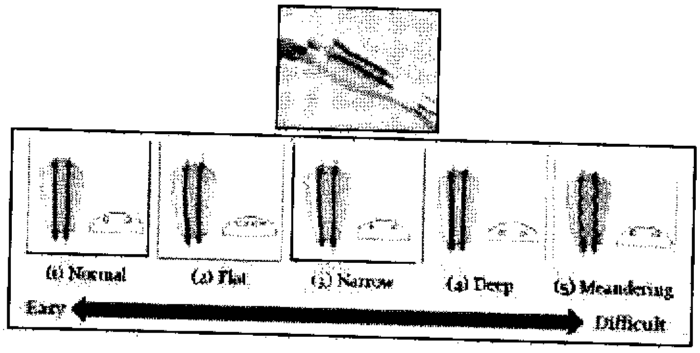

Figure. 2. Blood vein types of simulation arm modelX

IV. Results And Discussion

A *Success and failure in blood drawing*

A total of 20 trials yielded an 8.8 percent success rate for blood draws. Figure 3 depicts the success rate by kind of blood vein.

There was a 47.3 percent success rate for the whole study. When it comes to "flat" blood veins, the most successful veins were 57.1 percent. For "deep" ones, the lowest percentage was 15.3%.

"Narrow" and "meandering" blood veins took less than a minute to practise, but "flat" and "regular" ones took somewhat longer. Blood veins that had a poor success rate required almost 80 seconds to detect: "deep" veins. The more time it takes to insert a catheter into a vein, the more difficult it is. This research implies that even if a nurse fails to discover a blood vein, they will try again.

B *Practice time for blood drawing*

According to the table1, the average time for a blood drawing is indicated. "Narrow" and "meandering" blood vessels took less than a minute to practise, but "flat" and "regular" blood vessels took somewhat longer. The most difficult blood arteries to operate on, those with the lowest success rates, required the longest time to operate on: over 80 seconds. Effort is directly related to difficulties in blood vessels. According to this study, nurses keep trying to discover blood veins even if they've already failed.

C *Nurses' reflections*

"I can recognise a reverse blood flow," "The blood was drawn nicely," "I started to feel less resistance," and "I felt like I had burst bubble wrap (puchi') after experiencing resistance" were some of the comments made by the nurses. For the causes of failure, they claimed, "I couldn't locate (a deep blood vein)," a mistake in picking the blood vein, "I didn't enter a needle deeply enough," and the blood vessel had to be reinserted since it had slid out. "I am thinking about numerous things when taking blood," said the nurse (No. 9) with the highest success rate (60 percent) and the most "deep" success instances (17 times, 85 percent). The grounds behind my failure have been sensuously removed (after I have failed)." If the nurse used Donald A. Schön's reflection-inaction[5] in blood drawing, then she likely established a trial theory to exclude potential causes of failure and then took action in a hypothesis-testing manner.

Table I. Average Success Rate and Required Time by Type of Blood Vessel

Blood vessel Type	Narrow	Meandering	Flat	Normal	Deep
Success rate(%)	53.7	48.4	57.1	44.0	15.3
Average time (s)	56.4	58.8	62.4	66.0	77.2
MIN(s)	21.0	24.0	23.0	31.0	21.0
MAX(s)	159.0	160.0	242.0	122.0	253.0
SD	26.0	23.9	35.5	29.7	42.0

V. Conclusion

We found comparable patterns in the outcomes of nurses' reflections on the moment of success or failure [1]. As the No. 9 nurse said, Donald A. Schön's reflection-in-action[2] was conducted in blood drawing as an instant reaction practise, a trial theory was constructed to minimise causes for failure, and action was taken in a hypothesis-testing manner. Using many data sources, such as brain waves, cerebral blood flow, line of sight, and blood vein extension pressure upon injection, we want to continue this research in the future.

Acknowledgment

Conflicts of Interest: The authors declare no conflict of interest.

Funding: The authors receive no funding for this work

Ethical approval: This paper has not submitted to anywhere and published anywhere. It does not contain any studies with human participants or animals performed by any one of the authors

References

[1] Hjelmgren, H., Ygge, B. M., Nordlund, B., & Andersson, N. (2021). Nurses' Experiences of Blood Sample Collection from Children: A Qualitative Study from Swedish Paediatric Hospital Care.

[2] Ravik, M., & Bjørk, I. T. (2021). Registered Nurses' Supervision of Nursing Students During Practical Skill Learning: A Qualitative Exploratory Study. Scandinavian Journal of Educational Research, 1-15.

[3] Cooper, M. (2019). Improving Nurses' Knowledge of Central Line-Associated Bloodstream Infection (Doctoral dissertation, Walden University).

[4] Seah, B., Ho, B., Liaw, S. Y., Ang, E. N. K., & Lau, S. T. (2021). To volunteer or not? Perspectives towards pre-registered nursing students volunteering frontline during COVID-19 pandemic to ease healthcare workforce: A qualitative study. International Journal of Environmental Research and Public Health, 18(12), 6668.

[5] Zyhier, S. (2018). The Efficacy of Near Infrared Vein Finder Technology to Decrease Multiple Intravenous Cannulation in Patients by Novice and Advanced Beginner Nurses: A Mixed Methods Study on Improving Intravenous Catheter Insertion. Robert Morris University.

[6] De Icco, R., Fiamingo, G., Greco, R., Bottiroli, S., Demartini, C., Zanaboni, A. M., ... & Tassorelli, C. (2020). Neurophysiological and biomolecular effects of erenumab in chronic migraine: an open label study. Cephalalgia, 40(12), 1336-1345.

[7] Nicholl, A., Evelegh, K., Deering, K. E., Russell, K., Lawrence, D., Lyons-Wall, P., & O'Sullivan, T. A. (2020). Using a Respectful Approach to Child-centred Healthcare (ReACH) in a paediatric clinical trial: A feasibility study. Plos one, 15(11), e0241764.

[8] Azami, G., Soh, K. L., Sazlina, S. G., Salmiah, M., Aazami, S., Mozafari, M., & Taghinejad, H. (2018). Effect of a nurse-led diabetes self-management education program on glycosylated hemoglobin among adults with type 2 diabetes. Journal of diabetes research, 2018.

[9] Alcântara, D. C., de Freitas Peregrino, A. A., Siqueira, A. P., Silva, P. O. D., Marta, C. B., Silva, R. C. L. D., & Silva, C. R. L. D. (2019). PERIPHERALLY INSERTED CENTRAL CATHETER: CONTRIBUTIONS TO ONCOLOGICAL NURSING. Journal of Nursing UFPE/Revista de Enfermagem UFPE, 13(3).

[10] PEATE, I., STEGGALL, M., JONES, K., MORRIS, N., & DOOHER, P. (2019). Nursing patients with disorders of the breast and reproductive systems. Alexander's Nursing Practice E-Book: Hospital and Home, 183.

ISSN 2515-8260 Volume 08, Issue 01, 2021

A real time hierarchical shift design process at nursing homes A 2-stage Technique

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Abstract— the demand for nursing homes has grown as a result of the ageing of the population. "Multi-shift, high time-varying demand, hierarchical and collaborative" characterizes nursing practice. The number of nurses needed in a 24-hour period will vary greatly depending on the time of day; hierarchical means that different levels of nurses' abilities exist; collaborative means that different levels of employees collaborate to serve the elderly. Because of the high time-varying demand, the number of nurses needed in a 24-hour period will vary greatly. SDP and hierarchical staffing issues are the focus of our research, which includes the design of each shift's time frame to accommodate demand times and how to deploy hierarchical employees to the shifts. The two-stage technique will be used to tackle the issue. In the first step, we construct the shift schedule and calculate the number of employees required for each shift based on the characteristics of high time-varying demand. According to the restrictions of hierarchical coordination and collaboration, we calculate the number of employees required for each shift at each level in the second step. Different demand variations are studied and useful conclusions are made from the sensitivity analysis. Our findings may help nursing facilities cope with increased demands and personnel shortages by providing efficient decision-making tools and methodologies.

Key words: Hierarchical staffing; shift design problem; aging population; nursing homes; healthcare

I. INTRODUCTION

As the world's population becomes older, so does the number of elderly individuals. Nursing facilities have risen to fill a void left by the failure of family caregivers to satisfy the demands of an ageing population. The following features also characterise the job of the nursing staff in charge of caring for the elderly in nursing homes: the number of staff required in a 24-hour period varies substantially depending on the period. (2) there can be multiple shifts in a day covering the same time period; (3) employees will be classified into different levels according to their abilities, and the workers with higher level need more cost; (4) due to the different service quality provided by nursing workers of different levels, it is necessary for these workers to collaborate to serve the elderly. These features show that nursing home staffing is a complex combinatorial optimization problem. However, most nursing homes use manual scheduling, which takes more time and results in lower efficiency while also easily appearing poor service quality due to understaffing and waste of cost and resources due to overstaffing. So they desperately need a type of efficient and systematic scheduling solution. This study examines the issues that now plague nursing facilities, as well as the effects that fluctuations in demand for certain time periods have on the process of designing shifts.

Hospitals, banks, and contact centres are just a few of the places where shift design problem(SDP) occurs[1-4]. Y. Chen[1] highlights the relevance and difficulties of workforce allocation. Some researches[1,2,5] separated a day into multiple times, and variables such as understaffing and overstaffing were examined, which is comparable to our work as we also take the demand in each period into account. The task scheduling problem (TSP) was addressed by Lapègue [6], and shifts were created based on the duration of the job, but this is not the same as our issue.

Hierarchical labour scheduling issue is frequent in many industries. To be effective, workers, according to TSP Volland and Andreas, etc.[4,7,8], must possess the requisite skills. A task just required one worker in their issue, but our hierarchical staffing problem will mix employees at multiple levels. Seckiner [9] arranged a hierarchical workforce with changeable demands depending to the amount of personnel with various levels required each day. Based on [9], Oezgueven [10] made improvements to the model. In all of these models, it is assumed that a worker with a greater level of education may replace a person with a lower level of education. As a result of the hierarchical nature of nursing home staffing, the better-qualified worker may guide the less-qualified one. Besides, In our situation, the need of workers with various levels was decided by the limits of hierarchical cooperation instead of preset, which is also distinct from them.

With so many variables, the set-covering approach [11] was used to find a solution to the SDP. Afterwards, Aykin [12] adopted implicit modelling approach for SDP, which considerably enhanced the solution efficiency. Since our challenge incorporates shift design and hierarchical cooperation, a two-stage modelling technique will be utilised. The two-stage technique may represent the model more simply and plainly. Using heuristics approaches in both phases [13,14], these papers[6,13,14] both explained the application of the two-stage method in detail. Additionally, Dahmen[14] demonstrated the method's efficacy in terms of solution quality and operation time. A genetic algorithm or a hybrid algorithm, as proposed by P. Pakpoom[16], may also be used to solve the problem[2,15], as can tabu search[2,15].

This paper's challenge is characterised by high time changing, multiple shift, hierarchical and collaborative qualities. We'll focus on finding a solution to the issue presented by these qualities, and the following is an explanation of what this article is all about: Section 2 presents and examines the challenge of multi-shift design and multi-level staff scheduling. In Section 3, a two-stage model will be constructed, and the issue will be solved using a genetic algorithm and heuristics. The sensitivity analysis approach is used in Section 4 to get some managerial insight with realistic guiding importance, and Section 5 concludes the paper and suggests future research directions.

II. PROBLEM DESCRIPTION

A. Global Structure

Due to the nature of nursing labour, nursing facilities are in a difficult condition to attract staff, which further affects the scarcity of nursing finances. Despite the importance of these issues, no comprehensive solution has yet been established. This article will provide an innovative approach to resolving these issues.

Firstly, as the nursing labor has the characteristics of high time-varying and various shifts, it is required to plan suitable shifts. Secondly, it also has the characteristics of hierarchical and collaborative, so the collocation of workers at various levels should be addressed. On this premise, the article will employ a two-stage technique. The first step is to create shifts that are highly time-variable, and then use a genetic algorithm to calculate the time schedules for each shift and the number of nurses required for each shift. When determining final staffing numbers, the restrictions of hierarchical cooperation are applied to the constraints of shift arrangements that have been established in the first step.

B. Assumptions

Some assumptions are offered for our situation, and the specifics are as follows:

1. The shift may only start and finish within the given period, and the shifts are separated into several categories according to the start time, such as morning shift, day shift, afternoon shift and night shift.

2. The length of each shift must be within 4h-8h.

3. Each day, a single employee is limited to working one shift.

4. Multiple shifts need to be booked each day and multi shifts are permitted to span the same time period.

5. The demand of each time period within 24 hours a day may be different, but the demands of each period must be addressed.

III. APPLICATION OF TWO-STAGE METHOD

A. Parameter Definition

ISSN 2515-8260 Volume 08, Issue 01, 2021

We have the following definitions for our problems:

1. First, let's set the start time of each shift to t=0, 1, 2, 3,..., 23. 2. The shift may only start within the provided time, e.g., if the value of t is 0, the start time of the shift is 0 o 'clock in the evening. In addition, we use h to denote the shift's length, which ranges from 4 to 8.
2. S symbolises shift, and Sth stands for the shift which is begun at time t and has a duration of h, Sth contains all conceivable combinations of shifts.
3. We use k to denote distinct shift kinds. When k is 1, 2, 3 and 4, it represents morning shift, day shift, afternoon shift and night shift accordingly, and dk denotes the total number of shift type corresponding to k.
4. A 24-hour period was denoted by I I = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31..., 23. The total number of people needed in time I is represented by bi, and bi must be an integer.
5. m denotes the rank of each employee, m=1,2,3. When m is 1, it signifies senior staff. When m takes 2 and 3, it denotes intermediate and junior workers accordingly.
6. W indicates the total number of workers in the shift with a start time of t and a duration of h, whereas Wmth represents the total number of employees in the level m and the shift with a start time of t and h, respectively.
7. n stands for the matching ratio of senior and junior workers, e.g., when n is 3, it signifies that a senior employee may manage 3 junior employees at maximum.
8. The cost of an employee with a level of m is represented by Cm, whereas the cost of an employee with a level of m and a working length of h is represented by Cmh.

B. First Stage - shift design

The two-stage technique is used to this issue. In the first stage, the major goal is design the shifts, and constraints connected to shift need to be addressed, and the model may be constructed as follows:

$$\min \sum_{t,h} C_h W_{th} S_{th}$$

$$\sum_{t,h} S_{th} W_{th} \ge b_i \quad (i = 0,1,\dots,23) \qquad (1)$$

$$S_{th} = \begin{cases} 1 & \text{when the shift } S_{th} \text{ includes the time period } i \\ 0 & \text{otherwise} \end{cases}$$

$$\sum_{th \in k} S_{th} \le d_k \ (\forall k)$$

$$d_k, W_{th}, b_i \ge 0 \text{ and all integer} \qquad (2)$$

ISSN 2515-8260 Volume 08, Issue 01, 2021

The goal of the first stage's integer programming model (IP1) is to reduce the overall cost of human resources. In this level, there is no hierarchy of workers, and the cost is merely connected to the shift length. (1) Requires that shift staffing be tailored to the specific needs of each time period. (2) Indicates that the total number of shift type corresponding to k cannot exceed dk.

C. Algorithms

Shift design begins with determining the start and end times of each shift, as well as how many employees will be working each shift. We utilize genetic algorithm to produce a matrix comprised of the start time and working hours of the shift, and each value in the matrix reflects the number of employees in the associated shift. In the iteration, first of all, we will produce random possible solutions and identify some better solutions, and then we randomly swap one component of the two feasible solutions; ultimately, we're going to choose a random value in the matrix that's not zero and make it zero. We will determine the value that differs the most from the demand for each time period after the exchange and replace the matrix element with the difference value if the demand for that time period cannot be supplied after the modification. To get at the best result, this process is performed several times.

In the second step, we analyze the restrictions of hierarchical personnel cooperation. For this scenario, we utilize certain guidelines to solve the issue. For example, the lower-cost collocation technique and the shift with the longer working hours should be prioritized when completing the requirements of each period.

For the issues in the two separate phases, we apply genetic algorithm and heuristic to answer them accordingly, then iterate between the two stages to increase the quality of the solutions.

IV. EXPERIMENT RESULTS

A. Parameter Setting

For the issues in this study, we specified certain parameters:

1. If the cost of one hour for an employee is 10, the cost of a worker with four hours (C4) is 40, and so on, the cost of worker with eight hours (C8) is 80.

2. We cannot have more than three people working in each shift type (morning/day/evening/night), which means dk = 3 in all cases. As you can see in Table 1, the particular timetable for each sort of shift is provided.

3. The cost of a senior employee is 100, an intermediate worker is 70 and a junior worker is 50, and the overall cost of an employee (Cmh) is equal to the cost of the shift length plus the cost of the employee level.

4. At maximum, a senior worker may oversee three juniors, therefore n is equal to three.

5. Each period's demand fluctuation (bi) circumstances are distinct.

TABLE I. EACH SHIFT TYPE'S TIME SCHEDULE

European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 08, Issue 01, 2021

Shift type	Min-start	Max-start	Min-length	Max-length
Morning shift	04:00	06:00	02:00	06:00
Day shift	07:00	09:00	02:00	06:00
Afternoon shift	10:00	14:00	02:00	06:00
Night shift	20:00	00:00	02:00	06:00

The sensory information received by brain networks is likely to be temporally linked. To better understand how inputs influence the dynamics of the network and the encoding of memories in the brain, we use numerical simulations and mean-field analysis to investigate temporally asymmetric Hebbian learning rules in a recurrent network of rate-based neurons. We demonstrate that the network dynamics rely on the temporal correlations in the input stream the network receives. For inputs with short correlation timescale, the network displays sequential activity (Fig. 1 A left), whereas for longer correlations within the stream of input, the network settles into a fixed point attractor during retrieval (Fig. 1A right) (Fig. 1A right). An attractor state is reached when the network has completed a partial traversal of the input sequence at an intermediate value of correlations (Fig. 1 A middle). Correlations boost the network's capacity for sequential memory, according to our findings. The range of timescales of correlation for which networks represent memories as sequential activity in the network is expanded by non-linear learning rules (Fig. 1 B). Both in the succession of discrete patterns and in the continuum limit, we demonstrate that the network preserve a sequential representation (Fig. 1 C). Our result therefore implies that the correlation time scales of inputs at the time of learning have a considerable effect on the form of network dynamics during retrieval.

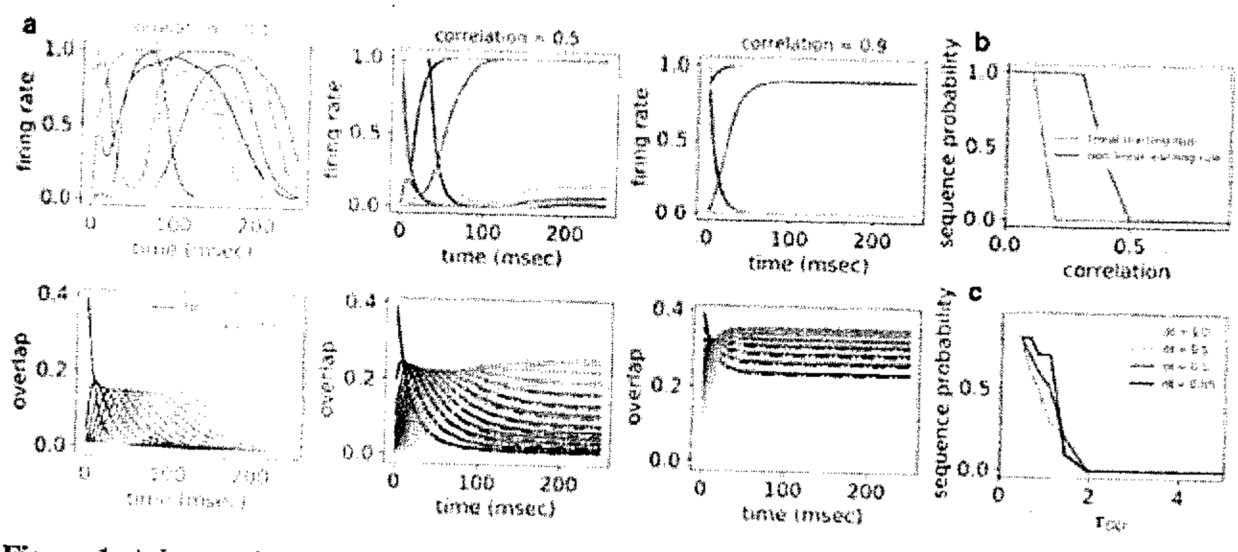

Figure 1. A Interactions between neuronal activity (top) and stored patterns from simulations and mean-field theory (bottom) (L to R). A linear and non-linear learning algorithm for retrieving sequences as functions of correlation B and tau OU, for alternative discretizations of a continuous OU process C

1) When the peak number of demand curve is calculated, the total number of people required for the ideal shift design schemes steadily grow as the ratio of high and low peaks increase. To make matters more complicated, under the unimodal scenario, a growth in the overall population rises and falls according to shifts in demand.

2) It is not necessary to raise or reduce the overall number of workers needed for 8 hours as much as the total number of individuals required for 4h-7h in the best shift design scheme as the ratio of high and low peaks grows progressively. 2.

3) When demand fluctuates more dramatically, fewer personnel are required for the ideal shift design scheme with an 8-hour shift duration for each of three distinct peak instances, in the same ratio of high and low peak demand.

4) According to the foregoing findings, it can be shown that when the demand varies in each period, the optimum shift design scheme and the overall cost are changed to a considerable amount, and the experiment results are significantly different from the usual condition of three shifts with 8h. The overall cost and the total number of personnel needed in the ideal shift design scheme would grow gradually with the increase of the ratio of high peak and low peak. although the increase is not linear. In addition, the demand scenario which has more peaks demands higher expense. In addition, the ideal solution requires fewer personnel with 8-hour shifts and lower overall costs when demand varies more sharply, and fluctuation circumstances have a greater influence when there are fewer peaks.

V. CONCLUSION

This research primarily covers the issues experienced by nursing homes owing to the features of nursing job, and a two-stage modelling technique was established based on these characteristics. Genetic algorithm and rules are respectively employed to tackle the issue of shift design in the first stage and the problem of hierarchical cooperation in the second stage. This article studied the issue from the following aspects: the number of peaks, the ratio of the number of persons in high and low peaks, and the variation of demand. Overall cost and best shift design are both impacted by variations in demand, and the experiment's findings vary significantly from the conventional model of three 8-hour shifts. Summarizing, this work proposes an effective approach to address issues in nursing homes, conducts a number of case studies, and draws conclusions from those studies, all of which have some relevance in solving real-world issues. However, further research into these issues is needed.

REFERENCES

[1] Pahlevanzadeh, M. J., Jolai, F., Goodarzian, F., & Ghasemi, P. (2021). A new two-stage nurse scheduling approach based on occupational justice considering assurance attendance in works shifts by using Z-number method: A real case study. RAIRO-Operations Research, 55(6), 3317-3338.

[2] Ganz, T. J., Donner, R., Hines, K. M., Waithe-Alleyne, M. L., Slate, D. L., Abel, G., & Auclair, J. R. (2021). Two-Stage Hierarchical Group Testing Strategy to Increase SARS-CoV-2 Testing Capacity at an Institution of Higher Education: A Retrospective Analysis. The Journal of Molecular Diagnostics, 23(12), 1691-1698.

[3] Chen, P. S., Lin, Y. J., & Peng, N. C. (2016). A two-stage method to determine the allocation and scheduling of medical staff in uncertain environments. Computers & Industrial Engineering, 99, 174-188.

[4] Leung, P. L. (2021). Optimisation of staff level planning and scheduling for nursing homes.

[5] Chen, K., Lou, V. W. Q., Tan, K. C. K., Wai, M. Y., & Chan, L. L. (2021). Burnout and intention to leave among care workers in residential care homes in Hong Kong: Technology acceptance as a moderator. Health & Social Care in the Community, 29(6), 1833-1843.

[6] Erdem, M., & Bulkan, S. (2017). A two-stage solution approach for the large-scale home healthcare routeing and scheduling problem. South African Journal of Industrial Engineering, 28(4), 133-149.

[7] Mousavi, S., Sajadi, S. M., AlemTabriz, A., & Najafi, S. E. (2021). Location and hierarchical allocation disaster with combined ε-constraint and simulation-based optimization approach. Simulation, 00375497211063900.

[8] Zhang, T., Liu, S., Feng, P., Zheng, Y., & Chen, W. (2020, July). Hierarchical Staffing Problem Under High-Time Varying Demand. In International Conference on Digital Health and Medical Analytics (pp. 40-51). Springer, Singapore.

[9] Marchesi, J. F., Hamacher, S., & Fleck, J. L. (2020). A stochastic programming approach to the physician staffing and scheduling problem. Computers & Industrial Engineering, 142, 106281.

[10] Singh, R. K., & Gorantla, R. (2020). DMENet: diabetic macular edema diagnosis using hierarchical ensemble of CNNs. Plos one, 15(2), e0220677.

JOURNAL OF CRITICAL REVIEWS

ISSN- 2394-5125 VOL 09, ISSUE 02,

The nursing care activity and records estimation using experiment and dataset system

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Abstract - Here, we describe an activity-recognition system that captures the varied activities of elderly individuals in a Japanese nursing home. For the duration of four months, nurses kept track of patients' activity levels, as well as sensor data from their cell phones. Several staff members or nurses have registered 28 different activity labels. The 6-story building's networked system and a mobile app for encoding data make up the system architecture, which serves a large number of people. Even a non-expert nurse or user may easily handle this system because of the system's intuitive design. Using statistical characteristics and an extremely randomized tree, we were able to identify the activities that were taking place. We found inconsistencies in the timestamps at the beginning and end of the recordings. To this end, we investigated the possibility of time reversal. In smart homes or elder care facilities, the information may be used to identify a variety of activities. The dataset is made up of labels that employees put on their phones and care information that they put in the system.

I. Introduction

As our population ages, the need for nursing homes grows, resulting in a labour deficit. The use of information technology to improve nursing care efficiency is critical. Mobile sensors such as cellphones have been used in studies in the area of ubiquitous computing to identify human activities [1]. Nursing care activities, nursing care tasks, and residents' care records may all be recognised using this technology. Using this technology at a nursing home will allow us to better track the care and work of our residents. The nursing facility centre may benefit from this data analysis.

In this study, we used data from a nursing care facility to perform activity recognition. Smartphones are used by nursing staff to keep track of patient care. To increase the effectiveness of nursing care records, we've developed a new system for nursing homes. Phones are used to make nurse care records, and sensor data is sent to a cloud service. We conducted a four-month experiment to gather data from medical records.

During the first two months of employment, employees maintain paper records in addition to electronic ones. In the past two months, they have totally reverted to using the suggested system to store care data. Initially, the system was unfamiliar to the personnel. They got more proficient at keeping track of the passing of time as they became more familiar with the method. Fa

Using the acquired data, we assess whether or not activities may be recognized. Algorithms and measures for assessing class imbalance were utilized. In particular, each class was classified as a one-class subclass. In order to take advantage of user dependence, we expand the label timestamps and perform user-dependent training. As a result of this, five activities had AUCs greater than 80%, and 15 had AUCs greater than 60%.

ISSN- 2394-5125 VOL 09, ISSUE 02,

Using the information acquired, researchers may use it in care facilities to recognize activity patterns and mine data. Sensor data from employees' cellphones, activity labels, and care information entered into the system are all included in the dataset.

II. Annotation challenge in the wild

There is a lot of literature on activity recognition studies. However, there are few instances of complex tasks being carried out at work locations. Most cases are utilized in health care settings like hospitals and nursing homes.

Data with a training label is required for machine learning algorithms, although this aspect is quite expensive. This is one difficulty. Giving training labels (annotation) in real-time by the person herself/himself is unusual, and if there is a risk that the original responsibility may be altered if s/he conducts extra work, the activity itself becomes weird and strangely performed.

Observers need to be prepared, and manual effort is often required as a result. Even if done later, visualising all of the raw data and assigning a label typically takes longer than the actual duration of the action itself. It is typically more difficult to understand sensor data from acceleration sensors than from video cameras. Video cameras may be set up to take measurements at a specific location or in a lab.

However, in the wild, it might be a challenge to find evidence.

An approach based on a person's memory, and a method to complement and complement experience-based sampling, have been suggested to reduce the strictness necessary for such training labels. Even if the label time is erroneous, we have presented a strategy to increase accuracy.

Using the task records and activity label records often used by nursing staff, we provide in this study a method for integrating them. Even though self-labeling may lead to errors, this method tries to improve the number of labels collected by making recording more convenient.

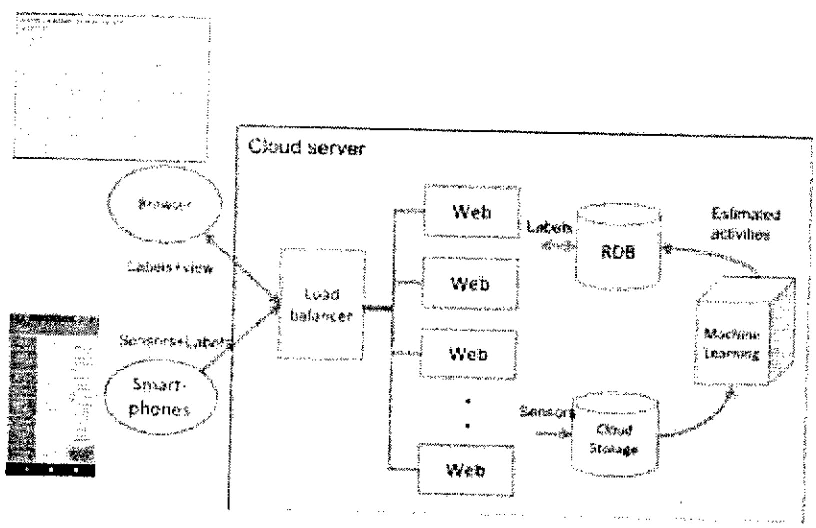

Figure. 1. Care record / activity recognition system configuration.

III. CARE RECORD / ACTIVITY RECOGNITION SYSTEM

It gathers sensors and labels for machine learning, stores them in a cloud server, and lets staff enter nursing care records on their phones while they work at a nursing home. This system's software is an enhancement of [12]. For a few days, activity labels may be used to estimate how much time a nurse spends providing care to patients.

The architecture of this system is presented in Figure 1. Using a Wi-Fi network at the facility, the Smartphone transmits sensor data and nursing care records entered by facility employees to a central server on the cloud side of things. The cloud service offers authentication and Web user interface (UI), and at the same time, it trains the activity recognition model by machine learning from the data received regularly, at the same time identifying activity recognition for sensor data. The predicted activity may be validated and smodified on the Web, which is also, used as learning data for future learning.

A. Smartphone Application

Staff members may submit their care records into the FonLog Android smartphone application while they are working and send it to a cloud server using the smartphone's sensors. It's possible that the nurses you're working with don't even know how to use their phones.

The following features are available with the FonLog smartphone app.

1). It is required to gather the right responses (activity labels) to activities combined with sensor data in order for activity identification to be supervised and machine-learning. Keeping track of the start and finish times of an activity label is essential since it is time-series data. Figure 2 in FonLog demonstrates this.

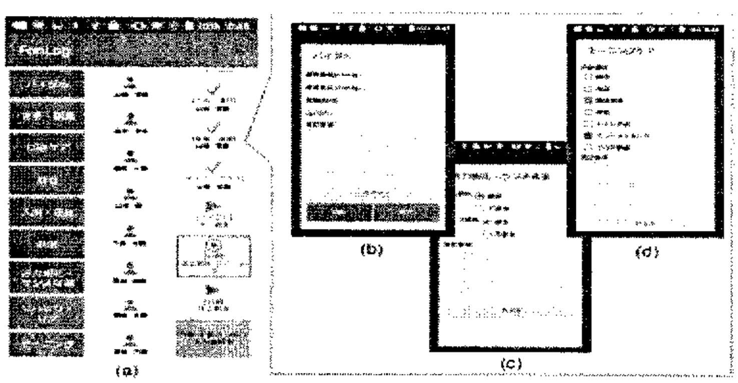

Figure. 2. Screen for entering care record / activity labels.

"Activity class" indicates what kind of work has to be done, "care target" indicates who needs to be taken care of, and an "activity label" box appears in the right column when the grey button in that column is pressed. To go to before starting (I), just touch an activity label box. Doing something the start and end times of an activity may be recorded using finish (). Like on a slot machine, you may scroll up and down these three columns to see more material than the screen height allows.

The following procedure may be performed as well:

- A lot of different activity labels could start and stop at the same time. This is because one action could be taking place while another is going on.
- Because you may target numerous topics with one activity, like a meal, you can choose multiple subjects for one activity class. "
- The audience might also be categorized by floor or other specific criteria. This may be done on the server-side, and can be retrieved as metadata in the (8) section.
- Section IIIB's Web system uses the HTTPS protocol for user authentication, and after a single login, session information is retained in cookies and files of the programme so that it is possible to log in again automatically.

- The system moves into a background execution state and continues to run as long as data collection continues. The programme may be reopened even if it was suddenly terminated or the terminal was restarted, since it is set using the API given by the OS.

- Every minute, sensor data is sent to the cloud server by means of the HTTPS protocol through buffered data.

- Information on the activity class list, care receivers, and care details input form is needed to retrieve metadata. Every two hours, FonLog pulls these JSON files from the cloud server and shows them on the screen.

B. Nursing care record / activity recognition cloud service

Nursing care records, counting, and activity identification are all handled by the cloud service. It performs the following functions: (1)–(8).

1) A user's email address and password are used to authenticate using a smartphone app like Fon-Log or the UI on the website.

2) Function of receiving activity labels, care information, and sensor data from the smartphone application FonLog using the POST method in HTTPS protocol. CSV files are used to send data, which is then stored in a relational database so that it may be easily accessed. The sensor data are kept in the cloud when the receipt timings have been added.

3) Activity recognition and visualisation function: machine learning is conducted about once per hour and the daily activity of the user is predicted using prior activity labels and sensor data as training data. In the paper [13], we describe a method for recognising a person's daily activities.

4) It is possible to make changes to the activity label and care information entered on a smartphone, as well as the assumed activity from step 3), using the server's Web interface. The next training data is based on the corrected estimated activity.

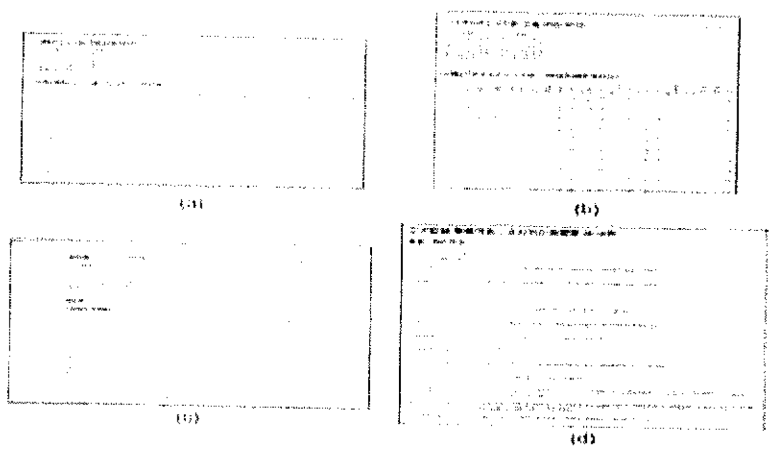

Figure. 3. Database of cloud forms. As demonstrated in Figure 2, activity labels and care information are produced in a nursing home-like format. A care record, as illustrated in Figure (d), is a form to be printed and presented to the municipality.

- As illustrated in Figure 3, the output of activity labels and care information is presented in a manner that is often used in nursing homes. Figure 3 (d) shows an example of a care record, which is a form to be printed and submitted to the municipality at a later time. When there is an emergency, we made buttons for each caregiver to print all of their previous records together so that they can be ready.

ISSN- 2394-5125 VOL 09, ISSUE 02,

- Additionally, it is feasible to create activity courses that stimulate employees or transmit sentiments of thankfulness through activity labels. This is because the middle row of Figure 2 includes not just the caretaker but also the nursing personnel (a).
- It is possible for the cloud server-side to gather all of the communication between these employees in order to evaluate and improve their work.
- In order to make sure that the data from the smartphone app is being provided appropriately, there is a monitoring mechanism for activity labels, care details, and sensor data. For this reason, our daily checks may be visually checked by counting and showing the number of received data for every caregiver and each cared-for individual.
- Applicable to the smartphone application's function 8, (Metadata download function), is a JSON-based metadata editing function that supports data classes of activity classes, care recipients, and care details.

For implementing the system, Ruby on Rails and Elastic Beanstalk, Amazon's online load balancing PaaS for relational database systems, are the best options for implementing the system. Storage was handled by RDS and S3. When it comes to receiving a huge quantity of sensor data, load balancing is essential, so Elastic Beanstalk's load balancing function is combined with the Web feature. The EC2 server for activity recognition written in R was deployed on EC2, received activity label from RDS, sensor data from S3, and wrote back the estimated result to RDS for the 3rd time.

IV. EXPERIMENT IN A CARE FACILITY

The focus of our experiments in this part is a care facility in Japan, where a large number of elderly individuals are supported by staff and nurses.

In most cases, the target facility's nursing care records are kept by hand. It is important to note that in our experiment, this technique was used alongside the traditional handwritten recording system for the first two months (March and April). In the second part of May and the first half of June, this system's stability and usability greatly improved. Because of this, nurses and other staff members have been instructed to cease maintaining handwritten notes, and all data has been gathered and entered using our system since then. In this way, the system is tested in a real-world setting in a trustworthy way. As a result, our system's resilience is guaranteed in a real-life setting like a nursing home.

We're now going to talk about the actual location where the data is being stored.

The parking lot and entrance are on the ground level, while the administrative offices are on the second floor of a six-story structure. The aged (who we refer to as "residents") are housed in 65 separate rooms on the second through fifth levels. A few common areas may be found on the 2nd and 4th floors, such as the dining room and dining halls; the trash disposal room; the laundry room; and the community restrooms. Experiments involving 27 people, including 23 carers and four nurses, were carried out over the course of four months. During the experiment, which was done by the researchers, workers could keep their phones with them at work and in other places, like their pockets.

A. Experimental Equipment

Plus One Marketing provided us with Priori 3 LTE cellphones for testing.

Mobile data routers and Wi-Fi base station routers were put up on each level since the building lacked network infrastructure like a wireless LAN. Sensor data is saved on the smartphone even if it is not connected to the network, so data is not lost during this process and the network status is realistic. This is even though there was already a mobile router in the area. A special wireless router was built beneath it to make more connections with the smartphone and improve the bandwidth in that area.

B. Activity Classes

After consulting with the personnel and reviewing manuals such as care records from nursing homes, we came up with a list of 28 different types of activities. Many different types of activities may be found in this dataset. Each activity class has its own set of care details. Table 1 shows the whole list. Among the categories of direct care activities listed in the table are vitals (checking), excretion, and bathing/wiping, maintenance (preparation and checking of goods), medication organisation (organisation of medications), and communication (family/guest response, delegation/meeting) and correspondence with doctors. Several sorts of care details are available, including numerical ones like food intake and drink intake, as well as single-choice options like the location of care support on the body.

TABLE I ACTIVITY CLASSES

1: Vital, 2: Meal / medication, 3: Oral care, 4: Excretion, 5: Bathing / wiping, 6: Treatment, 7: Morning gathering / exercises, 8: Rehabilitation / recreation, 9: Morning care, 10 : Daytime user response, 11: Night care, 12: Nighttime user response, 13: Family / guest response, 14: Outing response, 15: Linen exchange, 16: Cleaning, 17: Handwriting recording, 18: Delegating / meeting, 19: Get up assistance, 20: Change dressing assistance, 21: Washing assistance, 22: Medical doctor visit correspondence, 23: Preparation and inspection of goods, 24: Organization of medications, 25: Family / doctor contact, 26: Break, 27: Emergency response such as accident, and 28: Special remarks / notes

C. **Result.**

A number of nursing care records and their accompanying recording times were collected and analysed as part of the experiment to determine the impact of the system. Our research focused on —

a) Nursing care records and activity labels are collected by the system or not, and

b) If the system has reduced the time it takes to enter nursing care records.

Two aspects, the quantity of nursing care records and nursing care record time, are discussed here.

1). Number of nursing care records: We gathered 38,076 activity labels, 46,803 record details, and 2834 hours of sensor data throughout this experiment's last two months of usage. Figure 4 depicts the total number of activity labels throughout the course of the four-month period as a time-series graph. Charting time in minutes using an abscissa (time series) and an ordinate (total time in minutes) While in the first half, there were 101 activity labels per day, this number rose to 494.3 labels per day in the second half of the recording period. When comparing this time to the earlier one, the quality of the recordings has improved dramatically.

As for the care record input 1, the care record in Fig. 2 showed whether or not the degree was raised (d). The computer used about 1.5 times the amount of input material.

2). Nursing care record time: The activity record time for Activity Classes was then evaluated. However, when we looked at the recorded activity label's time, we discovered that quite a few tasks were completed in under a minute. Since there were worries that the staff remembered or documented the "time of nursing care record" instead of documenting the "time of activity," we have added extra questions to staff members. As a consequence, in the first half of the studies, 18 participants completed the handwritten records after the activity labels had been completed in the lab. On the other hand, 13 out of 22 participants completed the detailed input once the activity labels were completed over the whole duration. In addition, 11 of the 23 people who filled out the activity labels worked as nurses.

ISSN- 2394-5125 VOL 09, ISSUE 02,

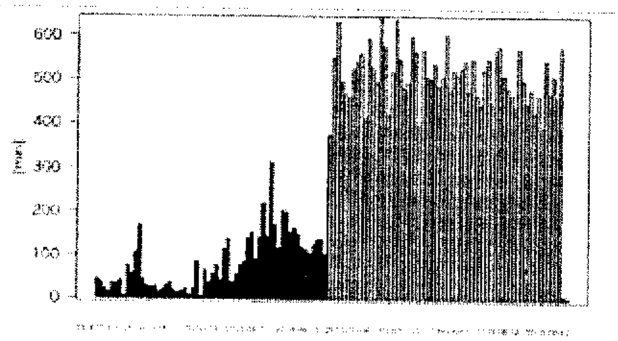

Figure. 4. Daily activity labels during the four months data recordings vs. the total recording period in terms of minutes. In the first half, the average activity labels/day is 101, which has improved to 494.3 during the latter half period of data recordings.

Inaccuracies persist in the start and finish times of activity labels, and the record time can be lowered when compared to the standard handwritten recording method, but label collections can enhance the kinds, number of records, and activity label collections.

We'll look at ways to reduce recording time in the next section, which builds on our work with activity detection.

V. ACTIVITY RECOGNITION FROM SMARTPHONE SENSORS

A machine learning-based solution to recognizing activities was tested. Sensor data has been used to compile this list of activities. Preprocessing and assessment methods using Extremely Randomized Trees are discussed in the following sections.

A. Preprocessing

In this scenario, X, Y, and Z axes data were taken from the accelerometer of the smartphone. Our feature vectors are derived from accelerometer time series data and are based on metrics such as the mean value, standard deviation, maximum and lowest values. For assessment purposes, the activity labels and time stamps were reworked. As previously noted, nearly half of the nurses' records were collected after the activity was completed. Since the primary goal of a nurse is to serve the patient as quickly as possible, this is understandable. Then, the nurse will be able to keep track of the information. Adding records to the system will be more challenging if s/he is overworked. We relocated each activity label to a larger time-segment in order to address this real-world difficulty. We added 20 minutes to the start time and 17 minutes to the end time based on the initially reported timestamps for both the start and the finish. This enhancement has the potential to enhance recognition rates.

B. Evaluation method

The accelerometer data was utilized for statistical analysis. Each user received a set of 1000 features.

The Extremely Randomized Tree [4] is used in our strategy for categorization. A leave-one-day-out cross-validation strategy is used to divide training and testing data.

ISSN- 2394-5125 VOL 09, ISSUE 02,

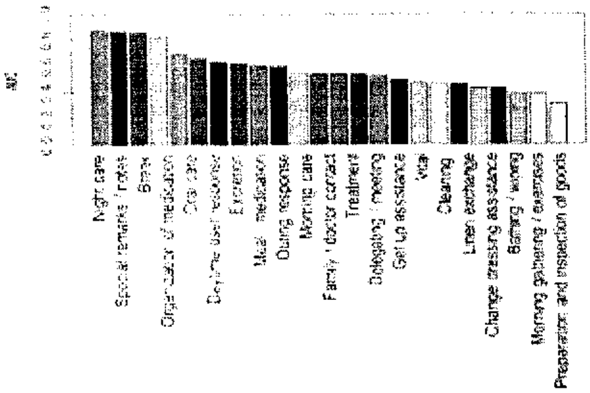

Figure. 5. Reaction time accuracy It demonstrates 80% precision for 4 tasks and 60% accuracy for 10 activities.

C. Discussion

Using a smartphone's accelerometer, for example, it is predicted that this degree of accuracy may be achieved. Nursing care recording systems capture enough samples for each person, which is why there are so many results. Based on these findings, nursing care recording time may be reduced even further. We designed our system's smartphone user interface so that recordings may be made more quickly and intelligently. However, a nurse or caregiver may, in the event of an emergency, enter the data incorrectly. The system's flaws may be uncovered by additional investigation of this dataset. While providing care to an elderly or disabled client, a nurse may need additional time to record the information she collects. Recording time may be shortened with practise and regular use of the system.

VI. CONCLUSION

In this study, we provide a method for nursing staff to record information on patient care, activity labels, and smartphone sensors. At a Japanese elderly home, these statistics were gathered over the course of four months. From the user's perspective, the care record system and its settings have been explained. A smartphone app named FonLog has been created for a variety of activities, including activity label entry, care detail input, sensor data recording, and more. This experiment has 28 action classifications.

In this study, we used several statistical aspects of accelerometer data to identify activities. We've looked at Extremely Randomized Trees as a classification strategy. The first findings are encouraging. However, by shortening the recording time, it is possible to enhance the recognition accuracy. This is a critical problem that we must address in the future. Nursing care records, daily health activity logs, and any work-related tasks are all good candidates for the system's server-side customizability, which makes it relevant to a wide range of industries outside nursing care. This publication presents a dataset that may be used for such studies and analysis.

REFERENCES

[1] Subasi, A., Radhwan, M., Kurdi, R., & Khateeb, K. (2018, February). IoT based mobile healthcare system for human activity recognition. In 2018 15th learning and technology conference (L&T) (pp. 29-34). IEEE.

[2] Arbabshirani, M. R., Fornwalt, B. K., Mongelluzzo, G. J., Suever, J. D., Geise, B. D., Patel, A. A., & Moore, G. J. (2018). Advanced machine learning in action: identification of intracranial hemorrhage on computed tomography scans of the head with clinical workflow integration. NPJ digital medicine, 1(1), 1-7.

ISSN- 2394-5125 VOL 09, ISSUE 02,

[3] Bianchi, V., Bassoli, M., Lombardo, G., Fornacciari, P., Mordonini, M., & De Munari, I. (2019). IoT wearable sensor and deep learning: An integrated approach for personalized human activity recognition in a smart home environment. IEEE Internet of Things Journal, 6(5), 8553-8562.

[4] De-La-Hoz-Franco, E., Ariza-Colpas, P., Quero, J. M., & Espinilla, M. (2018). Sensor-based datasets for human activity recognition–a systematic review of literature. IEEE Access, 6, 59192-59210.

[5] Dang, L. M., Min, K., Wang, H., Piran, M. J., Lee, C. H., & Moon, H. (2020). Sensor-based and vision-based human activity recognition: A comprehensive survey. Pattern Recognition, 108, 107561.

[6] Zhou, X., Liang, W., Kevin, I., Wang, K., Wang, H., Yang, L. T., & Jin, Q. (2020). Deep-learning-enhanced human activity recognition for Internet of healthcare things. IEEE Internet of Things Journal, 7(7), 6429-6438.

[7] Alhussein, M., Muhammad, G., Hossain, M. S., & Amin, S. U. (2018). Cognitive IoT-cloud integration for smart healthcare: case study for epileptic seizure detection and monitoring. Mobile Networks and Applications, 23(6), 1624-1635.

[8] Twomey, N., Diethe, T., Fafoutis, X., Elsts, A., McConville, R., Flach, P., & Craddock, I. (2018, June). A comprehensive study of activity recognition using accelerometers. In Informatics (Vol. 5, No. 2, p. 27). Multidisciplinary Digital Publishing Institute.

[9] Nweke, H. F., Teh, Y. W., Mujtaba, G., & Al-Garadi, M. A. (2019). Data fusion and multiple classifier systems for human activity detection and health monitoring: Review and open research directions. Information Fusion, 46, 147-170.

[10] Wang, Y., Cang, S., & Yu, H. (2019). A survey on wearable sensor modality centred human activity recognition in health care. Expert Systems with Applications, 137, 167-190.

[11] Chen, Y., Qin, X., Wang, J., Yu, C., & Gao, W. (2020). Fedhealth: A federated transfer learning framework for wearable healthcare. IEEE Intelligent Systems, 35(4), 83-93.

[12] Do, H. M., Pham, M., Sheng, W., Yang, D., & Liu, M. (2018). RiSH: A robot-integrated smart home for elderly care. Robotics and Autonomous Systems, 101, 74-92.

Digital technologies supporting towards nursing care: a brief review

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Abstract: There is a wide range of digital technologies being developed or used in nursing care. According to this scoping review, the findings on the good or negative impacts on people in need of care, careers, and facilities that provide care are available, and the reliability of these data will be assessed. Using a scoping review methodology, researchers have identified papers focusing on the efficacy of digital technology in nursing care for patients, careers, and care facilities. A total of 19,510 scholarly papers from nine databases were screened for inclusion in the study. A total of 123 individual papers and 31 reviews were analyzed for this research project. For example, aides for the disabled and information and communication technologies are among the technologies that are included in the category of nursing and health information technology. There are numerous studies that suggest good outcomes, but the quality of evidence is usually poor and the research sizes are often tiny. Few technologies have been studied in depth enough to provide solid results. There aren't many high-quality research studies (RCTs) in most technical fields. Heterogeneous outcomes suggest that the impact of new technologies may be substantially influenced by the way they are introduced and the unique environment in which they are placed. It's understandable that care facilities are wary of using new technology because of the lack of proof of their usefulness in nursing care. The scoping assessment identifies technological areas in need of further in-depth investigation in the future. It is imperative that more research be done on outpatient, informal, and cross-sectoral care in order to fully use and benefit from the possibilities of digital technology in order to help patients become more self-sufficient and relieve stress on both formal and informal caregivers alike.

Keywords: innovative technology, care-dependent, caregivers, nurses, patients.

I. Introduction

Many countries are conducting research into digital technologies for nursing care in the hopes that these technologies will facilitate or even substitute some aspects of human nursing work and thus help to mitigate the rapidly rising costs of care and shortages of skilled workers. These technologies. 1–4 Many nations currently have nursing care personnel shortages, which are anticipated to worsen as the population ages. 5 Despite the availability of digital technology for nursing care, many nurses do not use them. 6 "Nursing Care Innovation Center" is part of the German Federal Ministry of Education and Research's (BMBF) "Future of Nursing Care" research cluster, which has received funding from the BMBF. It aims to create new technologies, evaluate promising ones, and encourage their use. The project team has been given the goal of compiling a list of technologies that have been shown to have positive impacts on people in need of care, such as patients in hospitals, their carers, or the environments in which they are offered care.

These new technologies have the potential to have far-reaching consequences. Care recipients' quality of life (QoL) may be increased, and the freedom of those who may need care may be enhanced by the use of technology, allowing them to remain at home with little or no nursing assistance while their QoL improves. 13–16 Formal carers' health may benefit from psychological or physical assistance. As a result, individuals may be able to work longer, or their informal carers may be relieved to the point that they no longer need official care assistance. 19–23 Nursing personnel in hospitals and long-term care facilities may be aided in their efforts to work more efficiently, improve patient care, or enhance patient safety. 24–27 Direct care assistance or an enhanced, digitally enabled structure of care procedures might accomplish these results. It is also possible to make nursing job easier by streamlining the handover procedure or cooperating with other institutions. 28,29

There is a wide range of digital technologies being developed or currently being used to assist in nursing care. 30 This scoping study focuses on technology that aids caregivers or those in need of care, whether they are official or informal. There are several ways to aid someone in need of care: social, mental, and/or physical. For the purposes of this scoping study, we want to get a broad picture of how various technologies affect people who are in need of care, the people who deliver that care, and institutions. Additionally, the quality of these outcomes is a consideration. Specifically, we looked at the sorts of research included in our review to answer this issue. Due to the vast number of studies included, a detailed evaluation of each study's quality could not be completed. The degree of evidence that may be obtained is strongly influenced by the study types that are utilised as a proxy.

Several key research topics underlie this assessment: When it comes to evaluating the efficiency of digital technologies used in nursing care, which ones have previously been tested? Which medical technology have been scientifically shown to have positive or bad impacts on the quality of treatment received or the length of time it takes to get it? Which kind of care facilities and patient populations has been studied so far?

II. Methods

Based on Arksey and O'Malley's scoping review approach, this study used a wide variety of study types in order to offer a comprehensive overview of the area of research. – 31 The iterative selection of studies was made easier by following the processual suggestions described in Levac et al32. Starting with a broad research topic, the scoping review began the process. During the study phase, the question was revised in order to allow for more extensive evaluations of the efficacy outcomes. We began by looking for areas of digital technology that have received the greatest attention in terms of acceptability, effectiveness, and efficiency in support of informal and formal care settings.

For this inquiry, we were trying to get an overall picture on what is currently being researched in the subject of digital technology in nursing care. Krick et al. have published an analysis relevant to this subject. 30 An further part of the review focused on studies of efficacy, enabling not only the identification of locations in which these studies are carried out but also the identification of technologies that are successful or not.

III. Methodology

Medline, Scopus, CINAHL, Cochrane Library, ACM Digital Library, IEEE Xplore, the Collection of Computer Science Bibliographies, GeroLit, and CareLit were the nine electronic databases we utilised for our search. To round up the research, we conducted a manual search of related initiatives in German-speaking nations. Scientific articles published between 2011 and 2018 that comprised empirical investigations (abstracts accessible in German or English) were included in the search. In March of 2018, all databases were searched. It was decided that a seven-year term would be sufficient to keep the scope reasonable and concentrate on the most cutting-edge advancements.

Kricket et al.30 provides a detailed description of the initial search approach, research identification, and data extraction method. A total of 19,510 scholarly papers were screened throughout the research selection process. The following key phrases were entered into the search engine:

The terms "care" and "nursing" are often used interchangeably, but the terms "robot" and "intelligent" are both used interchangeably, as are the terms "assistive" and "decision support system." The terms "ambient assisted living" and "sensor" are both used interchangeably, as are the terms "virtual reality" and "mixed reality." The terms "tagging" and "tracking" are both used interchangeably, as are the terms "remote (Effectiveness OR Efficacy OR Effect OR Efficiency OR Acceptance OR Adoption OR Acceptability HTA OR Health Technology Assessment OR Evaluation OR Evaluations OR Cost- Benefit Analysis OR Cost Benefit OR Cost Effectiveness OR Cost Utility OR Cost Analysis OR Cost Analyses OR Cost Consequence OR Economic Evaluation OR Economic Evaluations OR Economic Analysis OR Economic Analyses OR Costs and Benefits OR Benefits and Costs OR Costs and Outcomes OR Marginal Analysis).

- **Selection of Studies**

A total of 715 papers were found after a thorough search and selection procedure based on the original research topic. 30 Studies that only looked at acceptance or efficiency results (e.g. economic modelling studies), targeted educational settings or were situated solely in laboratories were excluded from the analysis in order to concentrate on effectiveness results that are relevant for people in need of care, formal or informal caregivers, or care institutions. On the basis of these limitations, data from 212 studies and 48 reviews were extracted in further detail in order to concentrate on the kind, intended audience, and substance of the reported results. Anness-outcomes with direct benefits for a patient, caregiver, or an institution were only included in the final analysis and presentation of data from single quantitative and qualitative research. We excluded studies that solely looked at technical or usability aspects of efficacy.

Studies included in meta-analyses and systematic reviews have to have at least a minimum level of systematic quality evaluation. Since the significance of the given findings could not be assessed without taking into account the study's overall quality into account, this judgement was necessary to make. Even if they claimed to be systematic or integrative reviews, they were removed from the analysis if they did not offer at least a basic quality evaluation of the included papers. No studies were included in this evaluation that met the eligibility requirements or where it could not be determined to which particular technical application the findings related. Systematic reviews were also omitted.

Figure 1 depicts the whole research selection process, including the exclusion of studies for various reasons.

To begin with, we gathered information on the studies' technology categories, research types, study settings, nation, number of study participants, target audience demographics, study settings, support fields, and the problems they were meant to solve. 30 Results from individual investigations were analysed in detail, focusing on their tiveness. People in need of care, caregivers, institutions, or the technology's usefulness were all grouped into one of four categories. It was determined if the reported impact was positive, tive, neutral, or ambivalent for each of these categories (ie, positive or neutral effects that were accompanied by some negative effects). Each category's influence was described in great detail. The first phase's data extraction was double-checked in terms of technology categories, research types, study settings, and the number of study participants. Effectiveness and acceptability results were included in certain dies. In cases where alternative methodologies or sample sizes were used to analyse these outcome dimensions, only the information relevant to the efficacy findings is shown or reported in this study.

Assisted living, assistive devices, ICT, monitoring/sensors, robotics, and virtual reality were among the technology areas in which the research were grouped together. Each technology-specific result section includes a list of category descriptions.

Review types, primary topics and/or relevant technologies, search period, study count, and key findings regarding efficacy as stated by authors were all taken into consideration when extracting data for a more in-depth analysis. A brief summary of study methodological quality and/or study limitations was also included in the data extraction process.

A single researcher extracted the data for the individual investigations, which was then double-checked by a second researcher.

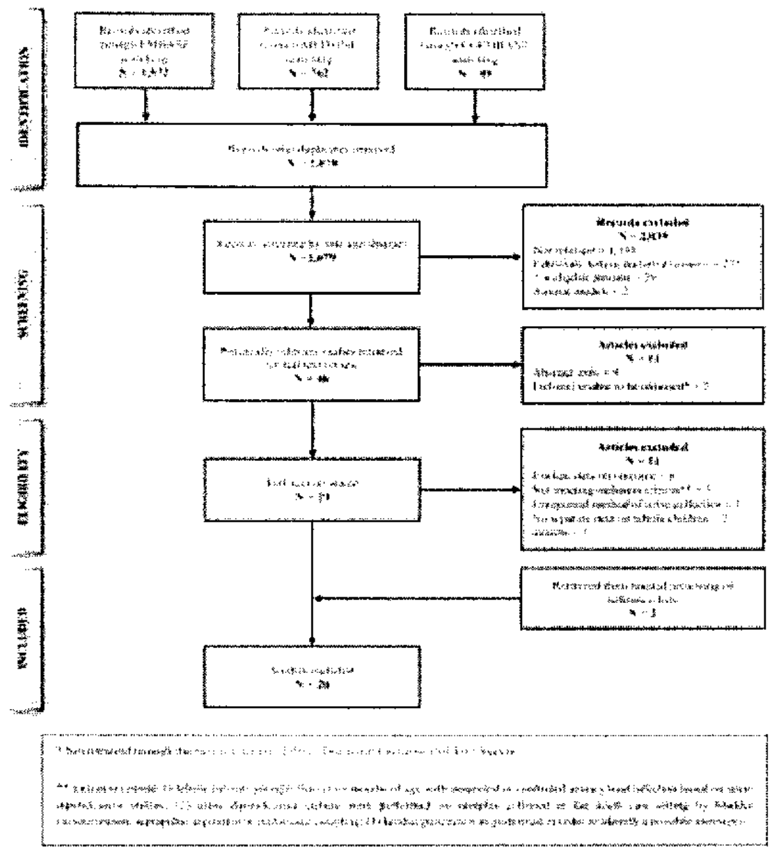

Figure 1 Flowchart: Documentation of study selection process.

Results were discussed between the two researchers if there was a dispute, and a compromise was reached. A single researcher extracted the data for the systematic reviews, and reviews that were omitted due to a lack of a quality assessment were reviewed a second time.

Table 1 shows the evidence level allocated to each research design based on standard evidence-based nursing and evidence-based medicine guidelines33,34, in order to offer the best possible indication of the reliability of the findings. Because we were unable to evaluate the quality of each research, we have included the category of "well-designed" studies in parenthesis in this table. It is under this category that study designs are classified that are not often seen in nursing or health research, but instead are more commonly found in technological research. These studies often include a small number of people and are conducted at an early stage in the creation of an ogy. A study with a control group is included in this category if there are fewer than 10 participants in the intervention group and the study does not offer sample size estimates (power calculations) or test data. The highest quality papers included in systematic reviews are used to provide a score to the review.

IV. Results

The results of a search:

The complete analysis of research findings (direction of results and kind of outcomes), target groups and set parameters, study type (degree of evidence) and study size comprised 123 single studies and 31 reviews in total.

Table 1 Level of Evidence Scale

Level of Evidence	Study Type
1a	Systematic reviews and meta-analyses that include more than one (well-designed) randomized controlled trial (RCT)
1b	(Well-designed) RCT
2	(Well-designed) controlled studies, without randomisation, ie quasi-experiments; or pilot RCTs (self-designated)
3	(Well-designed) case-control or cohort studies, (preferably from more than one centre or research group)
4	Findings obtained from descriptive, other observational and/or qualitative research designs (including case studies), cross-sectional studies, user studies

General Results:

For the most part, this study aims to identify digital technologies that have previously been tested for their impact on individuals in need of care, official or informal caregivers, or care institutions, and to identify technologies for which credible empirical evidence of beneficial benefits is available. Prior to going into depth about the technologies featured and their unique efficacy outcomes, below are the research kinds and study sizes that have been used to determine the reliability of the findings. Additional File 1 provides a comprehensive summary of the findings from each individual research (including information on study type and size, target setting, target group, direction and type of effect). Additional File 2 provides an overview of systematic reviews and their key features.

Direction of Results:

The goal of this study is to identify technologies that demonstrate promising positive results in terms of outcomes that directly influence people in need of care, formal or informal carers, or the efficacy of a care facility. In all, 74% of the included studies found favourable outcomes, whereas 15% revealed equivocal outcomes, i.e., the research provided positive and negative findings for various outcome aspects. Of the research, 11 percent couldn't find any statistically significant effects, and no study found pure negative effects. Table 2 shows the direction of the results of the various research, broken down by kind. Studies with greater evidence levels had a smaller percentage of positive findings, and this is worth noting. The RCTs included had only 60% positive findings and 30% neutral results, however the user studies have favourable results for 92% of the studies included in the dataset. Mixed-methods studies are an exception, with 50 percent reporting ambiguous findings.

Study Results in Detail by Technology Categories:

More information on the technologies that make up this review and the overall direction of its findings are offered in the following sections. Short descriptions of each category will be provided in the introduction. There is a comprehensive summary of all the findings from each study in Additional File 1.

For certain technical areas, relevant systematic reviews are stated if they exist in the appropriate sections. Many systematic reviews contain a broad variety of gies, while some of them concentrate on particular care issues and include just a small number of research using digital technologies. This paper's breadth prohibits the inclusion of a focused synthesis of all systematic reviews. This scoping review includes all systematic studies or meta-analyses that are included in Additional File 2. Most systematic reviews contain or mention that the quality of the studies included is moderate or low and that high-quality evidence is absent. A large number of them claim that the studies are essentially unrepresentative of each other. These studies, however, assist to highlight the scope of the analysed nologies, which is important. High-quality outcomes can only be achieved using a limited number of techniques.

Information and Communication Technologies (ICT):

A broad range of technologies are included under ICT. In general, they may be described as tools for gathering, storing, providing, managing, and/or improving interpersonal communication between people. They are all of these things. The following subcategories are used to categorise the mentioned technologies:

Table 2 Direction of Results by Study Type in Percent

Study Type	Level of Evidence	Number of Studies	In Percent	Direction of the Results		
				Positive	Neutral	Ambivalent
RCT	1b	20	16.3	60.0	30.0	10.0
Pilot RCT	2	4	3.3	75.0		25.0
Quasi-experiment	2	34	27.6	76.4	14.7	8.8
Case-control study	3	1	0.8	100.0		
Cohort study	3	1	0.8	100.0		
Mixed methods	4	6	4.1	33.3	16.7	50.0
Cross-sectional study	4	8	6.5	75.0	12.5	12.5
Case study	4	23	18.7	78.3	4.3	17.4
Qualitative study	4	13	10.6	76.9		23.1
User study	4	13	10.6	92.3		7.7
Total		123	100.0	74.0	11.4	14.6

(1). Hospital (or care institution) information systems (HIS)
(2). Electronic health (EHR)/electronic medical records (EMR)
(3). Computerized decision support systems (CDSS)
(4). Telecare
(5). General communication support
(6). Systems to support process planning and/or data exchange
(7). Specific Apps
(8). Target group specific interfaces

The category "Specific Apps" covers apps that don't fit into any of the other categories; it includes software solutions that help professionals, informal caregivers, or care-dependents in a variety of ways. Computerized decision support systems, for example, are often found in HIS and EHR/EMR systems because of their high level of integration.

ISSN- 2394-5125 VOL 09, ISSUE 02,

Patients' electronic medical records (EMRs) are a part of many hospital/care institution information systems (HIS). HIS collects, stores, manages and transmits patient data in hospitals and other care institutions.

V. Discussion

In general, a wide number of technologies are being investigated in connection to assisting nursing care, although almost no technology has been thoroughly examined to provide solid outcomes. In general, there aren't many research with a high degree of proof.

There are few randomised controlled trials (RCTs) among the papers included in this scoping review, which focuses on information and communications technology (ICT). Robotics and sensors/monitoring technologies are also heavily featured in this analysis. Two-thirds of the studies and all RCTs in the robotics category centre on the robotic seal Paro, therefore this is one of the few technologies that is thoroughly explored; nonetheless, most of the studies are fairly tiny. Only two of the four RCTs in the monitoring/sensors category indicate favourable outcomes, one on pressure ulcer prevention and the other on behaviour analysis for care decision support. 133 In spite of this, there are still a number of studies that generate favourable findings, indicating prospective study fields in the future. Scoping evaluations on sensor or monitoring applications that include studies on technological efficacy demonstrate that development in this subject is thriving. 30,156 10 different sensor systems were discovered in 118 investigations on enabling fall detection in a recent scoping review. 156 In most cases, they were just familiar with technology, and their degree of technical preparedness was typically poor. Nevertheless, this suggests that new applications may be developed if the technology's dependability is improved.

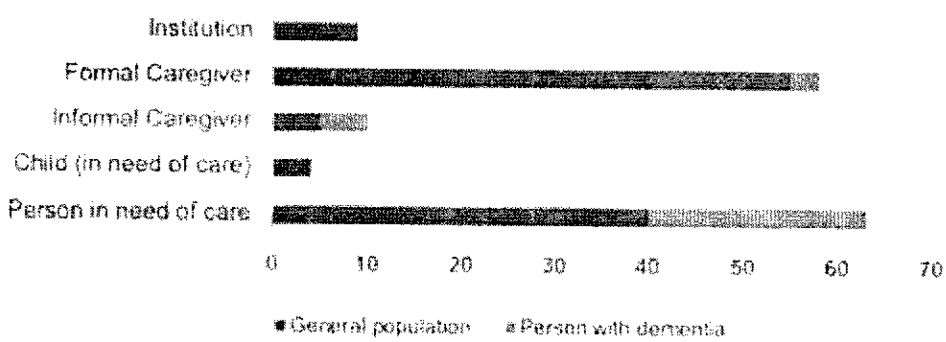

Figure 2 Number of studies by target group.

Due to the generally poor quality of the studies included in this scoping review in terms of evidence level, it is difficult to extrapolate much from what has been reported. It is consistent with the summaries of several of the systematic reviews that were included in this study. According to the majority of them, there was a wide range in quality amongst the included studies, the stated outcomes were frequently inconsistent, and the results could only be extrapolated so far. 1,4,23,25,92,93,112,113,157 Many systematic studies are older than this one, yet it can be inferred from this evaluation of the literature that this issue has not altered in recent years.

However, computerised decision support is an exception: a systematic review conducted by Bright et al. in 2010 had 148 RCTs66 and another meta-analysis conducted by Roshanov et al. in 2010 included 162 RCTs68; hence, this kind of system has a strong evidence basis. However, most of the included research pertains to medical treatment, and the number of papers that exclusively refer to nursing care remains unclear.

Settings and Target Groups:

There are strong hopes that digital technology will enable persons in need of care keep their freedom and support both official and informal carers. 1–3,158

In many industrial nations, the fast rise in the need for competent nursing care personnel brought on by population shifts is a primary motivation for technological research in health care.

158 To far, most research on technology care assistance have focused on hospital and inpatient long-term care settings, which is surprising given these issues. Only a few studies have been done on long-term care in the home, as this review indicates. Cross-sectoral care assistance, in particular, is substantially understudied. This may be owing to the fact that conducting scientific research studies in inpatient settings is considerably simpler than doing so in the outside world. Digital technology may play a part in lowering the need for professional care help, but it is necessary to support persons in need of care so that they can remain in their home surroundings, as many of them want. 159 Of course, research that relieves hospital and long-term care facility caregivers must also be encouraged. As a result, more attention should be paid to study into the use of technology to postpone or assist outpatient care arrangements. 30 As a result of a limited number of research, we may conclude that informal caregivers need help. There may be untapped opportunities to better incorporate informal carers into formal care systems, or lessen their care load, since just a few research have focused on this population.

VI. Conclusion

There have been several studies in the last few years looking at how new technologies may help those in need of assistance, as well as those who offer care and organisations. Also included in this analysis is information on the evidence levels at which the research were conducted, which reveals that high-quality studies are still lacking in the vast majority of technological fields.

It's clear that digital technologies may have a big impact on efficiency, but it's also important to consider how they're implemented in a certain environment. Potential advantages may not be realised if for example, nurses do not feel at ease with the system.

There is relatively little evidence of beneficial impacts for many technologies. As a result, it is understandable that healthcare organisations are hesitant to adopt cutting-edge technical solutions. According to this in-depth evaluation, there are a number of emerging technologies that need further study in the form of high-quality research.

The goal of relieving caregivers and addressing the nursing care deficit is commonly expressed, yet there is surprisingly few research that prove that it is possible to achieve this goal. The fact that so many researches are aimed at improving the quality of care or providing positive benefits for individuals in need is heartening. Research on outpatient long-term care and informal providers, in particular, should be supported more actively, as should research on gical solutions that allow older persons to stay at home (with a restricted amount of professional help). Cross-sectoral care research is also lacking at this point.

References

[1] Bemelmans R, Gelderblom GJ, Jonker P, de Witte L. Socially assistive robots in elderly care: a systematic review into effects and effectiveness. J Am Med Dir Assoc. 2012;13(2):114–120.e111. doi:10.1016/j.jamda.2010.10.002

[2] Fleming R, Sum S. Empirical studies on the effectiveness of assistive technology in the care of people with dementia: a systematic review. J Assistive Technol. 2014;8(1):14–34. doi:10.1108/JAT-09-2012-0021

[3] Liu L, Stroulia E, Nikolaidis I, Miguel-Cruz A, Rios Rincon A. Smart homes and home health monitoring technologies for older adults: a systematic review. Int J Med Inform. 2016;91:44–59. doi:10.1016/j. ijmedinf.2016.04.007

[4] Khosravi P, Ghapanchi AH. Investigating the effectiveness of technologies applied to assist seniors: a systematic literature review. Int J Med Inform. 2016;85(1):17–26. doi:10.1016/j.ijmedinf.2015.05.01

[5] CEDEFOP. Briefing Note: Skill Shortage and Surplus Occupations in Europe. Thessaloniki; 2016

[6] Greenhalgh T, Wherton J, Papoutsi C, et al. Beyond adoption: a new framework for theorizing and evaluating nonadoption, abandonment, and challenges to the scale-up, spread, and sustainability of health and care technologies. J Med Internet Res. 2017;19(11):e367. doi:10.2196/ jmir.8775

[7] Krick T, Huter K, Seibert K, Domhoff D, Wolf-Ostermann K. Measuring the effectiveness of digital nursing technologies: development of a comprehensive digital nursing technology outcome framework based on a scoping review. BMC Health Serv Res. 2020;20 (1):243. doi:10.1186/s12913-020-05106-8

[8] Rouleau G, Gagnon MP, Côté J, Payne-Gagnon J, Hudson E, Dubois CA. Impact of information and communication technologies on nursing care: results of an overview of systematic reviews. J Med Internet Res. 2017;19(4):e122. doi:10.2196/jmir.6686

[9] Billings J, Carretero Gomez S, Kagialaris G, Mastroyiannakis T, MerilÄInen-Porras S. The role of information technology in long term care for older people. In: Le A, editor. Long-Term Care in Europe. Palgrave Macmillan; 2013:252–277

[10] Billings J, Carretero Gomez S, Kagialaris G, Mastroyiannakis T, MerilÄInen-Porras S. The role of information technology in long term care for older people. In: Le A, editor. Long-Term Care in Europe. Palgrave Macmillan; 2013:252–277

Study and development of medical/nursing care support classification Using Radar technology and Hybrid WSN

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Abstract - As the world's population ages, medical and nursing care facilities are becoming more reliant on fewer and fewer employees. COVID-19, which took place in 2020, was confronted with the worldwide dilemma of failing medical practise under such conditions. The fear of a COVID-19 pandemic has brought home to people all across the globe just how critical it is that health care workers take precautions to avoid being infected. Observing the state of patients and care receivers without direct interaction is regarded very useful from this perspective. Using a combination of 24GHz radar and numerous Wireless Sensor Network devices, we will use this study to gather vital signs like breathing and heartbeat in a facility without making physical touch with the subjects. With our hybrid wireless sensor network technology, we can monitor the health and well-being of patients and care receivers across the institution, as well as outlying areas and suburbs. Data from each room's 24GHz radar signals will be shared in real time by using a high-speed mesh Wi-Fi network throughout the facility. The identification of passenger activity, breathing, and heartbeat by analysing radar signals is one of our challenges since cameras, which are difficult to place in the field owing to privacy concerns, and sensors worn by the subject must be avoided. If a patient or resident has left the institution, the Wi-SUN FAN mesh network in the vicinity of the facility with a radius of approximately 500 metres may be used to determine the current state of the resident's walking area. In addition, in the suburbs, individuals without cellphones will be able to access their position data through a LoRaWAN tiny terminal. In this research, we present the Hybrid Wireless Sensor Network platform for medical and nursing care locations based on 24 GHz radar sensing technology and hybrid wireless sensor network technology, as previously stated. This technology will be put to the test in a real nursing home, and the results will be presented

Keywords - WSN, HybridWSN, FM-CW, Wi-Fi, Wi-SUN, LoRaWAN.

I. Introduction

In affluent nations, the proportion of the population over the age of 65 now stands at 20 to 25 percent, but this figure is predicted to rise to 25 to 35 percent by the year 2040 as the population ages. A shortfall of more than 370,000 caregivers is expected in Japan by the year 2025. Human resources are projected to be in limited supply, particularly in metropolitan regions. Dementia affects roughly 50 million individuals throughout the globe now, and there are an estimated 10 million new cases each year. It is projected that these concerns would grow increasingly significant over the world in the medical and nursing care sectors.

COVID-19, which took place in 2020, was confronted with the worldwide dilemma of failing medical practise under such conditions. The fear of a COVID-19 pandemic has brought home to people all across the globe just how critical it is that health-care workers take precautions to avoid being infected. As a

ISSN- 2394-5125 VOL 09, ISSUE 01,

result, it is thought to be incredibly beneficial to identify the state of patients and care receivers as much as possible without interaction.

The 24GHz radar sensing technology is combined with several wireless sensor networks in this study to capture non-contact data on the facility's living behaviour and biological data, such as breathing and heartbeat. We'll build a medical/nursing hybrid sensor network platform that can monitor patients and care receivers across the hospital, as well as outlying areas and suburbs. Multi-hop real-time sharing of 24-GHz radar signal data will be made possible at the facility through a fast Wi-Fi mesh network. When a patient or resident leaves the institution, the Wi-SUN FAN mesh network may be used in an area with a radius of roughly 400 metres to determine their current location. Residents without cellphones in the distant suburb zone may have their position data managed centrally using GPS data from a tiny LoRaWAN terminal. A hybrid wireless sensor network platform for medical and nursing care facilities is proposed in this study using 24 GHz radar sensing and hybrid wireless sensor network technology, as previously stated. The findings of a real-world field experiment of this technology at a nursing home will be presented in this article.

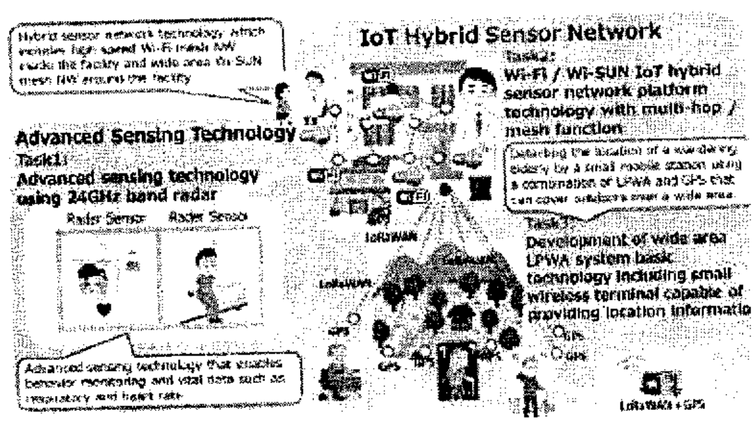

Figure 1: Hybrid Wireless Sensor Network System for Medical/Nursing Care with 24GHz Radar

II. 24GHz Radar Sensing

Because privacy is an issue in medical treatment, we utilize 24GHz radar instead of a camera to monitor a patient's actions (such as sleeping, sitting, and falling) in their room. We'll also be able to monitor heart and breathing rates without the need of touch sensors. Radar technology uses FM-CW (Frequency Modulated Continuous Wave) radar. Using the amplitude and phase components of the distance spectrum, it is feasible to detect a very small displacement.

Breathing and heart rate are recorded using minute displacement, while behaviour is assessed using distance. ARIB STD-T73, a standard for low power radio stations that do not need a licence, is used to set the radar's centre frequency at 24.15 GHz and all other configuration settings.

A *Life behavior detection*

The 24GHz FM-CW radar described above may be used to identify the living behaviour of a resident without the need of image analysis by a camera, which has a privacy concern. Nursing home residents were used as subjects for an experiment. When a 24GHz radar sensor is mounted on the ceiling (2.4m high) at the living room's entryway, a measurement is made to determine the resident's living habits.

ISSN- 2394-5125 VOL 09, ISSUE 01,

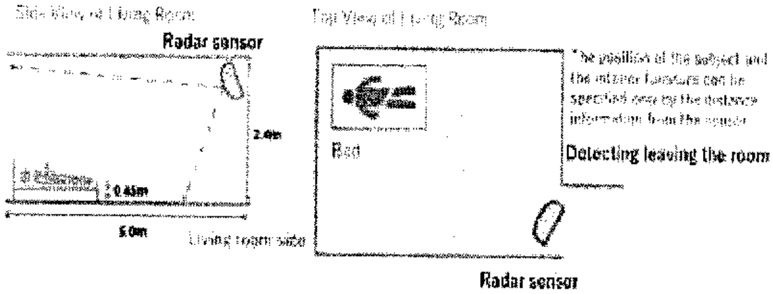

Figure 2: Installation of radar sensors in genuine nursing homes

We'll go through how to look for certain patterns in the behaviour of living things. The resident of the above-mentioned experimental environment performs five fundamental motions that we categorise as "on bed," "walking," "crouching," and "falling," and we look for continuous movements that combine these movements. First Table 1.

Table 1: 5 Life Behavior Definitions

	On the Bed	On the Floor			
Life Behavior	sleeping	walking	crouching	falling	absence

Installing a camera and a radar sensor in the living room allows researchers to determine whether or not the real behaviour being seen can be appropriately identified and utilised as a standard for comparison. Our machine learning model was built utilising the radar sensor's data and Keras, an open source neural network framework for the model, to analyse the subject's live behaviour. This machine learning model was created on a single board computer coupled to the sensor in the experimental setting. For the machine learning model, we utilised data from ten adults, three from each sexe, who were tested three times each for five distinct patterns of behaviour. Table 2 shows that the five most common forms of conduct were recognised at a specific level of accuracy.

Table 2: Basic 5 definition of Life Behavior

	On the Bed	On the Floor				average
Life Behavior	sleeping	walking	crouching	falling	absence	
Recognition rate	82.5%	72.8%	38.6%	45.0%	83.8%	75.5%

B *Respiratory rate detection*

The detection of respiratory rate will be explained first as a method for obtaining crucial data without having to make physical touch with the person, such with a wearable device. An FFT analysis of the FM-CW radar's time-varying phase component of the distance spectrum is initially used to identify a small change in the target's breathing rate.

An FM-CW radar sensor positioned on the ceiling emits a 24 GHz signal, and the top left figure depicts the temporal change of the phase component of the spectrum.

The data produced by transforming this distance spectrum's time change data into the frequency domain by FFT processing are shown in the graph below. The highest value of this data is used to determine the usual breathing rate of an adult at rest, which is between 8 and 24 breaths per minute. A respiratory rate of 11.6 breaths per minute was recorded in this case.

We compared our radar's estimated respiration rate to a wearable sensor's estimated respiratory rate in order to verify its accuracy.

III. Hybrid Wireless Sensor Network System

Many approaches have previously been suggested for WSN (Wireless Sensor Networks) networks, including some currently classed as LPWA (Low Power Wide Area) (Low Power Wide Area).

Wireless sensor networks were built in each of three zones: within the institution, surrounding it and outlying it. We then performed a demonstration experiment to show how a hybrid wireless sensor network may be used in medical and nursing care facilities, based on real use cases.

A *Wireless sensor network around the facility (Zone2) (multi-hop Wi-SUN FAN network)*

To convey periodic still photographs and other data throughout the facility, we will establish a wireless sensor network with a specific data speed and a radius of roughly 400 m. Due to the data rate limitations of the typical LPWA (Low Power Wide Region) approach, it is impossible to cover such a large area using Wi-Fi. We utilised Wi-SUN as a WSN for Zone2 because of these kinds of requirements.

While the Wi-SUN system's communication range is less than other LPWA systems, the data throughput is comparable to other LPWA systems, and multi-hop is supported, making it a viable alternative. An experiment with one-hop Wi-SUN FAN communication in a real elderly home may be shown in Figure 3. Figure 3 shows that the Wi-SUN FAN 1-hop connectivity was verified within the 400 m visible range of the installation. Furthermore, the Wi-SUN FAN's multi-hop capability enables communication even when the Wi-SUN FAN is not directly in line of sight.

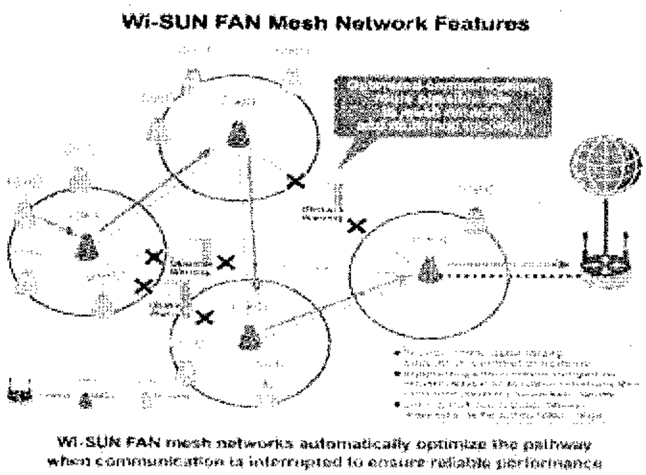

Figure 3: Wi-SUN FAN network coverage in one hop around the site (Zone2)

Wi-SUN FAN is used to demonstrate a still image transmission experiment. As previously mentioned, we ran an experiment in which a still picture that is difficult for standard LPWA to communicate was sent on a

ISSN- 2394-5125 VOL 09, ISSUE 01,

regular basis. A still picture captured by a Web camera with 1,2 million pixels, as illustrated in Figure 4, may be delivered about once per minute.

In Zone2, the Wi-SUN FAN network allows for the transmission of still picture data every minute, which is otherwise impossible with Wi-Fi or the conventional LPWA system owing to data speed limitations. A function of monitoring a hazardous location surrounding the facility may be accomplished without Wi-Fi or mobile network, for example, when the care receiver of the institution leaves.

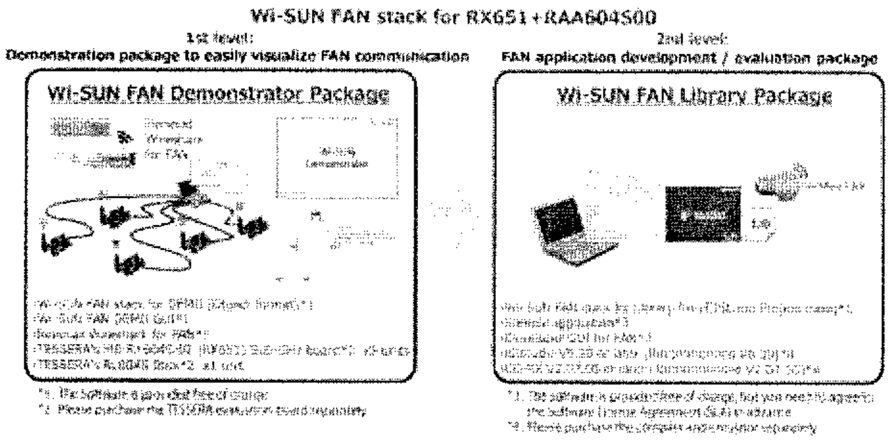

Figure 4: Wi-SUN FAN still image transmission Experiment

B *Wireless sensor network in the suburbs of the facility (Zone3) (LoRaWAN)*

Assume a 10 km radius around the site while creating a wireless sensor network for monitoring. Sensor networks that value distance over speed, such as identifying when a facility resident has left the suburbs, are assumed to be in place. LoRaWAN is employed here, despite the fact that other LPWA (Low Power Wide Area) solutions have been offered.

An experiment was carried out in the field to verify the real coverage area of LoRaWAN. The received power was simulated using the radio simulation programme "Radio Moble" at the field experiment region. The LoRaWAN system design in these experiments is shown in Figure 5.

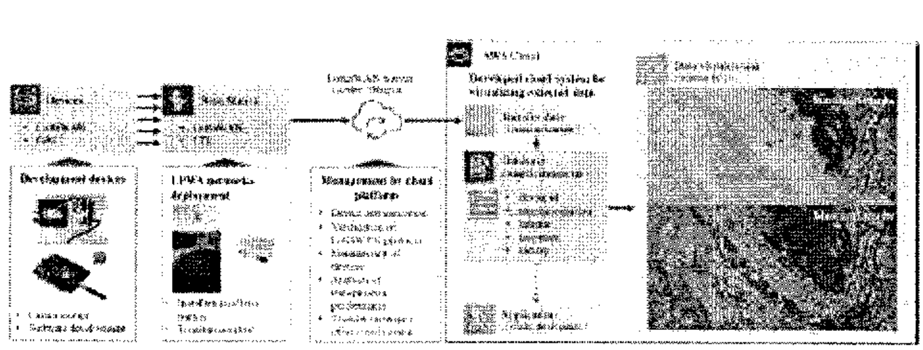

Figure 5: LoRaWAN system setup

There are 26 real measurement points shown in the simulation results shown in Figure 12. The "Radio Mobile" topography elevation difference simulation and the observed data are almost identical. It's clear that communications are working within a radius of around 10 kilometres of these findings.

ISSN- 2394-5125 VOL 09, ISSUE 01.

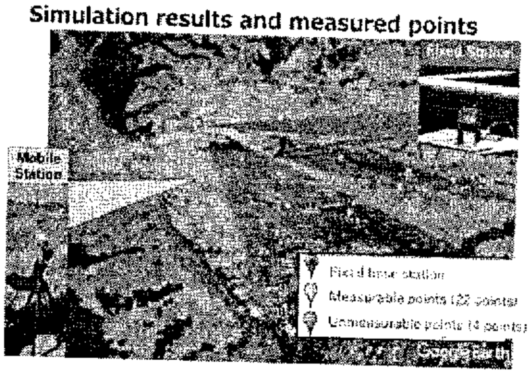

Figure 12: Training in LoRaWAN

IV. Discussion and future research

We've been employing 24 GHz radar sensing technology to collect vital signs like breathing and heartbeat from patients and care receivers without having to make any physical contact. A hybrid WSN environment for medical and nursing care has also been created by merging this non-contact sensing technology employing radar with numerous WSNs that are appropriate for each zone of the institution.

Using 24GHz radar, we studied the definition and detection of five essential life activities. Efforts to enhance the identification rate will continue in the future, while the machine learning model will be fine-tuned, as it has been for the core five categories of living activity detection so far. An 80% to 90% identification success rate was achieved in both the supine and sideways positions when utilising 24GHz radar sensing for respiratory rate detection, but heart rate detection is still challenging unless in the case of supine and a relatively small detection distance. The detecting method for heart rate will be improved in the future.

With the use of Wi-SUN FAN and LoRaWAN, Zone1 at the facility, Zone2 surrounding the facility, and Zone3 in the suburbs were all established as a hybrid wireless sensor network. The Zone1 facility was able to exchange radar sensor data thanks to its hybrid WSN environment. When it detects that a resident has left the institution, it has activated still picture surveillance in the Zone 2 region surrounding it. When a resident leaves Zone3 for the suburbs, a check to see whether the location information has been enabled will be performed. In a real nursing home, we were able to confirm the existence of hybrid WSN settings.

The hybrid WSN platform may be built using the WSN technologies in a scalable and adaptable way, depending on the IoT application's needs. By merging Wi-Fi 6 or local 5G high-speed networks, it is possible to create an environment that is faster and more responsive. We'd want to build a hybrid WSN platform that can handle a wide range of IoT applications, including smart cities, agriculture, forestry and fisheries, disaster mitigation, manufacturing, and other areas that aren't only medical or nursing care-related.

V. Conclusion

Patients and caregivers' important data may be detected without any physical touch thanks to a 24GHz radar sensing technology and a hybrid WSN environment that uses several wireless sensor networks in each of the three zones. We built a hybrid WSN environment for medical/nursing institutions and tested it in the field at real nursing homes to verify its usefulness. We think that the technology developed in this study may help address not just the medical issues associated with an ageing population that are becoming more prevalent throughout the globe, but also situations like the global medical crisis seen at COVID-19.

ISSN- 2394-5125 VOL 09, ISSUE 01.

References

[1] Seibert, K., Domhoff, D., Bruch, D., Schulte-Althoff, M., Fürstenau, D., Biessmann, F., & Wolf-Ostermann, K. (2021). Application Scenarios for Artificial Intelligence in Nursing Care: Rapid Review. Journal of medical Internet research, 23(11), e26522.

[2] Gasmi, A. (2021). Enabled IoT Applications for Covid-19. In Computational Intelligence Techniques for Combating COVID-19 (pp. 305-331). Springer, Cham.

[3] Haleem, A., Javaid, M., & Vaishya, R. (2020). Effects of COVID-19 pandemic in daily life. Current medicine research and practice, 10(2), 78.

[4] IZADP, N., & Naudé, W. (2020). DISCUSSION PAPER SERIES artificial intelligence against COVID-19. An Early REv, 13110.

[5] Hartmann, M., Hashmi, U. S., & Imran, A. (2019). Edge computing in smart health care systems: Review, challenges, and research directions. Transactions on Emerging Telecommunications Technologies, e3710.

[6] Li, D. (2019). 5G and intelligence medicine—how the next generation of wireless technology will reconstruct healthcare?. Precision clinical medicine, 2(4), 205-208.

A design and application of unobtrusive sensor system to support incontinence care of elderly nursing homes

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Abstract:

Patients in long-term care facilities often suffer from incontinence. Elderly people are burdened physically and mentally, but so are caretakers, who have to deal with an increased task. In order to alleviate the burden of caring for someone with incontinence, there are a variety of technological solutions available. Because of this, these systems are too expensive. Residents of nursing homes complain about the inconvenience of these facilities. To find a solution to address these issues, we've developed an attached sensor system.to a mattress equipped with incontinence detection and monitoring technology events. Bluetooth Low Energy and Influx DB were used to create a prototype. Using the sensor data, may be accessed by other systems in real-time so that it may be put through even more checks. There will be more safeguards in the future energy measurements and other components may be used to create the system is completely relocatable.

Keywords – Bluetooth Low Energy, incontinence, Grafana, InfluxDB, sensor system

I. INTRODUCTION:

More than half of the residents in nursing homes suffer from some form of incontinence, whether it be urinary or faecal. Elderly people with incontinence need to be taken to the bathroom on a frequent basis for incontinence management. Caregiver checks are often done too early or too late, leading to incontinence material being replaced too early or too late. As a result, residents suffer, and caregivers are burdened with extra labour [1], [2]. Incontinence occurrences account for 20% of the time spent on caring throughout the daytime [3]. As a result of current methods, not only are nursing homes dealing with more patients, but they are also having to pay more money.

In order to address these issues, a system that is both comfortable for the patient and capable of measuring parameters related to incontinence must be developed.

Sensors on the bed and in the room are used to showcase a novel sensor system for measuring incontinence-related metrics in an unobtrusive manner. A fast prototype was made utilising widely available components. As a starting point, we believe that incontinence incidents may be recognised by comparing temperature, humidity, and ammonia (NH_3) concentrations surrounding the bed and in the room.

Below is a breakdown of the rest of this document: The shortcomings of today's cutting-edge systems are examined in Section II. Sensor technology is discussed in Section III. In this case, sensors are discreetly integrated into the room and the bed. Using Bluetooth Low Energy and off-the-shelf sensors, an example sensor system is shown in Section IV. Hardware and software components are included in this category. Sensor data may be retained and exported for further analysis in Section V. In Sections VI and VII, further research and conclusions are made.

II. BACKGROUND

In most modern systems, sensors implanted in incontinence products are used. These have a number of drawbacks [4]. Nursing home patients frequently complain that these items are too intrusive and unpleasant for them to use. Adding these sensors also raises the price of the incontinence product. This is compounded by the fact that the embedded sensors can only measure for a limited period of time and may not be monitored in real time. Instead, a urinary diary is used to keep track of a person's progress. This means that health care workers are unable to respond quickly when required. As a result, they put people on the toilet at certain periods based on information obtained over a short period of time, such as 72 hours. Because of the disparate nature of the systems' software, it is almost difficult for them to communicate with one another, for example, a nurse call system. The cost of this programme is also included. Connecting them to nurse call systems would allow for the suggestion of patients to be communicated directly to medical workers, saving them from learning and using a new system.

By combining sensors on the bed and sensors throughout the room, we want to create a new sensor system for use in nursing homes, one that is both interoperable and inconspicuous to nursing home residents with urine incontinence.

III. PROPOSED SYSTEM

A new sensor system is required to address the issues outlined in Section II. Figure 1 depicts a high-level representation of the proposed sensor system. Here is a rendering of a nursing home room with sensors installed around the space, even on the bed itself. To continue processing, the data is sent to a server through a gateway.

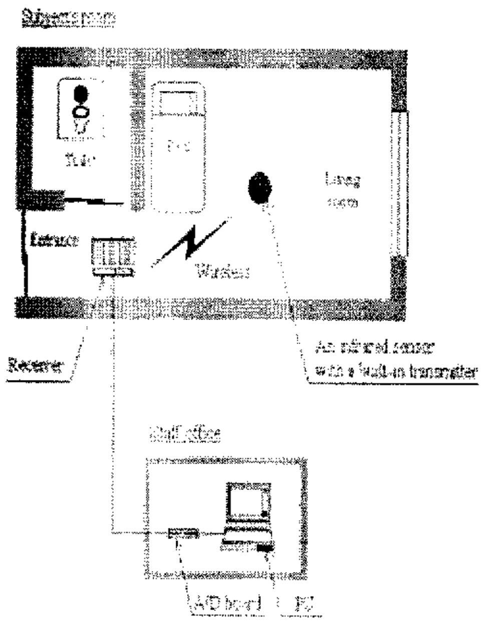

Figure 1. A room at a nursing home with the planned sensor system

Sensors may be built into the mattress or attached to the side of the bed. Detecting incontinence incidents may be achievable by integrating and comparing sensor readings from the bed itself and the surrounding environment. When an incontinence occurrence occurs, caregivers might be alerted to the situation. It is also cheaper than other systems since the sensors only need to be bought once, reducing the burden on carers. Sensors may be easily incorporated into the bed, making them less disruptive to nursing home residents.

The raw sensor data is saved on a server in a time-based database for processing. As a result, all sensor data must be sent to the gateway, which then delivers the data to the database with the appropriate information. Extraction, visualisation, and processing of this data are all possible.

IV. SENSOR SYSTEM

The sensor system that has been suggested has already had a prototype produced. It is possible to collect data from patients at a nursing home. A simple attachment to a bed is all that is needed to test this device. It was built from commercially available parts in order to speed up the prototype process.

A. Sensor selection

Commercially available sensors were utilised to create a sensor system mounted to the bed. Click boards are breakout boards from MikroElektronica that employ the mikroBUSTM standard for its sensors.To rapidly prototype and develop a test system, this open standard lets you link the click board into the click shield without having to design a bespoke printed circuit board. A wide range of sensors may be connected to the mikroBUS standard, which supports a wide range of communication protocols. Here are the sensors that were used and why they were selected.

The Weather click is the first sensor to be introduced. The Bosch Sensortec BME280 environmental sensor is at the heart of this board's design. In addition to humidity and pressure, the sensor can also monitor temperature and humidity (+/-0.3% rh).It is feasible to detect changes in an incontinence episode by taking temperature and humidity measurements near to the bed and comparing them to ambient values.

Second temperature and humidity sensor, the Temp&Hum 2 click, is installed and may be used to monitor environmental data just close to the mattress. Silicon Labs' Si7034 sensor powers it. Moisture content (+/-4% rh) and temperature (+/-0.4°C) may both be measured by this device.

Additional sensors include the Accel 5 click, which collects data from the accelerometer in all three directions (x,y,z). The sensor used for this is the Bosh Sensortec BMA400 low power triaxial accelerometer. It is possible to observe when the patient gets out of bed, enters the bed, or leaves the bed by attaching this to the mattress. It's possible that a resident's pain is one reason for moving.

The Air quality 5 click sensor is the system's last piece of hardware. Using a MiCS-6814, three MOS sensors are integrated into this sensor board. All of these sensors are sensitive to certain gases. Various gases may be measured using these sensors. Carbon monoxide (CO), nitrogen dioxide (NO2), ethanol (C2H5OH), hydrogen (H2), ammonia (NH3), methane (CH4), propane (C3H8), and butane (C3H10) are some examples (C4H10). An incontinence sensor may be connected to the patient's bedside in order to detect gases. Incontinence episodes may be detected in the air using an NH3 dilution process, which was previously shown. In these studies, sensors like the commercially available MICS-6814 were shown to be capable of measuring NH3 concentrations that are comparable to urine's NH3 content [5]. The usual concentration ranges from 6 to 47 ppm. Custom boards with the same layout were made to measure minuscule changes in gas composition. The design has a 16-bit A/D converter instead of a 12-bit one. This improves the precision even more.

B. Bluetooth Low Energy (BLE)

Bluetooth low energy (BLE) was utilised to create a portable system that allows sensors to be added to the bed. As part of the Bluetooth standard stack with the release of Bluetooth 4.0 is the Bluetooth SIG's BLE technology. If you're looking for an energy-efficient device, this is the one for you! In this scenario, the "just works" connection is employed.

Connecting two devices is now easier since no security key has to be entered before they can be used together, Using Generic Attribute Profile (GATT) transactions, BLE devices may exchange data. Client-server model: GATT-server holds data and GATT-client may request particular data from the server based on the transaction type. Services, a term used to describe a collection of distinct features, are used to categorise this information. There is a single globally distinct identification for each service and attribute (UUID). Some of these services are established in the Bluetooth standard and may be addressed using 16-bit UUIDs. The Heart Rate Service (0x180D) features a feature called Heart Rate Measurement as an example of a predefined service (0x2A37).

You may create your own unique Bluetooth features and services that don't appear in the Bluetooth standard for your own personal usage. Using a 128-bit UUID, they may be categorised. As a GATT-server peripheral, a sensor might provide a variety of capabilities and services. In order to receive the data, a GATT-client must be installed on a gateway (central).

The microcontroller in this device is a nRF52840 chip. The Nordic Semiconductors chip includes a variety of ways to transmit wirelessly. Bluetooth 5, Thread, and Zigbee are all supported by its multiprotocol system on chip. This implies that data may be sent and received using the eco-friendly Bluetooth low energy standard.

The nRF52840 chip is housed in a nRF52 Development Kit. The configuration of this board is comparable to that of an Arduino Uno board, which is a benefit. Arduino Uno shields may now be attached to the board using this feature. The Arduino Uno Click Shield is available from MikroElektronika. This shield can hold all of the click boards. Many click sensors may be found connected to this kind of development kit, as seen in Figure 2.

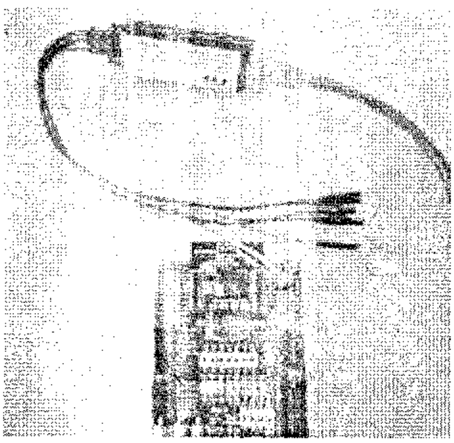

Figure.2. Image of nRF52 measuring equipment with click sensor

The nRF sensor board's expandability and power control are made easier with Zephyr RTOS. In addition to Intel, NXP, Texas Instruments, and Nordic Semiconductor, it is an open source Real Time Operating System [6]. It is because Nordic Semiconductor is actively involved in the Bluetooth stack that Zephyr is picked above other Real-time operating system options. Additionally, drivers for SPI, UART, CAN/I2C, and more are included. As a result, the Click sensor drivers may be easily integrated.

A special BLE GATT service, the Bed Service, has been developed to deliver data via Bluetooth Low Energy. f364adc9-00b0-4240-ba50- 05ca45bf8abc is the UUID assigned to this service. This is a 128-bit UUID created at random.

For each of the click boards, the service base address is used to generate a unique identifier (UUID) for each board. The 'XX' bytes represent a sensor board's particular code. It's shown in Table 1 that every characteristic code has a matching MikroE sensor.

TABLE 1. CHARACTER CODES LIST

Characteristic code	Corresponding click sensor
0x01	Weather
0x02	Accelerometer 5
0x03	Air quality 5
0x04	Temp & hum 2

There are permissions in place for all of the attributes to be read or alerted. A client may subscribe to a feature if it performs a notify action. The sensor provides a notification to the client who has subscribed to it when that characteristic changes.

There is a requirement for a gateway since the sensor does not have direct internet connectivity. As a room gateway, a Raspberry Pi is used. To connect to the Bed sensor, a BLE central is built on the Raspberry Pi. The central will scan for advertising BLE peripherals, while the Bed sensor will begin advertising. Afterwards, the Raspberry Pi will attempt to establish communication with the Bed device. After the connection is formed the

Raspberry Pi will subscribe to all the characteristics in the bed service. A notice is sent to the Raspberry Pi central every time a value on the peripheral side is modified. An InfluxDB database gets notified every time this notification is received.

V. DATA STORAGE AND USAGE

Data must be saved in a database before it can be analysed.The use of a time series database, such as InfluxDB [7], is necessary since the data must be taken into account throughout the course of time. Open source time series database that can store enormous volumes of data in real-time with their accompanying timestamps is available.

An open source library is used to deliver data to the InfluxDB data storage. The gateway will use this library to transfer data received over BLE to the InfluxDB datastore. When the data is imported, it produces a timestamp automatically.

To do data analysis, it is necessary to see and export all of the data. For this, we'll be using Grafana [8], an open source data visualisation tool. Using Grafana's tight connection with InfluxDB, you can see all of the data saved in the InfluxDB datastore.

VI. FUTURE WORK

There is currently a power source for all of the sensors and the microcontrollers. We need to know how much energy a sensor system uses in order to make future sensor systems more portable. In order to save battery life and lessen the load on the network, it will be necessary to conduct data aggregation given that only raw data is transferred.

Because the sensors were transmitting biological data, they needed to be secure. However, under the existing system, there has been no addition of security. Authentic and private data must be sent to the server in a secure way at all times.

For the time being, the data is merely being kept and shown. Incontinence occurrences may still be detected and perhaps predicted using machine learning utilising that data. Additional BLE-enabled sensors may be added to a room or a bed to collect additional data if necessary.

VII. CONCLUSION

An inconspicuous method of supporting continence care has been explored in this research. In the first place, we've explained why a sensor system is necessary. Present-day tactics are often pricey, intrusive, and unpleasant for nursing home patients. Using sensors placed in the bed or connected to the mattress, we then presented a system that could detect incontinence incidents without being intrusive.

Next, a sensor system that can be connected to a bed was shown using commercially available components. Sensors may be quickly and affordably added by using a Bluetooth Low Energy microcontroller. All sensors in a single room are connected to a single gateway, which then sends the data to a server for further processing. This is where the data is kept in order to be used in the future.

REFERENCES

[1] Strauven, H., D'haeseleer, I., T'Jonck, K., Hallez, H., Abeele, V. V., Crombez, P., & Vanrumste, B. (2020). Towards an Ambient Support System for Continence Management in Nursing Homes: An Exploratory Study. In Healthinf (pp. 438-446).

[2] T'Jonck, K., Kancharla, C. R., Hallez, H., & Boydens, J. (2020, September). Accelerometer Based Activity Tracking to Support Elderly Care in Nursing Homes. In 2020 XXIX International Scientific Conference Electronics (ET) (pp. 1-4). IEEE.

[3] Gattinger, H., Hantikainen, V., Ott, S., & Stark, M. (2017). Effectiveness of a mobility monitoring system included in the nursing care process in order to enhance the sleep quality of nursing home residents with cognitive impairment. Health and Technology, 7(2), 161-171.
[4] Yang, K., Isaia, B., Brown, L. J., & Beeby, S. (2019). E-textiles for healthy ageing. Sensors, 19(20), 4463.
[5] Raepsaet, C., Serraes, B., Verhaeghe, S., & Beeckman, D. (2021). Integrating Sensor Technology in Disposable Body-Worn Absorbent Products: A Qualitative Study to Define User Profile,(Technical) Criteria, Conditions, and Potential Benefits. Journal of Wound, Ostomy and Continence Nursing, 48(6), 560-567.
[6] Banerjee, A., & Armstrong, P. (2015). Centring care: Explaining regulatory tensions in residential care for older persons. Studies in Political Economy, 95(1), 7-28.
[7] Oguntala, G. A., Abd-Alhameed, R. A., Jones, S. M., & Noras, J. M. (2017, June). Unobtrusive mobile approach to patient location and orientation recognition for elderly care homes. In 2017 13th International Wireless Communications and Mobile Computing Conference (IWCMC) (pp. 1517-1521). IEEE.
[8] Oguntala, G., Obeidat, H., Al Khambashi, M., Elmegri, F., Abd-Alhameed, R. A., Yuxiang, T., & Noras, J. J. M. (2017, September). Design framework for unobtrusive patient location recognition using passive RFID and particle filtering. In 2017 Internet Technologies and Applications (ITA) (pp. 212-217). IEEE.
[9] Edoh, T., & Degila, J. (2019). Iot-enabled health monitoring and assistive systems for in place aging dementia patient and elderly. Internet of Things (IoT) for Automated and Smart Applications, 69.
[10] Petrushin, A., Freddolini, M., Barresi, G., Bustreo, M., Laffranchi, M., Bue, A. D., & Michieli, L. D. (2022). IoT-Powered Monitoring Systems for Geriatric Healthcare: Overview. Internet of Things for Human-Centered Design, 99-122.
[11] Farrell, K., & Vellinga, A. (2019). Geriatric Medicine and Gerontology.
[12] Kehyayan, V., Hirdes, J. P., Tyas, S. L., & Stolee, P. (2015). Residents' self-reported quality of life in long-term care facilities in Canada. Canadian Journal on Aging/La Revue canadienne du vieillissement, 34(2), 149-164.

ISSN:1553-6939

The Robust Nurse Scheduling Problem

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Abstract — In hospitals, nurse scheduling and assignment is a major issue. In order to keep hospital expenses down and respect the preferences of the nurses, a well-planned schedule is needed. For the nurse scheduling problem (NSP), we provide a novel mathematical formulation that incorporates certain additional restrictions. For coping with uncertainty, we also present a resilient equivalent to the deterministic model, which is based on the worst-case scenario A future project will focus on developing a solution and putting it into action.

Keywords — nurse scheduling problem, robust optimization, worst case criterion, nurse preferences

I. INTRODUCTION

Many publications in the literature have dealt with scheduling issues in recent years, owing to its efficiency in maximising an organization's profitability and productivity.

In terms of health care, nurses have a lot of obligations in hospitals since they care for patients to boost their happiness. This may lead to overtime work and job discontent, both of which can significantly effect hospital quality of service.

To satisfy working contracts and hospital demand, the NSP entails arranging cyclic schedules (daily, weekly, or monthly) for nursing staff by allocating various nurses to several shifts.

The NSP may maximise a variety of goals, such as hospital costs, nurse preferences, and so on.

On the one hand, a novel formulation for the NSP is offered, and on the other hand, a robust optimization model for the nurse scheduling issue is presented for coping with uncertainty in the number of nurses in each period is presented in this paper. We consider the total hospital cost as well as the cost of overtime each day. The horizon, shifts, and the day off, which marks the holiday, are all factors in the planning.

The planning horizon is a period of time (usually considered as a week). A day is divided into 12 shifts, each of which lasts two hours. Each day consists of four morning shifts, four afternoon shifts, and four night shifts. Furthermore, multiple nurses must be pleased throughout each shift.

Normal nurses (grade 1), specialised nurses (grade 2), and head nurses (grade 3) are the three types of nurses examined (grade 3). Many restrictions must be considered as a result of hospital policy:

- Nurses have set working hours that must be adhered to.
- The nurses are required to take a day off.
- If nurses perform night shifts on a day, they have no work hours the following morning.
- If the nurses performed morning/afternoon shifts on the same day, they must not work all night shifts on the same day.

The goal of this research is to provide a novel NSP formulation that takes into consideration nurse availability on each shift. Using the worst-case criteria and the uncertainty in nurse demand in each shift, we offer a robust counterpart model.

II. LITERATURE REVIEW

Researchers employed many methodologies to solve the NSP in several literatures; we mention precise and approximant strategies. For accurate approaches, a fuzzy approach was given for the NSP. They took into account the unpredictability of nurses' preferences as well as the demand for nurses on any given day. For the NSP, I presented a mathematical model that reduced nurses' idle waiting time. They used optimization software to solve the issue after including certain limits. In cancer clinics, an optimization technique was presented to reduce nurse overtime and overall patient waiting time. The suggested optimization method was split into two multi-objective models: one for primary care delivery and the other for functional care delivery. Developed a strategy to assist hospital administrators and prevent manual scheduling, which might raise costs. For two types of nurses, they developed a heuristic and a mathematical model for the NSP. The NSP was solved using a multi-commodity network flow model and an integer linear programming (ILP) paradigm. Approximant techniques have been employed by several writers to solve the NSP. For the downgrade issue, I presented a strategy to enable nurse scheduling and preferences. The authors used an ILP model to address the issue and used the column-generation method to solve it. Developed a mathematical model to meet the needs of hospital administration and nurses. They employed a commercial optimizer and added limitations such as hospital policy and nursing preferences. At a large United Kingdom (UK) hospital, I presented a genetic algorithm method to solving the NSP. Because of the multi-objective character of the challenge, a method for integrating certain competing goals and constraints for the NSP was proposed. The column-generation technique and other heuristics were used to address the challenge. Introduced a method for maximising the preferences of nurses. A heuristic derived from a multi-agent system was used in their method. Developed a deterministic heuristic technique with the goal of meeting nurses' preferences while lowering the cost of soft constraint violations. There were two stages to the algorithm. A solution to the issue of nurse scheduling was proposed. They introduced an ant colony algorithm that takes numerous hard and soft limitations into consideration. Only a few papers have addressed the robust NSP. Considered two approaches to addressing the NSP goal: ensuring that each shift has an adequate number of nurses. SAWing and noising are compared to see which procedure produces the greatest results. A hyper-heuristic strategy was presented for an NSP that occurred at a prominent UK hospital. To demonstrate the efficacy of their method, they compared it to certain metaheuristics.

The following is a breakdown of the paper's structure. The deterministic mathematical model is provided and discussed in Section III. The robust formulation of the nurse scheduling issue is presented in Section IV. Section V concludes with some recommendations for further research.

III. PROBLEM FORMULATION

The suggested mathematical model (P1) is given and explored further down. Its goal is to cut costs as much as possible.

Normal nurses (grade1)$\{1,2,3,\ldots,H\}$, specialised nurses (grade 2) $\{H+1,\ldots,L\}$, and head nurses (grade 3)$\{L+1,\ldots,I\}$ are the three types of nurses.

A day is split into 12 shifts: four in the morning, four in the afternoon, and four in the evening.

A. Parameters

c_i : The price of a grad I nurse i ($i \in \{1,2,3\}$)

c_4 : Nurses' overtime costs (all grades)

W_i: A nurse's maximum number of shifts is i

Z_i: Nursing shifts that must be performed by i

M_j: The number of nurses that are required to perform shifts j

C: Indicated number of mandatory afternoon shifts

D: Night shifts that must be completed

Q: Grade 3 nurses are required to perform a certain number of shifts.

M: A huge number of people

B. Decision variables

$$x_{ij} = \begin{cases} 1 \text{ if nurse i is assigned to shift j} \\ 0 \text{ else} \end{cases}$$

$$\alpha_{ih} = \begin{cases} 1 \text{ if nurse i works at least one morning or afternoon shift on the day h} \\ 0 \quad \text{else} \end{cases}$$

$$\beta_{ih} = \begin{cases} 1 \text{ if nurse i works at least one night shift on the day h} \\ 0 \quad \text{else} \end{cases}$$

C. Objective function

$$\min \sum_{i=1}^{H} \sum_{j=1}^{J} (c_1 \times x_{ij}) + \sum_{i=1+H}^{L} \sum_{j=1}^{J} (c_2 \times x_{ij}) + \sum_{i=L+1}^{I} \sum_{j=1}^{J} (c_3 \times x_{ij}) + c_4 (\sum_{i=1}^{I} (\sum_{j=1}^{J} x_{ij} - Z_i)) + \sum_{h=0}^{\frac{J}{12}-1} \sum_{i=1}^{I} \tau_{ih}$$

The goal of the objective function is to reduce cost, which is divided into five components. The expenses of nurses' grade 1, grade 2, and grade 3 are shown in the first three portions. The fourth point is about overtime. Finally, the fifth indicates the cost of doing more work on a given day.

D. ROBUST FORMULATION

When it comes to identifying solutions before uncertainties are realised, the worst-case criteria might be called the robust optimization benchmark. In general, it identifies the best solution in the worst-case situation when applied to an unknown issue. The provided solution is robust since it provides a guarantee for all possible outcomes. The demand for nurses throughout each shift is affected by unknowns and is generally evaluated using a mean figure. (P1) can be thought of as a programme with interval numbers on the right-hand side. We'll have a look at the strategy presented in the next section.

We investigate the issue (P1) and assume that the first constraint's right-hand side M_j ($j \in J$) fluctuates inside the interval $[M_j, M_j]$.

Except for the first restriction, (*) reflects all of the constraints of the issue (P1).

Consider the following polyhedron, which specifies the solutions that are possible (P1):

$$X^{M_j} = \{x_{ij} \in \{0,1\}: (*) \,\&\, \sum_{i=1}^{I} x_{ij} \geq M_j\}$$

IV. CONCLUSION

In this research, we provide a novel mathematical formulation for the NSP that intended to reduce overall hospital costs while taking nurses' preferences and hospital demand into account. Furthermore, when the number of necessary nurses in each shift is unclear, the robust counterpart model was established utilising the worst-case criteria. In the future, we'll use the tabu search method to solve the issue. Our approach will also be tested in a real-life case study at a French hospital.

Acknowledgment

Conflicts of Interest: The authors declare no conflict of interest.

Funding: The authors receive no funding for this work

Ethical approval: This paper has not submitted to anywhere and published anywhere. It does not contain any studies with human participants or animals performed by any one of the authors

References

[1] Abadi, M. Q. H., Rahmati, S., Sharifi, A., & Ahmadi, M. (2021). HSSAGA: designation and scheduling of nurses for taking care of COVID-19 patients using novel method of hybrid salp swarm algorithm and genetic algorithm. Applied Soft Computing, 108, 107449.

[2] Wong, T. C., Xu, M., & Chin, K. S. (2014). A two-stage heuristic approach for nurse scheduling problem: A case study in an emergency department. Computers & Operations Research, 51, 99-110.

[3] Guo, J., & Bard, J. F. (2022). A column generation-based algorithm for midterm nurse scheduling with specialized constraints, preference considerations, and overtime. Computers & Operations Research, 138, 105597.

[4] Parr, D., & Thompson, J. M. (2007). Solving the multi-objective nurse scheduling problem

with a weighted cost function. Annals of Operations Research, 155(1), 279-288.

[5] Bae, S. H. (2021). Relationships between comprehensive characteristics of nurse work schedules and adverse patient outcomes: A systematic literature review. Journal of Clinical Nursing, 30(15-16), 2202-2221.

[6] Dowsland, K. A., & Thompson, J. M. (2000). Solving a nurse scheduling problem with knapsacks, networks and tabu search. Journal of the operational research society, 51(7), 825-833.

[7] Sarkar, P., Chaki, R., & Cortesi, A. (2022). A Patient-Centric Nurse Scheduling Algorithm. SN Computer Science, 3(1), 1-16.

[8] Mobasher, A. (2011). Nurse scheduling optimization in a general clinic and an operating suite. University of Houston.

[9] Cho, H., Han, K., Ryu, E., & Choi, E. (2021). Work schedule characteristics, missed nursing care, and organizational commitment among hospital nurses in Korea. Journal of Nursing Scholarship, 53(1), 106-114.

[10] Maenhout, B., & Vanhoucke, M. (2010). Branching strategies in a branch-and-price approach for a multiple objective nurse scheduling problem. Journal of scheduling, 13(1), 77-93.

[11] Bullard, J. S., McAlister, B. S., & Chilton, J. M. (2021). COVID-19: Planning and postpandemic partnerships. NASN School Nurse, 36(2), 80-84.

Journal of Contemporary Issues in Business and Government
https://cibgp.com/
Vol. 25, No. 01, 2019
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.021

Design and Evaluation of a Healthcare Management Terminology Mobile Learning Application

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Abstract—The EZ-HCM App, a mobile learning tool for healthcare management terminology, is being developed in this project. We created a questionnaire using a five-point Likert scale based on the technology acceptance model (TAM) to explore students' impressions of the utility, ease of use, attitude toward usage, and intention to use the EZ-HCM App. Between July 2016 and June 2017, research participants were university students from Taiwan's fourth biggest Department of Health Care Management. To understand students' design needs for a healthcare management terminology translation dictionary and explanation, we use the persona technique. Following the development of the EZ-HCM App, 113 students from the department were asked to take part in pre- and post-testing surveys, as well as the EZ-HCM App Acceptance Questionnaire. There were seventy valid surveys returned. The findings revealed that the EZ-HCM App is widely accepted for its utility (mean=4.40, SD=0.46), ease of use (mean=4.49, SD=0.48), attitude toward usage (mean=4.42, SD=0.49), and intention to use (mean=4.15, SD=0.58). Participants' perceptions of the EZ-HCM App's usefulness and simplicity of use do not alter based on their frequency of smartphone use. The EZ-HCM App's acceptability is similar to that of other m-learning systems, with favourable attitudes toward usage (β =0.77, p.0001; β =0.47, p=.0002) and intention to use (β =0.87, p.0001; β =0.98, p.0001) among participating students.

Keywords—
Healthcaremanagement,Terminology,Technologyacceptancemodel,TAM,Mobilelearning

I. INTRODUCTION

The United States had a significant effect on the diffusion of healthcare management expertise in Taiwan. In the 1960s, Americans first brought the notion of healthcare management to Taiwan. In 1965, the first Taiwanese, Jin-Wen Zhang (1934–2012), received a master's degree in healthcare administration from a university in the United States [1]. In Taiwan, the first five-year

Vol. 25, No. 01, 2019
P-ISSN: 2204-1990; E-ISSN: 1323-6903
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junior college programme in healthcare management was founded in 1965. In the 1990s, university departments and graduate schools began to emerge [2]. The number of graduates has topped 350,000 since 1998 [3]. Prior to entrance, the majority of undergraduate students lacked relevant educational experience. Additionally, postgraduate students may come from a variety of disciplines, including nursing and business management.

There are fewer websites that provide learning resources on healthcare management than there are for medicine and nursing. Furthermore, since most healthcare management resources are written in English, students from non-English-speaking nations who utilise Chinese will have to spend more time looking for information. The breadth of healthcare management language, in particular, is quite broad. There are also those in health insurance policies, public health, healthcare-related legislation, and so on, in addition to management terms in health-care institutions. The most significant distinction in terminologies between medicine and nursing and healthcare administration is that the former may read a word and know what it means, but the latter requires knowledge of its historical context or specifics to completely comprehend its meaning. There are, however, a limited number of healthcare management terminology learning assistant software and systems available on the market.

To make studying healthcare management terminology simpler, we created the first English-Chinese and Chinese-English healthcare management terminology mobile learning application (called the EZ-HCM App). In addition, we asked students in a Department of Health Care Management who are native speakers of Chinese and were chosen using a purposive sampling method to complete an online healthcare management terminology test to determine their knowledge of healthcare management terminology and an online healthcare management terminology test based on the EZ-HCM App to confirm the students' abilities to use the app for assistance to complete an online healthcare management terminology test. Finally, we created a survey for students to fill out in order to indicate their approval of the EZ-HCM App. In a nutshell, the study's goal and the research issues we'd want to investigate are as follows:

- To create the EZ-HCM App, which will help university and postgraduate students understand healthcare management terms.
- Do students' perceptions of the EZ-HCM App's usefulness and simplicity of use alter depending on their frequency of smartphone usage?
- How do students feel about the EZ-HCM App's utility, simplicity of use, attitudes toward utilising it, and intend to utilise it?
- Is the EZ-HCM App's technology acceptability approach the same as that utilised in previous studies for educational apps?

II. METHOD

A. *Participants*

When conducting this research, the National Taipei University of Nursing and Healthcare

Vol. 25, No. 01, 2019
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.021

Sciences, which is Taiwan's fourth-largest health care management department, was chosen since it has the seventh-largest number of students in this sector in Taiwan. We selected three sophomore and junior college students for interviews using purposive sampling in order to learn what healthcare management terminology they thought was most frequently used and what needed translation, as well as the functional requirements for the EZ-HCM App. They all agreed to participate. There were 49 freshmen, 22 sophomores, 13 juniors, 14 seniors and 15 postgraduate students recruited to participate in the study to assess the app using a convenience sample method. Informed permission forms were signed by all participants, and they were aware that they might withdraw from the study at any moment.

B. The EZ-HCM App Design and Evaluation

EZ-HCM Software, our first app for healthcare management students, was created using the persona method, which allowed us to categorise students according to their learning styles into two categories for the sake of analysing the app's requirements (see Fig. 1). A more user-friendly interface may be created using the persona approach than with conventional system design [20, 21] because it better understands the demands of various types of users. Also included in our definitions were English and Chinese translations, as well as links to existing videos on YouTube that explain healthcare management terminology in both languages. The authors' own videos were also included. The EZ-HCM App uses Google Sheets to save the aforementioned information for future use. To ensure the accuracy of the information, we had a professor from the Department of Health Care Management check it. Cacoo and jQuery mobile were used to create the EZ-HCM App's function display. Both iOS and Android versions were available for download.

The EZ-HCM App has three features: the most recent news, a terminology dictionary, and a timeline of terminologies. As we release new versions, we'll let you know which terminology and how many of them have been modified or added. There is also an alphabetical list of healthcare management terms in both English and Chinese. Use of terminologies in the chronology of terms may help users better comprehend the link between various healthcare management plans and services as well as insurances and other types of insurance (see Fig. 2).

Vol. 25, No. 01, 2019
P-ISSN: 2204-1990; E-ISSN: 1323-6903
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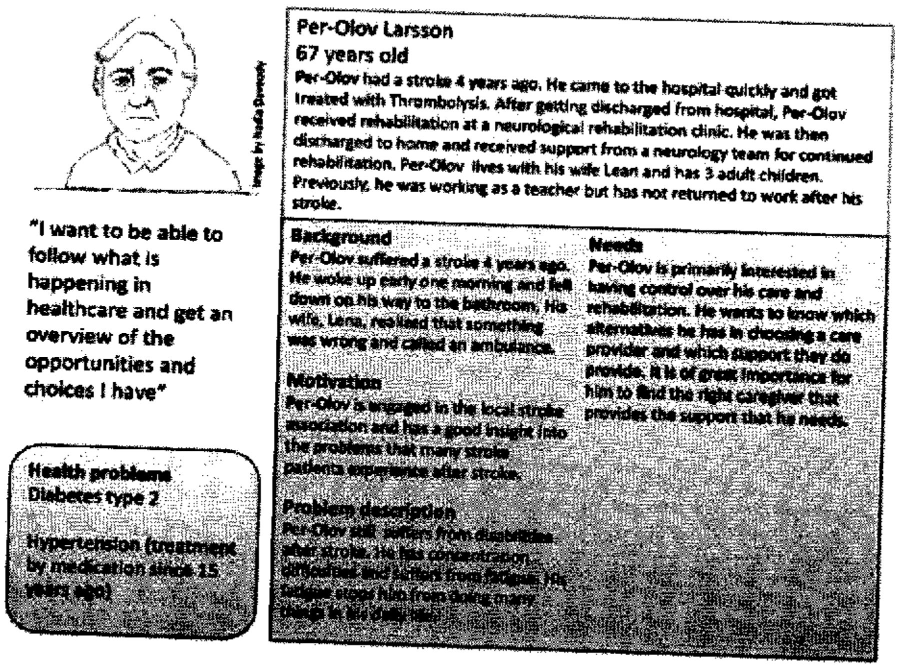

Figure 1 An example of a persona that represents a user group. The data is not from a real individual.

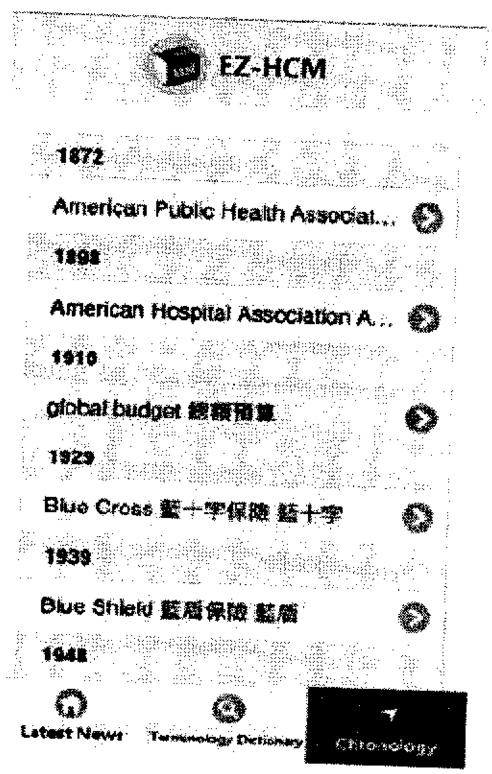

Figure 2 The evolution of language across time.

Vol. 25, No. 01, 2019
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.021

A pre- and post-test consisting of ten online multiple-choice questions on healthcare management terminology was administered to participants before and after the course. For each correct answer, students received ten points, for a possible score of 100. There were two different sorts of questions. Two types of translations were made: one from English to Chinese, and the other from Chinese to English. Sample 20 words from the EZ-HCM App's extensive vocabulary. Participant comprehension of healthcare management language is determined by doing pre-testing without the use of any learning aids or resources. Participant usage of the EZ-HCM App is allowed during the post-testing. A better score in post-testing indicates that a participant's ability to acquire healthcare management terminology has been aided by the app. In the beginning of 2017, there was a pre-testing phase. In May of 2017, when the app was completed, it was put through post-testing. Participant training is not required prior to post-testing.

Two sections were included in the EZ-HCM App Acceptance Questionnaire (see Appendix I). Attitude toward use (ATU), perceived utility (PU), perceived ease of use (PEOU), and behavioural intention to use (BIW) were all changed in the first section, which included 14 questions (BI). From one point (strongly disagree) to five points (strongly agree), we developed a 5-point scale (strongly agree). Positive language was used in all sections. The EZ-HCM App has a higher rating if more people use it. Gender, grade level, educational background, previous experience using other applications to search for healthcare management terms and frequency of smartphone usage were the six questions in the second portion of the questionnaire (i.e., the frequency of smartphone use and amount of time spent accessing the internet when using a smartphone).

C. *Acceptance Survey and Hypothesis*

The hypotheses for testing are shown in Fig. 3. It is easier for students to use cellphones if they have been using them for a longer period of time. This means they are more likely to be assertive in making decisions about whether or not to adopt new m-learning systems. Students who don't commonly use cellphones, on the other hand, may depend on the opinions of their peers when determining whether or not to use it.

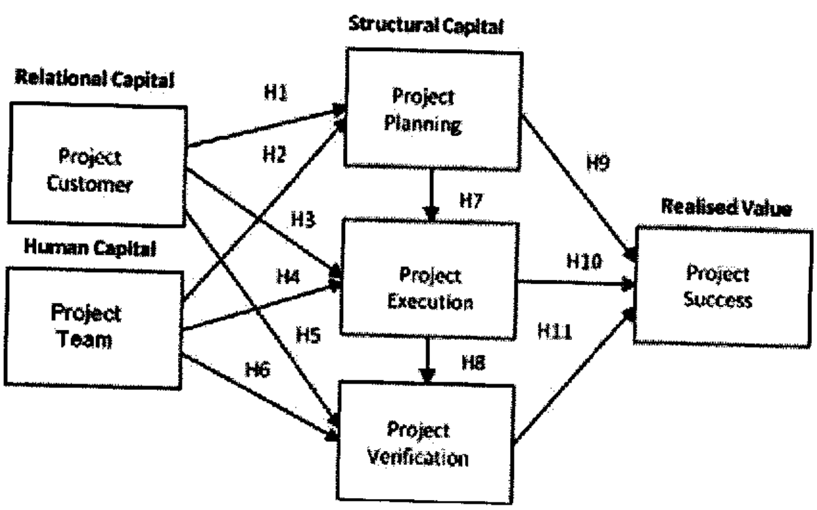

Figure3. Model and hypothesis of research

Vol. 25, No. 01, 2019
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.021

More experienced smartphone users are more likely to see the value in new systems, and this is especially true for students. However, they have a lower level of acceptance of new systems' ease of use. Students with greater internet experience care more about search results than user friendliness, as an example. Students with less online experience, on the other hand, are more prone to get perplexed by the wide variety of information available and hence more concerned with and sensitive to user friendliness. The following four hypotheses are the focus of this investigation.

H1a: The EZ-HCM App has a varied degree of PU depending on how often students use their smartphones.

H1b: The PU of the EZ-HCM App varies depending on how much time students spend online through their cellphones.

H2a: Frequency of smartphone usage by students affects the EZ-HCM App's PEOU.

H2b: The EZ-HCM App's PEOU levels vary depending on how much time students spend on their cellphones accessing the internet.

PU and PEOU are significant TAM factors, according to Davis Bagozzi and Warshaw's research. M-learning has the potential to enhance student performance and quality of performance, allowing students to complete learning assignments at any time or place, according to a study by Purdue University. As a result, the following are the three possibilities put out by this investigation:

H3: PEOU has a beneficial effect on the EZ-HCM App's popularity.

In H4a, the EZ-HCM App's ATU is improved by the presence of PU. H4b: The EZ-HCM App's ATU is influenced favourably by PEOU.

The degree to which a person intends to make advantage of m-learning is captured by BI. Students are likely to be more inclined to utilise m-learning compared to other learning approaches. ATU, according to Davis Bagozzi and Warshaw and other researchers, is the most important aspect in students' m-learning BI, and it has a direct impact on BI. The following two theories are thus put up by this investigation:

ATU has a favourable impact on the EZ-HCM App's BI. H5b: EZ-HCM App's BI is favourably influenced by PU.

D. Data analysis

Three experts in the area evaluated the EZ-HCM App acceptance questionnaire's validity. One point was given for things that were clearly improper, while three points were assigned for those that were clearly acceptable (four points). A Content Validity Index (CVI) is used as a measure of validity, calculating both the Item CVI and Scale CVI for each item (S-CVI). The I-CVI is calculated by dividing the total number of experts who gave a three-point rating for each item by

Vol. 25, No. 01, 2019
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.021

the number of experts who gave a three-point rating. If all experts give an item three or more points, it is referred to be an S-CVI item. According to academics, a tool with strong content validity has an I-CVI more than or equal to 0.78 and an S-CVI greater than or equal to 0.8. A Cronbach's alpha value of more than or equal to 0.7 is considered acceptable for the internal consistency of the variables (dimensions).

III. RESULTS

A. *ResearchInstrument'sValidityandReliability*

There were 14 questions on the EZ-HCM App Acceptance Questionnaire, and one item had an I-CVI of 0.67, while the other 13 had an I-CVI of 1. 0.93 was the S-CVI Because one of the three experts disagreed, the I-CVI was lower than 0.78, resulting in a lower score. In addition, reliability a was more than 0.7 for the four dimensions PU, PEOU, ATU, and BI, showing that the questionnaire's internal consistency was rather strong (0.835, 0.778, 0.911, and 0.826).

B. *Respondents Descriptive Analysis*

More than six out of ten of the 70 students that took part in the survey were students in their freshman, sophomore, junior, and senior years. Table I summarizes the demographics of the participants in this research using descriptive statistics. The majority of the pupils (n=63, 90%) were female, with the same number of students in each grade level. In a vocational high school, students from the Dept. of Data Processing (n=22, 31.4 percent), followed by the Dept. of Business Affairs (n=21, 30 percent) had the most educational background. However, the majority of students (n=45, 64.3%) had never used an app to search for healthcare management terms. Only 36% of students used their smartphones more than once every 30 minutes (n=36, 51.4 percent), but when they did, they stayed online for an average of 57.1 minutes each visit.

Table 1: Demographics of those who took part.

Measure	Items	Frequency	Percentage
Gender	Male	37	40
	Female	56	60
Age	<21	22	24
	21–25	27	29
	26–30	20	22
	31–35	6	6
	36–40	5	5
	41–45	5	5
	46–50	4	4
	51–55	4	4
	>55	0	0
Education	Graduate studies or degree	31	33
	Undergraduate studies	14	15
	Some college studies	45	48
	High school	3	3

C. *Hypotheses Testing*

Online healthcare management terminology pre-testing scores (mean=71.86, SD=18.04) were

Vol. 25, No. 01, 2019
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.021

not significantly different across students of various grades and educational backgrounds (p=.284; p=.621) who did not use the EZ-HCM App. With the EZ-HCM App, there was no statistically significant change (p=.53; p=.27) in post-testing scores (mean=96.43, SD=7.81).

TABLE 2. TECHNOLOGY ACCEPTANCE MODEL ANALYSIS

Tobit Analysis	β	p-value
H3 (PEOU→PU)		
H3: PEOU → PU	0.86	<0.0001***
H4 (PU, PEOU→ATU)		
H4a: PU → ATU	0.77	<0.0001***
H4b: PEOU → ATU	0.47	0.0002**
H4 (PU, ATU→BI)		
H5a: ATU → BI	0.98	<0.0001***
H5b: PU → BI	0.87	<0.0001***
Notes: $^{**}p<.001$, $^{***}p<.0001$; PU=Perceived usefulness; PEOU=Perceived ease of use; ATU=Attitude toward using; BI=Behavioral intention to use		

IV. DISCUSSION AND CONCLUSION

A. *ConclusionandDiscussion*

An app for learning Chinese and English terms and concepts in healthcare management was released initially, called EZ-HCM. Students from the Department of Health Care Management took part in the research, which included first-years as well as postgraduates. More than half of the respondents were female, had a background in data processing or business affairs at a vocational high school, and had never used an app to search for healthcare management terminology. They were also frequent smartphone users who regularly used their devices to surf the internet for more than 30 minutes at a time. There is no difference in the capacity of students from various grade levels and educational backgrounds to comprehend terminology. They were able to locate the necessary healthcare management terms with the help of the app. An average of 4.15 to 4.49 was given to the EZ-HCM App's usefulness, convenience of use, attitudes toward utilising it and intentions to use it by all participants, regardless of their smartphone use frequency. Students who have used the EZ-HCM App have expressed optimism that it would be made available for download on Google Play and the Apple App Store in the near future. Students' perceptions of the EZ-HCM App's effectiveness will be influenced by its ease of use, according to this and previous research on m-learning applications. Both the utility and the convenience of use of the EZ-HCM App have an impact on students' perceptions. Additionally, students' perceptions of the EZ-HCM App's utility and usefulness impact their willingness to utilise it.

Vol. 25, No. 01, 2019
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.021

This inaccuracy happens if the characteristics of the respondents vary from the characteristics of those who did not participate in a poll or survey Respondents and non-respondents had comparable features in this study's purposive sampling method. Because all participating students had high perceptions about EZ-usefulness HCM's and ease of use, the endogenous variable smartphone use frequency (see Table 2) did not reach statistical significance. This could be because all students had high perceptions about the EZ-HCM App's usefulness and convenience.

Before and after the healthcare management terminology exam, all of the test takers had the same pre-test score. A three-credit course called "Introduction to Health Care Delivery Systems" may be to blame for this, since first-year students are required to complete the course for a semester. Findings are similar with those of previous research that have examined the link between the four dimensions.

Students will see the mobile app as a beneficial learning tool if they can readily utilise it. The relevance of ease of use has been emphasised in several research. In the event that students are required to put in a large amount of work in order to utilise m-learning, they are more likely to be dissatisfied with the system and hence less likely to use it in the future [16]. Designers of computer systems must thus enhance the user-friendly interface. Students' attitudes toward mobile learning and their opinions of the EZ-HCM App may be influenced by improving the system's simplicity of use.

B. Limitations

This research has two major flaws. To begin with, the study's time constraints meant that an assessment survey couldn't be conducted after the participants had been using the EZ-HCM App for a long time. In order to get the most accurate answers from the poll, students' subjective short-term perceptions play a large role. Purposive sampling for questionnaire distribution and analysis only covered fewer than 7 percent of prospective users throughout the nation; consequently, the findings of the study cannot be extrapolated to other departments and graduate schools of health management in the United States.

Acknowledgment

Conflicts of Interest: The authors declare no conflict of interest.

Funding: The authors receive no funding for this work

Ethical approval: This paper has not submitted to anywhere and published anywhere. It doesnot contain any studies with human participants or animals performed by any one ofthe authors

References

[1] Mohapatra, D. P., Mohapatra, M. M., Chittoria, R. K., Friji, M. T., & Kumar, S. D.

Vol. 25, No. 01, 2019
P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.021

(2015). The scope of mobile devices in health care and medical education. International Journal of Advanced Medical and Health Research, 2(1), 3.

[2] Kanstrup, A. M., Boye, N., &Nøhr, C. (2007). Designing m-Learning for Junior Registrars: activation of a Theoretical Model of Clinical Knowledge. In Medinfo 2007. Proceedings of the 12th World Congress on Health (Medical) Informatics: Building Sustainable Health Systems (pp. 1372-1376). IOS Press.

[3] Napoleon, A. E., &Åke, G. (2014, November). On mobile learning with learning content management systems: A contemporary literature review. In International Conference on Mobile and Contextual Learning (pp. 131-145). Springer, Cham.

[4] McCarthy, A., Maor, D., &McConney, A. (2019). Transforming mobile learning and digital pedagogies: An investigation of a customized professional development program for teachers in a hospital school. Contemporary Issues in Technology and Teacher Education, 19(3), 498-528.

[5] Winters, N., Oliver, M., & Langer, L. (2017). Can mobile health training meet the challenge of 'measuring better'?. Comparative Education, 53(1), 115-131.

[6] Guo, P., Watts, K., &Wharrad, H. (2016). An integrative review of the impact of mobile technologies used by healthcare professionals to support education and practice. Nursing Open, 3(2), 66-78.

[7] Boulos, M. N. K., Brewer, A. C., Karimkhani, C., Buller, D. B., &Dellavalle, R. P. (2014). Mobile medical and health apps: state of the art, concerns, regulatory control and certification. Online journal of public health informatics, 5(3), 229.

[8] Fu, Z., Hong, S., Zhang, R., & Du, S. (2021). Artificial-Intelligence-Enhanced Mobile System for Cardiovascular Health Management. Sensors, 21(3), 773.

International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 01, 2020
ISSN: 1475-7192

Intention to Utilize Mobile Game-Based Learning in Nursing Education from Teachers' Perspective: A Theory of Planned Behavior Approach

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Abstract - When faced with a pandemic such as coronavirus disease 2019 (COVID-19), many educational institutions are scrambling to find methods to enhance their present processes and prepare for the difficulties of this worldwide danger.. It's not apparent whether nursing professors are ready to employ ICTs like video games to lessen the bad impacts of the epidemic, despite advice from experts. To find out more about nursing instructors' behavioural purpose to use mobile game-based learning (MGBL) and its connection to key elements of the Theory of Planned Behavior, this research was conducted" (i.e., perceived behavioural control, subjective norms, and attitude). Most of the nursing instructors were female, a master's degree holder, with an academic rank of instructor, not a certified professional teacher, and a permanent and full-time employee at private institutions in the Visayas area of the Philippines, according to descriptive data. As a result, they have little knowledge about MGBL or mobile games in general. As a final note, we found that characteristics associated with Theory of Planned Behavior were positively connected with nursing educators' plans to use MGBL. Predicting whether or not nursing instructors would use MGBL in the classroom is the subject of future

research, which builds on the work done here by exploring the potential benefits of MGBL in nursing education.

Keywords: Theory of Planned Behavior, Nursing Education, Game-Based Learning, Mobile Learning Games.

I. Introduction

When the COVID-19 epidemic unexpectedly arrived, nursing education had to undergo a major adjustment (Gaffney et al., 2021). Many educational institutions have shifted from conventional face-to-face to virtual teaching and learning settings in order to comply with rules and recommendations published by the World Health Organization (WHO) and government organisations (Agu et al., 2021). Fortunately, the research shows that online education is well-accepted and well-liked among nursing students (Ali, 2016; Garcia, 2017; McCutcheon et al., 2015). Additional evidence of lecturers' readiness for online classes during pandemics (Cutri et al., 2020; Junus and colleagues, 2021) suggests that this "readiness" is complex and requires a contextual perspective (Scherer et al., 2021). Students in nursing programmes, on the other hand, may find taking classes entirely online during the pandemic to be a very stressful and time-consuming experience (Langegrd et al., 2021), as it limits their social interactions and can have a negative impact on their mental health (Rosenthal et al., 2021). (Oducado & Estoque, 2021). Agu et al., 2021) urge that health officials and nursing regulatory organisations put rules in place, but it is also advised that nursing instructors assist students who are having difficulty with online learning due to a lack of interest, motivation, or technical challenges (Gaffney et al., 2021).

Integration of ICT into the curriculum has been advocated as a means of decreasing the obstacles of teaching and learning during and sparked by the COVID-19 epidemic (Ukata & Onuekwa, 2020). In particular, digital game-based learning has resurfaced in the literature as an additional instrument for emergency online education as a technology modality (Ika Febriana & Yuniawatika, 2020; Park & Kim, 2021; Toquero et al., 2021). Before the pandemic, attracting the attention of nursing students was difficult since they preferred active teaching methods like as gaming (Snoek and colleagues, 2018). (McEnroe-Petitte & Farris, 2020). Nurse educators, on the other hand, have been more sluggish in adopting new teaching approaches and still rely on the lecture as their primary style of instruction (Lee et al., 2019). There is a possibility for nursing instructors to use gaming in emergency online education, as a comprehensive literature review concluded that the implementation of gaming in undergraduate nursing education led to good student comments, improved test scores and greater knowledge (Reed, 2020). Nurses may be reluctant to employ gaming in the face of this global health catastrophe, though. Nursing instructors' behavioural intention to include MGBL and the link between its fundamental elements, such as perceived behavioural control and attitude, subjective norms, were examined in this research. There were also additional details on the profile of nursing instructors with regard to the sort of institution they worked for and the type of licence they had in professional education as well as the amount of time they spent playing games on MGBL each day. Research from this study might aid academic institutions in developing plans for enticing nursing professors to include MGBL into their lectures, whether they do so live or virtually at the 1st Conference on Online Teaching for Mobile Education (OT4ME!) in 2021. Mobile gaming-based learning (MGBL) was chosen over computer game-based learning because it provides more learning possibilities than the latter (OC&C Strategy Consultants, 2020). (Garcia & Mangaba, 2017). MGBL in nursing education is being explored in this research, and a subsequent study will focus on the prediction of instructors' intentions to employ MGBL in their classrooms.

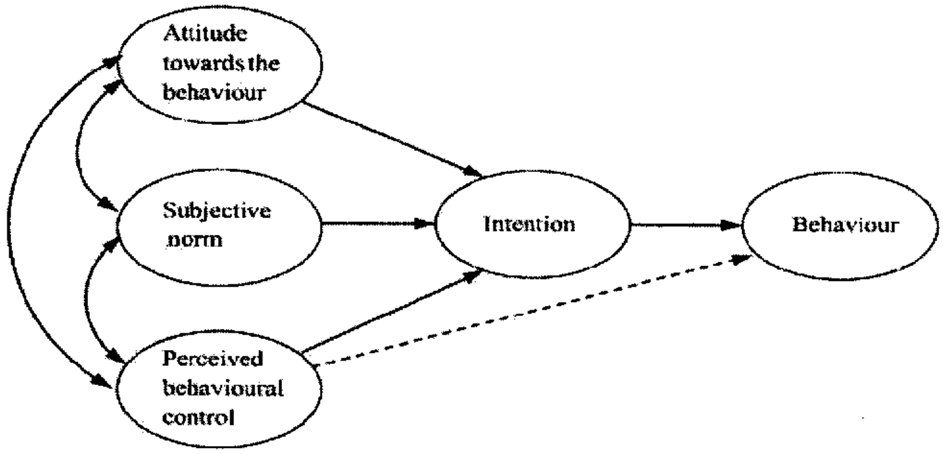

Figure 1: Theory of Planned Behavior

II. Background Of The Study

A *The Theory of Planned Behavior*

Psychological theories such as the Theory of Planned Conduct might be used by knowledge explorers seeking to understand the connection between beliefs and behaviour in order to assess nursing instructors' purpose to use MGBL. According to the Theory of Planned Behavior, the more strongly you intend to carry out a certain action, the more likely it is that you will follow through (Ajzen, 1991). Commitment to action is influenced by a variety of elements, such as personal standards, mindset, and a sense of behavioural control (see Figure 1). To better explain a range of actions (e.g., nursing students' purpose to seek clinical experiences, Meyer, 2002; Ben Natan et al., 2017); report medication mistakes, Gagnon et al., 2015; follow suggestions, and attend lectures), social psychologists created this theory (Skoglund et al., 2020). As a matter of fact, it is the most often utilised socio-cognitive theory for predicting healthcare workers' behaviour, and studies based on it had much superior predictive power than those that employed other theories (Godin et al., 2008). The Theory of Planned Behavior (TPB) was used as the psychological model for this research in order to assess the intention of the nursing instructors to use MGBL in the classroom.

B *Technology-Based Nursing Education*

Numerous studies have examined the importance of technology integration in classrooms and the efficient use of educational technology by instructors. There are seven distinct categories of learning environments and technologies identified in a systematic assessment of the literature, such as "adaptive" and "analytical" learning, "mobile" learning, "social media," "massive open online courses," "special education technology," and "game-based" learning (Martin et al., 2020). 'Digital native generation' necessitates that nurse educators include new teaching and learning modalities into their classes as a result of advances in technology. As an example, high-fidelity simulations may be included to case scenarios (Ali, 2016), podcasts can be used as a supplement for instructional materials (O'Connor et al., 2020), and many more (Martin et al., 2020).

Although they recognise its potential as a distraction, nursing students generally see technology as beneficial and simple to use (Williamson & Muckle, 2018). Practicing nurses have a good view of the use of technology since it improves care practises, makes it easier to collect data, and eliminates the waste of time and money that would otherwise be spent on it (Ozan & Duman, 2020). As a result, the use of technology-based teaching and learning methods in nursing education is embraced.

c *Mobile Game-Based Learning*

For the most part, researchers have focused on the impact that MGBL has on the emotional dimensions rather than the cognitive domains (32 out of 36, 88.19%, from 2004 to 2016). The positive impact of MGBL on students' attitudes, values, enjoyment, and motivation (McEnroe-Petitte and Farris, 2020) is still valuable, especially at a time when students are becoming more stressed (Oducado & Estoque; Rosenthal; et al., 2021) and having a negative impact on their mental health (Rosenthal et al., 2021). The use of mobile and computer-based games in healthcare is nothing new. Although these games may take various forms, some of the most popular are fooya! (Kato-Lin et al. 2020) and Theraphasia (Garcia, 2019), which uses implicit learning processes to help children acquire healthy eating habits. Despite this, the use of MGBL in nursing education is not as well accepted as it should be. There is a dearth of nursing-themed mobile games in academic journals, conference papers, and dissertations apart from commercial games available for download from app stores (see Figure 2). Research in this field is needed to generate evidence-based and verified MGBL mobile learning games. There can be no doubt that MGBL plays an important function as an educational tool, given that a thorough literature review found that introducing gaming into undergraduate nursing education resulted in favourable student comments, improved test scores, and enhanced knowledge (Reed, 2020).

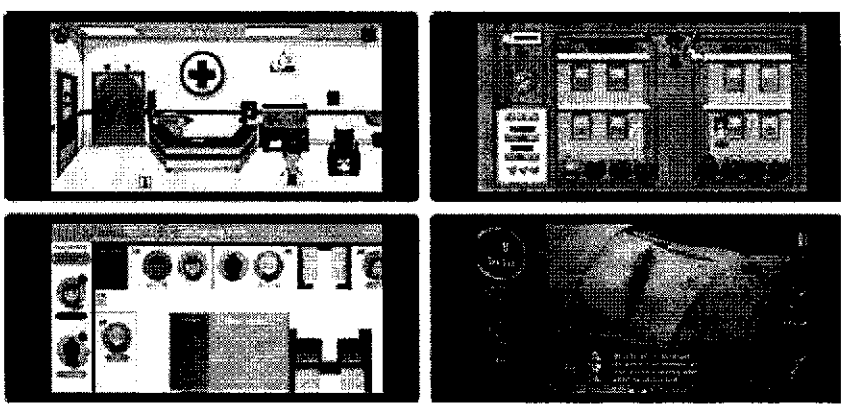

Figure 2: Examples of Casual and Educational Mobile Games for Nursing Education: Hospital Dash, a simulator clicker game for mastering time management as a busy nurse; Rookie Nurse, a fun nursery game where players are responsible for taking care of all the newborns; Nursing Sim, an educational mobile game to practice the multifactor decision-making process of nurse assignment; Operate Now: Hospital, a simulation game to perform realistic surgeries on patients.

III. Methodology

A *Study Design*

correlational studies were undertaken to examine the use of MGBL by nurses and the influence of characteristics such as subjective norms, perceived behavioural control, and attitude on their desire to use it. An example of an observational study design, a cross-sectional study examines both the exposure and the result simultaneously. Cross-sectional and correlational research designs may be combined when the phenomena to be researched are quantitative (as in this study) (Zangirolami-Raimundo et al., 2018). In addition, this study used a questionnaire prepared by the researchers to gather data from the participants. This questionnaire's content was derived from the Theory of Planned Behavior's fundamental elements. This work serves as an introduction to MGBL in nursing education, and a follow-up study will look at characteristics that predict MGBL in nursing students.

B *Sample and Sampling Technique*

During the period of data collection, the study's sample comprised of nursing professors who were presently working as faculty members at any Philippine higher education institution. Purposive and snowball sampling were employed in the research to choose and enrol individuals. As a first step, a purposive sampling strategy was used to guarantee that the initial group of respondents, namely, nursing instructors, was picked. A second method of increasing the sample size was snowball sampling.

C *Research Instrument*

Two sections of the questionnaire were utilised in the research. According to this first section's findings (e.g. sex orientation, academic rank, job schedule), the second section gathered information such as MGBL experience and daily playtime time. The second section of the study focused on the respondents' attitudes, perceptions of behavioural control, subjective norms, and behavioural intention with respect to MGBL. Using Cronbach's analysis, the reliability of the second section of the questionnaire was verified on a small sample of responders. We can say with confidence that the = 0.911 for the five items of attitude, 0.967 for the five items of subjective norms and 0.959 for the seven items of behavioural control were all accurate.

D *Data Collection and Analysis*

An online survey was utilised to gather data for this research in July 2021 because of the pandemic constraints. The link to the poll was posted on the authors' social media profiles and forwarded to the deans and faculty members of several nursing institutions for dissemination. Additionally, respondents had the option of forwarding a link to their colleagues and co-workers. On the first page of the poll, specifics about the investigation were offered. In order to start with the survey, nursing instructors had to provide their permission to participate in the research. All data obtained throughout the research was kept private and confidential at all times. Frequency counts, percentages, Cronbach's alpha analysis, one-way chi-square, and Spearman rank-order correlation coefficient were all used to analyse the data.

IV. Results And Discussion

To find out whether nursing instructors want to employ MGBL and if there is a connection between MGBL's key components, such as perceived behavioural control and attitude, as well as its subjective standards, this research set out to find out. As a result, it collected data on everything from the gender and age of nursing instructors to their job titles and educational backgrounds to the sort of institution they work at and their licence status to their daily playtime time and their MGBL experience.

Table 1: Demographics Profile Distribution

Age (years) Mean = 52.98	**Frequency**	**Percentage**
20 – 40	70	20.0
41 – 60	180	50.0
61 – 80	104	28.9
> 80	4	1.1
Total	**360**	**100**
Sex		
Male	311	86.4
Female	49	13.6
Total	**360**	**100**
Level of Education	**Mean = 8.38**	
No Formal Education	61	17.0
Primary	116	32.2
Secondary	108	30.0
Tertiary	75	20.8
Total	**360**	**100**
Household size	**Mean =7**	
1 – 5	119	33.0
6 – 10	172	47.8
11 – 15	59	16.4
> 15	10	2.8

A *Profile of the Respondents*

Table 1 shows the demographics of those who took the survey. The online survey was completed by 76 nursing educators. The respondents' average age was 41.28 years old, and they had an average of 11.14 years of teaching experience. Women (n = 51, 67.1 percent), master's degree holders (n = 44, 57.9 percent), instructors at private higher education institutions (n = 54, 71.1 percent), and full-time faculty members (n = 62, 81.6 percent) were found in the Visayas region of the Philippines (n = 55, 72.4 percent). The majority of faculty members were not licenced professional teachers (n = 44, 57.9 percent). More than half of the nursing instructors (n = 40; 52.6 percent) do not play mobile games on a regular basis, and most had never heard of MGBL (n = 56; 73.7 percent).

Because there were more women than men among the survey respondents, a one-way chi-square analysis revealed a significant gender imbalance (2 = 8.895, DF = 2, p = 0.003). Not surprisingly, the nursing profession and education are dominated by women (Oducado, 2019). Most nursing instructors had a master's degree (2 = 20.711, DF = 2, p = 0.000) and the maximum educational attainment of respondents was not evenly distributed. To teach at the university level, a master's degree is required. Despite the fact that the majority of instructors are not certified professional teachers (2 = 1.895, DF = 2, p =.169), the respondents were evenly split on the issue of licencing. Teaching at the university level does not need a professional teaching licence; however, teaching nursing courses at the undergraduate level does require a licence as a nurse. Most instructors had never used MGBL in the classroom (2 = 17.053; DF = 2; p =.000); but, respondents were not evenly split in terms of how much they have used it. According to Lee et al. (2019), former academics, most nursing instructors do not have a background in education and are accustomed to the conventional lecture discussion style.

Table 2: Correlation between Variables

Independent Variables	r	p-value
Subjective Norms	.617	.000
Attitude	.431	.000
Behavioral Control	.334	.003

Note: significant if < .05

B *Correlates of Behavioral Intention to Use MGBL*

Teachers in nursing seem to have a moderate to high intention to utilise MGBL, despite the fact that most of them do not play mobile games and have never used MGBL for educational reasons. Nursing instructors should benefit from being introduced to the concept of MGBL since it has been shown to be a good predictor of behaviour (Ajzen, 1991; Ditching et al., 2020). It has been established in Table 2 that there is a substantial, moderate association (r =.617) between subjective norms and intentions to use the product. Between the participants' attitudes about MGBL and their desire to utilise it, there was an important positive moderate association (r =.431, p = 000). There was a small but significant association (r =.334, p =.003) between attitude and intention to utilise MGBL when it came to perceived behavioural control. When individuals they care about support the use of MGBL, and they are optimistic about using MGBL, they are more likely to use MGBL than when they don't believe they are capable or in charge of using MGBL. Research on nursing educators' intentions to utilise MGBL is few, but evidence on the Theory of Planned Behavior's capacity to explain students' intentions to use mobile learning and play games on mobile devices has been consistent. In previous studies, attitudes, subjective norms, and behavioural control were shown to influence whether or not university students in the United States intended to play augmented reality mobile games (Koh et al., 2017). Using the Theory of Planned Behavior, a research in the United States found that college students' acceptance of mobile learning may be fairly well explained (Cheon et al., 2012). Furthermore, the three factors of the Theory of Planned Behavior (TPB) also had an impact on university students in Ghana's desire to use mobile learning (Tagoe & Abakah, 2014).

V. Conclusion

As part of the early examination of MGBL in nursing education, this study sought to assess the instructors' intentions to utilise MGBL and construct a picture of their personality. A majority of nursing instructors were female, with a master's degree, but not a certified professional teacher, a full-time employee of private higher education institutions, and a permanent and full-time employee. Despite the fact that they do not play mobile games and have never used MGBL for educational reasons, they nonetheless seem to have moderate to high intentions to do so. Attitude, subjective standards, and perceived behavioural control are all components of the Theory of Planned Behavior that might help explain why nursing professors choose to utilise MGBL in their classrooms. To boost the chance of MGBL acceptance, these elements may be used. Making a positive impression, altering one's outlook, and enhancing one's skill in using MGBL may be important to promote the use of MGBL in nursing education among instructors.'

Educators may also consider introducing MGBL to nursing instructors and giving them with training on its usefulness and usage.

Acknowledgment

Conflicts of Interest: The authors declare no conflict of interest.

Funding: The authors receive no funding for this work

Ethical approval: This paper has not submitted to anywhere and published anywhere. It does not contain any studies with human participants or animals performed by any one of the authors

References

[1] Ghani, M. T. A., Hamzah, M., Ramli, S., Ab, W., Daud, A. W., Romli, T. R. M., & Mokhtar, N. N. M. (2019). A questionnaire-based approach on technology acceptance model for mobile digital game-based learning. Journal of Global Business and Social Entrepreneurship (GBSE), 5(14), 11-21.

[2] Rana, N. P., Slade, E., Kitching, S., & Dwivedi, Y. K. (2019). The IT way of loafing in class: Extending the theory of planned behavior (TPB) to understand students' cyberslacking intentions. Computers in Human Behavior, 101, 114-123.

[3] Dehghani Pour, M. Comparison of two methods of micro-education and Flipped classroom on the conversation intention of midwifery students of Kerman University of Medical Sciences for counseling sexual function in pregnancy based on the theory of planned behavior 1399-1400 (Doctoral dissertation, Faculty of Nursing and Midwifery, Kerman University of Medical Sciences, Kerman, Iran).

[4] Chang, C. Y., Kao, C. H., Hwang, G. J., & Lin, F. H. (2020). From experiencing to critical thinking: A contextual game-based learning approach to improving nursing students' performance in Electrocardiogram training. Educational Technology Research and Development, 68(3), 1225-1245.

[5] Chung, C. J., Lai, C. L., & Hwang, G. J. (2021). Roles and research trends of flipped classrooms in nursing education: a review of academic publications from 2010 to 2017. Interactive Learning Environments, 29(6), 883-904.

[6] Li, F. Y., Hwang, G. J., Chen, P. Y., & Lin, Y. J. (2021). Effects of a concept mapping-based two-tier test strategy on students' digital game-based learning performances and behavioral patterns. Computers & Education, 173, 104293.

[7] Chang, C. Y., Lai, C. L., & Hwang, G. J. (2018). Trends and research issues of mobile learning studies in nursing education: A review of academic publications from 1971 to 2016. Computers & Education, 116, 28-48.

[8] Fan, K. K., Xiao, P. W., & Su, C. (2015). The effects of learning styles and meaningful learning on the learning achievement of gamification health education curriculum. Eurasia Journal of Mathematics, Science and Technology Education, 11(5), 1211-1229.

[9] Hwang, G. J., & Chang, C. Y. (2020). Facilitating decision-making performances in nursing treatments: a contextual digital game-based flipped learning approach. Interactive Learning Environments, 1-16.

JOURNAL OF CRITICAL REVIEWS

ISSN- 2394-5125 VOL 08, ISSUE 01,

A 2 stage- Stochastic Programming Method to Optimum Nursing Home Shift Scheduling

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Abstract

In this study, we look at the problem of balancing the needs of nursing home staff with the needs of their patients. Stochastic binary programming is used to reduce total labour costs (which are directly proportional to work time) for both full-time and part-time registered nurses (RNs) (PTNs). For each assessed shift, we must balance the entire work time of RRNs with the overall service needs of residents. In addition, traditional scheduling practises restrict the number of feasible shift configurations. We conduct a series of computer simulations to test the proposed paradigm. There are many different combinations of residents with differing levels of handicap that we discuss. Overall labour expenses and RRN scheduling flexibility are also compared to the indicated best solution under different RRN and PTN combinations. In the face of shifting demand, our study proposes a viable technique for providing appropriate service coverage, while minimising labour expenses.

Index Terms

Nurse Scheduling, Stochastic Integer Programming, Demand Scenario Generation, Minimum Data Set (MDS).

1. INRODUCTION

Nursing home care is becoming more popular in the United States as the population ages and the number of hospital beds becomes congested. According to the Department of Health and Human Services, almost 70 percent of the 76 million baby boomers will need some type of long-term care. A nursing home or other kind of specialised care facility may be the last resting place for more than 13 million people [1].

There is no healthcare system in the United States that would be complete without nursing homes. These facilities offer long-term care and rehabilitation for the elderly and disabled, both physically and mentally. Nurses are on call 24 hours a day in most nursing homes. There is a scarcity of qualified nurses in nursing homes because the rate of staff turnover exceeds the rate of increase in demand for nursing care.

ISSN- 2394-5125 VOL 08, ISSUE 01,

Over 40% of registered nurses (the core workforce in nursing homes) cited many work difficulties, such as burnout, a stressful environment, and unequal staffing as the reasons of high staff turnover, according to an American Nurses Association Annual Reports [2]. More than half of them complained about not having enough time to spend with patients, and 54% stated they were overburdened. Researchers have suggested efficient ways to staff nursing homes, such as a ratio of nurses to residents that is supported by scientific data. However, assessing whether these techniques are cost-effective may be challenging, particularly when dealing with continuously shifting resident demands.

For this project, we are developing a platform that may aid nursing homes in managing their operational staff schedules in order to maintain financial sustainability while providing model care for their patients with a wide range of needs. In addition, each nursing home must observe labour regulations on staffing and shift design, e.g., allowing adequate rest time for nurses between shifts, to ensure healthy continuous operations. Designing work schedules that balance financial viability with the need to provide high-quality care is critical for nursing homes.

Stochastic programming is used in this study to create an ideal work plan by allocating nurses to each shift in order to balance the workload on a shift-by-shift basis with the fluctuating needs of residents. The stochastic optimization problem we'll show you is computationally expensive to solve since it necessitates binary judgments at each stage. The prediction is also critical in creating an appropriate work schedule for shift-based shifts. Nursing home directors have a tough time guessing about these issues since they have to consider so many variables. Another complicating factor is that the time-varying nature of some of the aforementioned indicators, such as those of residents, makes it difficult to estimate service demand variability. An established prediction model allows us to gather data on the demand for services at various times within a two-week period (the common timeframe for nursing home staffing schedules); (the typical duration of shift scheduling in a nursing home). Two-week operating costs and shift patterns (full-time vs. part-time RNs and number of shifts for each full-time RN) are correlated, according to our findings (full-time registered nurses vs. part-time agency nurses, number of shifts for each full-time registered nurses).

Stochastic programming models for optimising nursing home staff scheduling decisions under variable demand are an important part of our contribution to this work. There are no decision support systems in the nursing home industry for operational scheduling. Our service demand classification approach is based on a long-term national nursing home time study, as well as real-world clinical assessment data. In this way, we may put our ideal judgements into action. Finally, we demonstrate the usefulness of our proposed sensitivity analysis in delivering management insights into the optimum schedule modification for case mix percentage adjustments and staff hourly payment changes by conducting operational tests in a sample nursing facility's operational environment.

Listed below is a breakdown of how the document is organised. On health services/outcomes research domains and operations engineering scheduling issues with different labour activities, we assess the relevant literature in Section 2. Here, we provide some context to the clinical examination outcomes. Our two-stage nursing home staff scheduling optimization task will benefit from these tools. Section 3 explains the two-stage approach in detail. The nursing home scheduling model's scenario set is also discussed in detail. In Section 4, we conduct computer experiments and analyse the results. Section 5 summarises our results and presents our next project.

2. LITERATURE REVIEW

To get started, let's take a look at some of the most influential studies in health care and outcomes research. Research in resource management and planning tends to concentrate on real-world assessments of experience-based staffing approaches (e.g., [3], [4]) and/or aggregate and one-size-fits-all policies (e.g., [5], [6]). (For instance, [5], [6]). Oversimplifying service demand by assuming all nursing home residents are the same is a common theme in these studies.

After that, we'll get into relevant operations research on human resource planning and management. Staffing and shift assignment optimization are two of the most important parts of our research. Hospital staffing and scheduling was revolutionised by Venkataraman and Brusco [7]. The goal is to lower the total cost of nursing labour. Although the writers made a first attempt, the ambiguity of demand was overlooked. Eastern and Rossin [8] provided an extensive personnel and scheduling model. As a result, wages will be reduced and there will be a reduction in overtime and penalties. Even though a probability distribution for the total amount of work is better than a detailed schedule at every minimum time unit, the best choice is still a probability distribution. Assuming there is a distribution of human resources, the authors use this uncertainty to their advantage in their model of optimization. Eastern and Mansour [9] developed an evolutionary method to tackle both deterministic and stochastic labour scheduling challenges, and they found that the overall labour expenditures and anticipated opportunity costs may be reduced by the system. Both strategies cover a limited set of stochastic scenarios, but both are focused on addressing problems within a one-week planning horizon.

In the next section, we review pertinent studies on nurse scheduling issues. Nurse Rostoring issues were reviewed by Burke et al. [10], who published a review paper on the subject. Methodologies, limitations, and performance measures used to address issues are used to categorise papers. Other tables provide information on the length of time it takes to plan, what data is used, and how many talents may be substituted for each other, among other things. Using deterministic resident demand, Wright and Bretthauer [11] solved both a nurse schedule optimization issue and a staff adjustment issue. It was Maenhout and Vanhoucke [12] who worked on optimising personnel and scheduling decisions together. In a deterministic situation, they used a Dantzig Wolfe decomposition approach to combine the options for nurse staffing and scheduling. Bard and Purnomo [13] utilised an optimal staffing and scheduling model to evaluate several options for coping with a staff shortage. Unpredictability was taken into consideration by the authors because of the always fluctuating market. In this technique, nurses are given the opportunity to design a daily schedule that is tailored to their individual needs, rather than a shift-based one. Punnakitikashem et al. [14] explored an optimal staffing and assignment problem in which the first-stage decision distributes each nurse to patients, while the second stage balances the workload for each nurse. [15] For Kim and Mehrotra [15], demand forecasts based on multiple-year patient volume data were the focus of their research on integrated staffing and scheduling decision optimization. Notably, hospitals and emergency rooms face all of the aforementioned scheduling issues with nurses.

ISSN- 2394-5125 VOL 08, ISSUE 01,

To the best of our knowledge, there is no study on the optimization of staff schedules in nursing homes when the need for care is unpredictable. To add insult to injury, very little research has used clinical assessment data to determine time-based care needs. Each resident of a Medicare- or Medicaid-certified nursing facility [16] is evaluated using the Minimum Data Set (MDS), a nationally mandated method. STRIVE, a nationwide nursing home staff time measurement (STM) research project, is used to transform the clinical assessment into time-based care needs. Nursing homes funded by Medicare and Medicaid may now take use of data collected via the STRIVE study.

3. Methodology

Using stochastic binary programming in two phases that integrates scheduling choices with additional part-time agency nurse personnel decisions to hedge service demand uncertainty, we built our research. We look at how nursing homes are set up in practise and how they are regulated. We assume that in any feasible schedule, there are three eight-hour shifts per day, which is the most suitable schedule for the pleasant working hours of nurses. On the second day, afternoon shifts begin at 3 p.m. and night shifts begin at 11 p.m., with the morning shift being the longest. To determine whether an individual works full or part time, a two-week schedule is the minimal period of time. Nurses' burnout may be reduced by enforcing fair nursing home scheduling standards that allow for enough rest hours.

- **Model of Stochastic Binary Programming**

Look at the situation from a long-term perspective (2 weeks in our study). Three shifts are scheduled for each of the 14 days. There will be 42 shifts in the planning horizon at all times. We begin by scheduling regular registered nurses (RRNs) for shifts, and then we adjust the quantity of staffing with part-time nurses (PTNs) as we go along in our planning process (denoted by vector y). To denote whether or whether pattern incorporates time t, we'll use t a. The schedules of RRNs are structured in a certain way. Calculate RRN and PTN hourly rates using the formulae below. These prices are based on a variety of scheduling patterns.

- **Demand Scenario Generator**

Shift-specific service demand generators are used in the following formulation in order to construct the scenario set To better understand the complex service needs of NH residents, we first developed a computer simulation decision platform that incorporated multi-source information and knowledge, including real NH data (i.e, Minimum Data Set 3.0 [16]) from our partnering local NH provider in Tama Bay area, patient classification system (e.g. [17]) adopted by the CMS, and existing NH staffing time study (i.e., STRIVE project [18]). A project like STRIVE [18] is an example. Individual lengths of stay (LOS) for NH patients are calculated by taking into account their various discharge options, such as home discharge or re-hospitalization. As a result of their various unique features (e.g. ADL), each resident's daily service needs might be somewhat variable over their stay (e.g., ADL). NH patients were divided into a variety of service need groups using the RUG-IV patient classification approach [17], and each service need group included persons with similar resource use levels. With the help of the earlier STRIVE project [18], we calculated daily nursing staff time (measured in minutes) required for NH residents in each service need category to better understand their service requirements. Real-time needs for facility and resident services may be produced as a consequence of this simulation for a varied population of inhabitants.

ISSN- 2394-5125 VOL 08, ISSUE 01,

Greystone Healthcare, based in Tampa, Florida, serves as our industrial partner and provides us with de-identified electronic health information of residents to evaluate the planned work. Detailed information on each resident's health status is gathered, as are records of admissions and discharges, including demographics, diagnosis and long-term conditions (e.g., physical limitation and cognitive impairment).

The original cohort from this data set is used in the baseline scenario. There are a total of 710 persons to consider. Inhabitants are mostly old and suffering with a range of serious illnesses. Moreover, the activities of daily living (ADL) score is further examined to show the needed functional help of each resident. A higher ADL score indicates that the person has a greater need for functional assistance. There are a total of 16 possible ADL points. Ten percent of residents are functionally independent and have ADL values no higher than 1, while fifteen percent of residents are very dependent (with ADL values more than 10) and so need considerable functional assistance. To explain the arrivals of NH residents, the negative binomial distribution (NB(r, p)) is recommended since it has the best fit compared to other parametric distributions (estimated parameters $r = 4.95$ and $p = 0.64$). According to the estimated model, the actual arrival data's p-value indicates that it has a reasonable goodness-of-fit (e.g., Chi-square test). A ratio of 2:1:1 was used to produce the facility-wide service demand (in minutes) for each shift throughout the scheduling horizon using our simulations of daily demand.

4. Experimental results

At the outset of our numerical trials, we determine the baseline setting before moving on to the case-mix setting. We use Python to develop the mathematical model and the Gurobi MIP solver to resolve the produced cases. Each stochastic programming problem has 150 possible solutions. Personal computers with Intel i5-6200U processors and 8GB of RAM are used for all of our research.

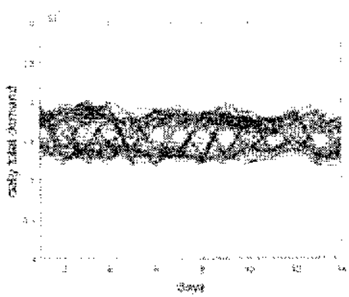
- **Scenario Description**

It was decided that the nursing home's capacity would be 500, which is large enough to accommodate all conditions, but small enough to avoid overcrowding (large enough for any scenarios since the optimal capacity varies when arrival rate changes). In addition to the baseline setting, we additionally take into consideration two rather harsh nursing home situations. Table I lists the characteristics of the three case-mixing configurations. One alternative scenario is that the majority of the population is heavily reliant. We refer to this as the HD setting. The vast majority of the population is self-sufficient. We refer to it as the LD setting. The LOS for each simulated individual varies according to the self-development LOS models used in the construction of scenarios for the two distinct contexts. The daily hourly demand fluctuates to about the same degree around various demand measurements because to different ADL distributions. Here is a breakdown of each of the three parameters' 150 possible service demand scenarios:

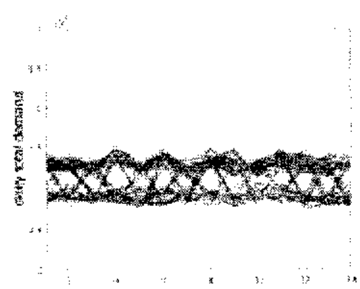
ISSN- 2394-5125 VOL 08, ISSUE 01,

Table 1 Patients' ROT and LOS during the analysis

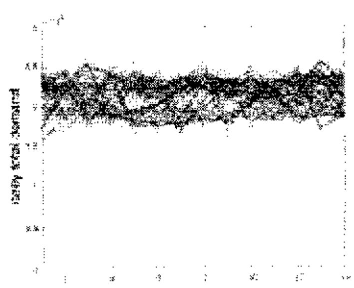
	Emergent			Elective				
				Ordinary			Day Surgery	
	# patients	ROT (hours)	LOS (days)	# patients	ROT (hours)	LOS (days)	# patients	ROT (hours)
DRG								
290	1	2.05	2	417	2.39	4	2	1.25
others	46	2.16	11	237	2.34	8	125	1.46
URG								
A	39	2.14	12	11	3.08	17	4	2.02
B	5	2.29	8	71	2.52	7	17	1.46
C	3	2.42	2	285	2.28	6	38	1.45
D	0	0	0	115	2.33	4	31	1.36
E	0	0	0	82	2.51	5	15	1.45
F	0	0	0	53	2.44	3	11	1.48
G	0	0	0	37	2.46	3	12	2.19



(a) BLD Setting



(b) LD Setting



(c) HD Setting

Figure 1 Demand on a daily basis for each of three cases mixing settings

RRNs (contractual full-time nurses) and PTNs (contractual part-time agency nurses) were paid first (part-time agency nurses). According to a national wage study, a nursing home must pay each RRN a basic salary plus F&A. Since RRNs work longer hours than PTNs, the compensation package they get has a higher per-hour value but a lower pay rate. PTNs' running costs must also include any additional expenditures that may be necessary (such as transportation). The hourly pricing for each RRN has been set at $11 because of the reasons outlined above. This rate is derived from the skilled nursing facility prospective payment mechanism (PPS). As a result, we calculated that the hourly rate for each PTN should be 1.5 times the RRN hourly rate. One to ten is a popular setting for the RRN-to-resident ratio in the real world. For a nursing facility with 500 residents, we set the baseline number of RRNs at 50. The tables below provide a breakdown of the data. Keep in mind that the price is expressed in tens of thousands.

5. CONCLUSION AND FUTURE WORK

Two different types of nursing staff, notably RRNs and PTNs, are the focus of our study as we attempt to optimise the scheduling of nursing home shifts. Each RRN is allocated a shift pattern based on a two-stage stochastic binary algorithm. In the case of a service supply shortfall, the programme describes the steps to be followed, including which shifts should be filled by PTNs. The RRN and PTN ratio should be utilised to create the nursing home's RRNs and PTNs, in our opinion. A lower RRN staffing level and more PTNs may help reduce labour expenses and provide schedule flexibility in nursing homes with high functional independence. Nursing institutions that have a large number of patients who are reliant on them might consider expanding the number of registered nurses (RNs) in order to reduce labour costs and help nurses cope with the stress of caring for them. In the future, we want to use Benders decomposition-based solution approaches with accurate convexification of the binary recourse in the formulation to improve the efficiency of the solution. For example, we can better justify the use of an individual demand generator by taking into account concerns regarding consistent nurse-resident assignments and a balanced workload for the nurses using this model. Nursing facilities that are plagued by high turnover of nursing staff and complaints from residents about inadequate patient-centeredness are likely to find the provided management insights more appealing. A Bayesian stochastic programming approach will be shown to deal with the temporal non stationarity in the uncertain service demand throughout numerous staff scheduling periods, and it will include the notion of rolling-horizon staff scheduling.

REFERENCES

[1] Parisio, A., & Jones, C. N. (2015). A two-stage stochastic programming approach to employee scheduling in retail outlets with uncertain demand. Omega, 53, 97-103.

[2] Leaven, L., & Qu, X. (2018). A two-stage stochastic programming model for phlebotomist scheduling in hospital laboratories. Health Systems, 7(2), 100-110.

[3] Hsu, P. Y., Angeloudis, P., & Aurisicchio, M. (2018). Optimal logistics planning for modular construction using two-stage stochastic programming. Automation in Construction, 94, 47-61.

[4] Wu, F., & Sioshansi, R. (2017). A two-stage stochastic optimization model for scheduling electric vehicle charging loads to relieve distribution-system constraints. Transportation Research Part B: Methodological, 102, 55-82.

[5] Gholami, A., Shekari, T., Aminifar, F., & Shahidehpour, M. (2016). Microgrid scheduling with uncertainty: The quest for resilience. IEEE Transactions on Smart Grid, 7(6), 2849-2858.

ISSN- 2394-5125 VOL 08, ISSUE 01,

[6] Abdulaal, A., Moghaddass, R., & Asfour, S. (2017). Two-stage discrete-continuous multi-objective load optimization: An industrial consumer utility approach to demand response. Applied energy, 206, 206-221.

[7] Good, N., Karangelos, E., Navarro-Espinosa, A., & Mancarella, P. (2015). Optimization under uncertainty of thermal storage-based flexible demand response with quantification of residential users' discomfort. IEEE Transactions on Smart Grid, 6(5), 2333-2342.

[8] Graber, G., Calderaro, V., Mancarella, P., & Galdi, V. (2020). Two-stage stochastic sizing and packetized energy scheduling of BEV charging stations with quality of service constraints. Applied Energy, 260, 114262.

[9] Gomez-Herrera, J. A., & Anjos, M. F. (2019). Optimization-based estimation of power capacity profiles for activity-based residential loads. International Journal of Electrical Power & Energy Systems, 104, 664-672.

[10] Conte, F., Massucco, S., Saviozzi, M., & Silvestro, F. (2017). A stochastic optimization method for planning and real-time control of integrated pv-storage systems: Design and experimental validation. IEEE Transactions on Sustainable Energy, 9(3), 1188-1197.

JOURNAL OF CRITICAL REVIEWS

ISSN- 2394-5125 VOL 09, ISSUE 02,

The palpation skills in maternity nursing using quantitative analysis process

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Abstract - Recent nursing education is claimed to have a large gap between rookie nurses' abilities and those necessary in clinical settings, and this gap has to be bridged in order to improve the educational experience of nursing students. However, expanding the clinical site's amenities and chances for practical nursing skill development are tough to come by. Due to decreased birth rates, it is also challenging for nursing students to strengthen their practical abilities, particularly in maternity nursing education. When a nurse uses Leopold Maneuvers to palpate the position of the foetus, it's important to know whether or not the palpation is done according to the textbook or not. According to the textbook, palpation prefers to investigate with less pressure and gently touch rather than apply excessive pressure to the skin. In the future, quantitative measurement of palpation in nursing education might help raise the bar for students.

Index Terms—Maternity nursing education, Palpation training, Qualitative evaluate support, Pressure data analysis.

I. Introduction

In recent years, the health care and medical environments have changed dramatically, and nursing staff have seen a variety of shifts in their duties [1]. The capacity of nursing personnel to adapt to changes in medical technology and ensure medical safety, for example, necessitates an increase in clinical practise competence.

In particular, newbie nursing staffs require any structured and systematic efforts to develop their clinical practise skills [1]. The Japan Nursing Association likewise aims to enhance people's lives both qualitatively and quantitatively via the extension of medical care [2]. However, it should be noted that each school has a different degree of proficiency in nursing abilities. The rationale for this is because each student has their own set of unique objectives, such as gaining practical nursing skills before graduating from a foundational nursing programme. There are also less possibilities for practical training and the development of practical nursing skills in real clinical settings [1].

In addition, there have been a number of issues in recent years, such as the need to ensure nursing training facilities, tailor education to the abilities of nursing students, and train supervisors [3]. Maternity nursing clinical site training may suffer as a result of Japan's recent decline in birthrate [4]. As a result, future generations of nursing students will have less opportunities to see actual pregnant women in the classroom [5]. Basic nursing skills are taught to nursing students as part of their undergraduate training, and these abilities must be retained throughout their careers as nurses [6]. Using virtual patients in nursing education also has major educational consequences, such as helping students comprehend the whole picture of nursing [7]. [8]. When it comes to teaching several nursing students at once at Kochi University's Department of Nursing, there is an issue.

As a result, there are less possibilities for nursing students to undergo training since they must complete a large number of different nursing classes and training courses. Many nursing students are afraid to palpate genuine pregnant ladies during practical training due to their lack of self-confidence. Aside from their theoretical knowledge, newbie nurses need to learn how to practise their abilities in a clinical setting throughout their maternity nursing training [6]. Additionally, in nursing education, the evaluation is often qualitative. As a result, the evaluation shows that there are issues with nursing education. Supervisors, for example, may find it difficult to explain their own experiences and perceptions to nursing students. Students may be left with an ineffective education as a consequence of this. Developing high-quality nursing personnel is critical to the success of the training process for basic nursing education. However, the concerns outlined above suggest that present nursing training is ineffective in terms of instruction for nursing students.

This research focuses on the use of quantitative assessment in maternity nurse education.

During a data collecting experiment that mimicked real-world maternity nursing training, we measured the pressure on the hands of nursing students and supervisors. We next evaluated the data in terms of the most often used finger palm, the intensity of pressure, and the rate at which pressure changed. ' Furthermore, we conducted a statistical analysis of the obtained data to see whether or not the palpation was consistent with the textbook. Lastly, we spoke about the use of the quantitative evaluation approach for maternity nursing training, including the experiment equipment for pressure data collecting, the analysed results, and the statistical test results.

II. Review Of Related Literature

A *Changes in hands pressure during palpation*

Hand pressure and the nurse's posture were studied by Kaetsu et al. when the nurse moved from a face-up to a lateral position [9]. Hand pressure was measured using pressure measuring films in this study's experiment. When pressure measuring film is used to measure pressure, we can see the precise maximum pressure of the whole hand, but we are unable to detect the pressure change over time. The goal of this study is to better understand how to utilise the palm of one's hand when doing palpation. As a result, we make use of a pressure sensor capable of continuously collecting pressure data. To capture data on finger palm pressure during palpation, researchers have devised experimental devices that install several pressure sensors in precise locations on the finger palm.

B *Skills acquisition*

An assessment approach that allows quantitative evaluation of qualitative evaluation in junior high school technical courses has been suggested by Fukutani et al. Students' work has previously been assessed visually and subjectively by previous technical instructors, and in their study, they offered a quantitative assessment approach based on smartphone technology. They were able to demonstrate the benefit of lessening teachers' assessment work, but they failed to take into consideration what instructors were being taught about skills and the educational effectiveness of their methods.

Aside from the quantitative measurement of nursing abilities, this study also attempts to enhance educational outcomes. We gather data on nursing students' and supervisors' palpation abilities and look at how they might be improved by using the palms of the hands.

C *Understanding of own palpation*

[11] Hosozawa et al. devised a technique to assist clinical nurses in developing effective physical assessment skills. For nursing, the abdomen simulator had a pressure sensor connected to it in the method they presented. In addition, when the image is being felt, the display shows the pressure distribution and the location of the centre of gravity. It helps nursing students comprehend how experienced nurses palpate the abdomen position and pressure changes. The clinical site, on the other hand, need the ability to practise nursing skills that are specific to each patient's needs and circumstances. Because of this, it is critical that students learn how to utilise their finger palms during palpation training, which is a fundamental part of nursing education.

ISSN- 2394-5125 VOL 09, ISSUE 02,

In this study, we opted to use a pressure sensor on the finger palm to capture pressure data during palpation. Our goal is to help nursing student's better grasp their palpation skills by examining how their fingers and palms were utilized throughout the examination process.

III. Data Collection Experiment

A *Experiment conditions*

Experiment conditions are shown in Figure 1. For this project, we worked along with the School of Medicine's Department of Nursing at Kochi University. Figure 1 depicts the setting for the experiment.

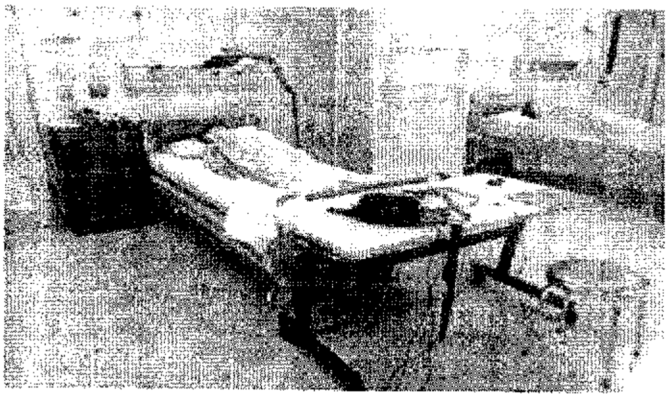

Figure. 1. The experiment environment

A total of 20 people participated in this study, including 10 third-year undergraduates, 6 second-year graduate students, and 4 nursing faculty members. All of the individuals are right-handed ladies who are both physically and cognitively fit.. It is expected in this experiment that the participants wear experimental instruments to perform the first and second phases of Leopold Maneuvers' maternity training. Pregnant woman posed for a doll that was used to do the palpation. Subjects use both hands to palpate the upper abdomen of the doll and interpret the presentation in the first phase. The position of the womb and the foetus termed the presentation. In the second step, each participant feels the doll's abdomen with both of her hands and determines where the doll is in relation to her body. The orientation of the fetus's back or face determines the presenting position. If the bed's height and the doll's belly's air pressure were both the same, this would be ideal.

Undergraduates are expected to be able to palpate in accordance with a textbook, according to the university's expectations. This person is well-known to them. Leopold Maneuvers' instruction, on the other hand, isn't available to them. As a result, the supervisor of the maternity nursing programme explained to them how the training would be similar to what they would get at the university level in the real world. Leopold Maneuvers were explained in detail, including a verbal and whiteboard presentation of the first and second phases of the manoeuvres, and an observation of the supervisor's performance. We also explained to them that the experiment's findings would have no influence on their future evaluations. Postgraduate students, on the other hand, have a great deal of training and experience.

As soon as each step of palpation was completed, we requested the subject to signal to us that she was done and to remove her hands from the doll at the same time. At the same moment as we make our indication, the patient begins palpation on her left side. We videotape her palpation and note the start time, end time, and duration of each phase.

B *Experiment Devices*

Fig. 2 shows the experimental gadgets, which include microcomputers and sensors that are attached to the fingers and palms. The microcomputers utilised were the Arduino UNO and 0.5-inch round sensitive

JOURNAL OF CRITICAL REVIEWS

ISSN- 2394-5125 VOL 09, ISSUE 02,

pressure sensors from Spark Fan Electronics. Every 30 milliseconds, the microcomputers communicate all of the pressure sensors' readings to a central computer.

Figure. 2.. The example of the palpation simulated the experience

The data collection computer was an Apple MacBook. Data supplied from the microcomputers is saved in CSV format by the collecting computer. Fig. 3 depicts the pressure-sensitive sensors. As illustrated in Fig. 3, each location for the sensitive-pressure sensors is referred to by its own name throughout this article. Little, Ring, Middle, Index, and Thumb Finger Sensors are numbered from the little finger in that sequence. As an additional note, "l-" is appended to the name of a left-handed fingertip, while a right-handed fingertip's name is given a "r-" suffix.

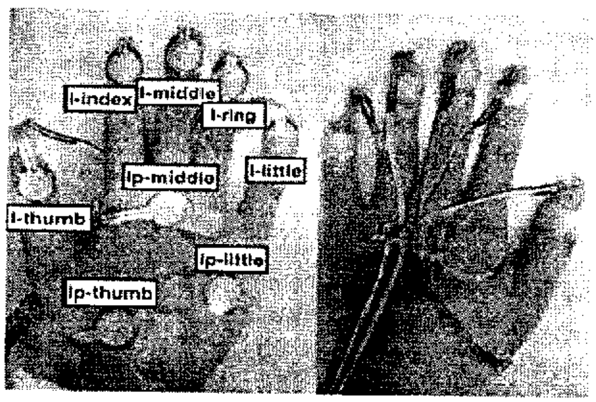

Figure. 3.. The positions of each sensor

As a side note, the lower portion of the little finger, lower part of the middle finger, and lower part of the thumb are all added to the name if the position is on the left hand, whereas if the position is on the right, "rp-" is added. Paper white tape was used as the tape to fix each of the 16 sensors, for a total of 8 on each hand. Each sensor was placed at the same location on the body of the individual. Fingertip sensors were positioned at a set 5-millimeter distance from the distal interphalangeal joint of each finger. The metacarpophalangeal joint of each little finger was fastened to the side of both palms' sensors beneath the little finger by 30 millimetres. The metacarpophalangeal joint of each middle finger was positioned at a distance of 7 millimetres from the sensors on both palms. The sensors beneath the thumb of both palms were mounted in the top 20 millimetres of each wrist. Ten thousand twenty-three is the sensor's maximum value. However, the sensor's maximum limit was pushed to 900 when the author put significant pressure on it.

IV. Result Of The Analysis And Statistical Hypothesis Test

A *Analysis of the values collected*

We meticulously pre-processed the data before doing the analysis. Initial adjustments were made to 30 ms multiples since certain values' times were not accurately recorded. Finally, if there was no record of time or values before and after, the time and values were supplemented by the mean value of their pre- and post-recorded counterparts. A few outliers caused by experimental equipment malfunctions were also verified. As a result, we adjusted the value to zero after verifying the video. Noises created by the experiment devices were eliminated by changing the value beneath 50 to zero.

The denominator for each topic is the total value of all fingers and palms, while the numerator is the value of each fingertip or palm. The "main finger palm" of the fingers and palms most often utilised by the individuals during palpation was defined as the one with the highest ratio. We also thought it was critical to consider the combination of each abdomen's location and the number of hands when defining the principal finger palm. To begin, the patients palpate their upper abdomen with both hands; however, to go on to the second phase, they only use their left hand and only use their right hand to palpate their upper abdomen. Because of this, each abdominal position has a main finger palm that serves as the starting point. In Tab. I, each subject's major finger palm is shown. There are three types of students: undergraduates, postgraduates, and supervisors. The first kind of student is referred to as "b."

Table I: The Primary Finger Palm Of Each Subject

Abdomen	*Upper*	*Right*	*Left*
b-0	l-middle	lp-little	rp-thumb
b-1	l-middle	lp-thumb	r-middle
b-2	l-ring	lp-little	r-ring
b-3	l-ring	lp-middle	r-index
b-4	l-ring	lp-thumb	rp-ring
b-5	l-index	lp-middle	r-middle
b-6	rp-little	lp-little	rp-thumb
b-7	rp-little	lp-middle	rp-thumb
b-8	rp-little	lp-middle	rp-middle
b-9	l-middle	lp-middle	rp-thumb
m-0	rp-little	lp-little	rp-middle
m-1	rp-little	lp-middle	rp-middle
m-2	l-ring	lp-little	r-ring
m-3	rp-little	lp-little	r-middle
m-4	lp-middle	lp-little	rp-thumb
m-5	rp-little	lp-thumb	r-index
n-0	l-middle	lp-middle	rp-middle
n-1	l-middle	lp-middle	rp-middle
n-2	rp-little	lp-middle	rp-middle
n-3	rp-little	lp-middle	rp-middle

Using the results of the analysis, each subject's main finger palm was given a maximum, average, maximum rate of change, positive and negative mean rate of change, and minimum rate of change. Difference between historical and current values was divided by 30 in order to calculate change. And the university's mission is to ensure that "every undergraduate student can palpate according to the textbook." This is why the results of each abdomen's study were divided into two groups.

As a result of this on this paper, N0 refers to the textbook's palpation group, and N1 refers to the other. It was also determined whether or not each subject's main finger palm was identical to that of the subject's maternity nursing supervisor. Consequently, each abdominal palpation yields an entirely distinct N0 and N1 value. Each analytical result is represented by a mean value in Tab. I.

Table II: The Mean Values For Each Analysis Result

ISSN- 2394-5125 VOL 09, ISSUE 02,

Abdomen	*Upper*	
Group	N_0	N_1
Max	347.889	642
Mean	183.483	363.654
Max rate of change	4.211	4.898
Positive mean rate of change	0.563	1.206
Negative mean rate of change	-0.556	-1.745
Min rate of change	-3.826	-7.321

Abdomen	*Right*	
Group	N_0	N_1
Max	341.7	650
Mean	172.962	319.624
Max rate of change	2.947	4.693
Positive mean rate of change	0.387	0.825
Negative mean rate of change	-0.482	-1.043
Min rate of change	-3.313	-5.623

Abdomen	*Left*	
Group	N_0	N_1
Max	260	545.462
Mean	133.459	261.766
Max rate of change	3.781	4.6
Positive mean rate of change	0.546	0.868
Negative mean rate of change	-0.554	-1.148
Min rate of change	-3.557	-4.769

B *Statistical difference between the two groups*

For each abdomen, we conducted a statistical comparison of the analytical findings between two groups. We conducted a Shapiro-Wilk test to see whether the population of the data set was normally distributed before comparing the two groups. A one-sided Mann-Whitney U test was used in this study since the population of certain data sets did not follow a normal distribution. There is further confirmation that, across both groups, the absolute value of N0 is less than that of N1, with respect to the median value of N1. No difference in the median value of the two groups (H0) and a difference in the median value (H1) are the two hypotheses being tested. Null hypothesis is adopted based on statistics and rejection limit value in case the same rank is not present in data set, and p-value is adopted based on statistics and rejection limit value in case it is present in data set. Tab. III displays the test results.

Table III: Mann-Whitney U Test

Abdomen	*Upper*	*Right*	*Left*
Max	Reject*	Reject*	Reject*
Mean	Reject*	Reject*	Reject*
Max rate of change	Accept	Reject*	Accept
Positive mean rate of change	Reject*	Reject*	Accept
Negative mean rate of change	Accept	Accept	Accept
Min rate of change	Accept	Reject*	Accept

*: $p<0.01$

V. Discussion

A *Validity of data collection and data analysis*

The purpose of this study is to better understand the pedagogical application of quantitative assessment in maternity nursing education. The validity of data collecting and data analysis will be discussed in this study.

Paper tape was used to fix pressure data on the hands of individuals in the data gathering experiment. We were concerned about the effect that any fixing method may have on the experiment. In general, however, majority of the participants reported little pain with the devices. During the trial, the gadgets did not move while being palpated. In addition, the obtained data reveals the features of palpation, such as "palpation used fingers only" and "palpation utilised complete hands." As a result, it is believed that the experiment equipment' data collecting for palpation analysis was accurate. As a result, it may be difficult to attach sensors to the hands of hyperhidrosis patients due of the shifting of the tape. In the experiment, one participant's hands were moist from her own perspiration. We had the individuals wear rubber gloves and attach sensors to them. As a consequence, we decided to conduct the experiment under the same parameters. As a result, if the gadgets are to be used as assessment systems in the future, they will need to be improved in terms of wearability and flexibility.

After analysing the most often used finger palm, we also looked at the strength of the data and how it changed over time. Flexible palpation techniques are required by the nurse in Leopold Maneuvers.

Therefore, it is felt that it is important to determine which fingers are more often utilised, as well as to compare the pressure values of each finger.

Analysis of the rate of time for each finger palm is another method for determining main finger palm. Finger palm for supporting the object of palpation may be identified as the principal one based on time analysis. Therefore, it is assumed that the rate of pressure value may be used to evaluate the gathered data if we utilise the strength of pressure and also the change in pressure. According to researchers, the pressure value may be used statistically to determine whether palpation causes pregnant women to become worried.

B *Importance of primary finger palm*

Nurse students need to know how to utilise their own finger palm and the difference between their own and their supervisor's while palpating each abdomen. The maternity ward supervisor at the university instructs undergraduate nursing students how to palpate in accordance with the textbook. To begin, the distal interphalangeal joint of each finger is gently palpated with both hands curled in a clockwise direction. Second-phase palpation has relied heavily on the middle of their hand, with all of their fingers extended. In the first phase, the primary finger palms of the supervisors in Tab. I vary from one another; nevertheless, in the second phase, the main finger palms of all the supervisors are identical. They palpate each topic with their hands curved in the first phase, making it simple to distinguish the primary of each subject. A person's wrist and hand curvature affect the angle of each fingertip that touches their upper belly when lying on their backs. Two N1 supervisors acknowledged that they employed "lp-little" on the upper abdomen, therefore it can't be stated that they used a different palpation approach than textbooks. Second, the participants use their extended hands to palpate the skin. As a result, it seems that all supervisors had the same main finger palms.

When the right abdomen is palpated, the main finger palms of all subjects are present. Palpation to the left, on the other hand, has no characteristic. The location of the people and their postures seem to be the source of the trait. For the subjects, the right abdomen is in the front, and the left abdomen is in the rear for this palpation. They seem to have difficulty palpating with their centre right hand without planned postures under these settings. From the foregoing, we cannot neglect the link between each abdomen and the main finger palm on whether them palpation is appropriate to the textbook or not. Therefore, the knowledge about the main finger palm on each abdomen and the trend is incredibly crucial for the realization of appropriate instruction on the palpation training.

C *High-quality palpation*

It is crucial to distinguish between a training environment and an actual clinical setting when it comes to palpation. The best nursing care for actual patients includes not only specialist knowledge but also the ability to alleviate the patient's stress. Because of this, palpation with less pressure is a key component of high-quality nursing abilities. There are considerable discrepancies between N0 and N1 on the palpation for each

ISSN- 2394-5125 VOL 09, ISSUE 02,

abdomen, as shown in Tab. III by "Max" and "Mean." According to Tab. II, the N0's maximum and average pressure values are half of those of the N1. According to the intensity of the abdominal pressure, N0 is statistically lower than N1. When it comes to the difference in pressure to each abdomen, it was explained that participants of N0 may palpate with half the pressure of N1.

Tab. III also indicates substantial differences between N0 and N1 in terms of "Max rate of change," "Positive mean rate of change," and "Min rate of change" on the right abdomen. When the right abdomen is palpated, the subjects of N0 take longer than the subjects of N1 to change the pressure. There are no statistical differences in palpation of the left abdomen, however. These seem to be influenced by the persons' postures as well. Compared to the left abdomen, it seems that the individuals found it easier to alter the intensity of pressure on the right abdomen in the front. When we checked the frequency of left-hand fingertip and palm usage, we found that 18 of the patients had done so. It seems that individuals of N0 were better able to regulate their hand pressure than those of N1, as shown in Tab. II by the test-accepted change rate. As seen above, there are significant variations in both the palpable pressure and the rate of change between N0 and N1 for each abdomen. Primary finger palm pressure and change rate seem to have a significant impact on successful instruction..

D *Usefulness to effective education*

On the basis of this study, we examine from two angles how best to teach palpation training. First and foremost, this position serves as a resource for the supervisor. Prior to this, the university's supervisor validated by looking into the faces of various nursing students that they were able to palpate correctly and provided instruction where required. However, if palpation, confirmation by the eyes, and quality instruction are increased at the same time, more effective education may be achieved. For example, even if many palpation trainings are taking place at the same time, the supervisor's task of teaching will be significantly reduced. It is also likely that it will help nursing students with guidance and assessments, even if the substance of the training is difficult to grasp. Efforts to avoid overlooks and make learning easier for students seem to be critical to the success of nursing education.

There is also the potential of varying the degree of each student's nursing education. It is possible to tell by looking at the palpation data which fingers and palms are used, how painful the palpation feels, how much pressure is used, etc. The ability to assess one's own palpation abilities following training has been difficult for nursing students up until now.

Nursing students' understanding of their palpation abilities may improve if data on their training is included in their evaluation. It's also doable when comparing the palpation differences between the students and the supervisor. So the supervisor may educate and assess each student according to their ability, making it easier for students to master palpation skills than previously. It seems that nursing students' comprehension of things like their finger palm characteristics, pressure values, and other things related to palpation is critical for good training in education.

VI. Conclusion

According to modern nursing education, rookie nurses lack the competence to perform at the level needed in clinical settings; thus, it is necessary to increase the practical experience of nursing students and improve their educational outcomes. However, expanding the nursing school's facilities and chances for students to practise their practical skills is a challenging task. Due to Japan's dropping birthrate, it is also challenging for nursing students to strengthen their practical abilities, particularly in maternity nursing education. Nursing students and supervisors' finger palm pressure was measured during a simulated Leopold Maneuvers experiment. We initially assessed the obtained data from the perspective of the most frequently utilised finger palms. In addition, it was determined whether or not the palpation was done in accordance with the textbook while analysing the data. Analysis of obtained information was also conducted with regard to pressure measurements as well as their changes. Using a statistical hypothesis test, we show that the participants who palpate according to the textbook were palpating with no excessive pressure and gradual pressurisation. When discussing palpation data, we proposed that it would be beneficial to evaluate it and utilise the findings in maternity nursing training. For high-level novice nurses, we found that a quantitative assessment is more helpful than a qualitative evaluation.

References

[1] Douglas, C., Windsor, C., & Lewis, P. (2015). Too much knowledge for a nurse? Use of physical assessment by final-semester nursing students. Nursing & Health Sciences, 17(4), 492-499.

[2] Craft-Blacksheare, M., & Frencher, Y. (2018). Using high fidelity simulation to increase nursing students' clinical postpartum and newborn assessment proficiency: A mixed-methods research study. Nurse Education Today, 71, 198-204.

[3] Pinar, G., Abay, H., & Akalin, A. (2016). The effect of senario-based simulation training technology on knowledge and skills of maternity nursing students in Turkey. Int J Dev Res, 6(6), 8096-8101.

[4] Roma, N. Z. H., Mahmoud, N. S., & Shehata, Y. M. Effect of Moodle Based Learning on Maternity Nursing Students' Knowledge and Skills Regarding Fundal Assessment During Puerperium.

[5] Niklasson, B., Arnelo, C., Öhman, S. G., Segerdahl, M., & Blanck, A. (2015). Oral oxycodone for pain after caesarean section: A randomized comparison with nurse-administered IV morphine in a pragmatic study. Scandinavian Journal of Pain, 7(1), 17-24.

[6] Garcia, E. S. G. F., Bonelli, M. C. P., Oliveira, A. N., Clapis, M. J., & Leite, E. P. R. C. (2018). The nursing care actions toward the pregnant women: Challenging the primary health care. Revista de Pesquisa: Cuidado é fundamental online, 10(3), 863-870.

[7] Soni, R., Rani, S., Thokchom, S., & Sarkar, S. (2017). A comparative study to assess the opinion and level of satisfaction of the student nurses regarding objective structured clinical examination (OSCE) and Traditional Method of Clinical Skills Assessment related to Antenatal Examination. Int J Nurs Midwif Res, 4(2), 9-12.

[8] Larkin, V., Smith, G., Tennant, J., & Steven, A. (2018). Student midwives' experiences in relation to assessment of maternal postnatal genital tract health: A case study analysis. Midwifery, 56, 61-69.

[9] primaria de Salud, A. The Nursing Care Actions Toward the Pregnant women: Challenging the Primary Health Care.

[10] Abejirinde, I. O. O., Douwes, R., Bardají, A., Abugnaba-Abanga, R., Zweekhorst, M., van Roosmalen, J., & De Brouwere, V. (2018). Pregnant women's experiences with an integrated diagnostic and decision support device for antenatal care in Ghana. BMC pregnancy and childbirth, 18(1), 1-11.

[11] Saxena, M., Srivastava, A., Dwivedi, P., & Bhattacharyya, S. (2018). Is quality of care during childbirth consistent from admission to discharge? A qualitative study of delivery care in Uttar Pradesh, India. PLoS One, 13(9), e0204607.

[12] Çalik, K. Y., Karabulutlu, Ö., & Yavuz, C. (2018). First do no harm-interventions during labor and maternal satisfaction: a descriptive cross-sectional study. BMC pregnancy and childbirth, 18(1), 1-10.

A home resident and family connected nursing system using virtual live video call application

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Abstract- Many elderly people are hospitalised or cared for in a nursing home. They are more likely to go into delirium if they are separated from their loved ones. Even if video call is likely to lessen their tension, people may feel oppressed by a frequent video call and be reluctant to take the bother to call each time. Despite the lack of a strong familial bond in the living room, one individual may start a discussion with another at any moment and the conversation will naturally terminate without a clear indication. Using video calls, we provide a virtual living room system for connecting individuals who live far apart. A believe word is used to re-establish a connection to the other person after the video is disconnected.

Index Terms—Virtual living room, Video call, BLE beacon

I. INTRODUCTION

A nursing home or hospital is a common resting place for the elderly. When they split from their family, there is a chance of them suffering from delirium due to stress [1] [2]. Even if video call is likely to lessen their tension, people may feel oppressed by a frequent video call and be reluctant to take the bother to call each time as a consequence. A person may start a discussion with another person in the living room at any moment and the interaction will naturally come to an end without any evident termination indication. In this research, we propose virtual living room system to link remote people each other reasonably utilising video call service. It offers only information that the other person is present when video call is disconnected, and reconnects video call by a single spoken phrase.

II. VIRTUAL LIVING ROOM SYSTEM

If there is a family member present in the living room, you can know at a look. When using a virtual living room system, it is necessary to be able to determine whether or not the other is there. Watchers examine whether or not they are wearing beacons in order to ascertain whether they are or are not. The video call is initiated by the identification of a belief sword and is terminated when both parties remain silent to one other. Instead than developing a new video call system from scratch, Skype is utilised as a subsystem instead. It is necessary to transfer information from one system to another using the text chat feature of Skype.

Furthermore, the device displays information about one of the parties on one side of the screen (Fig. 1).

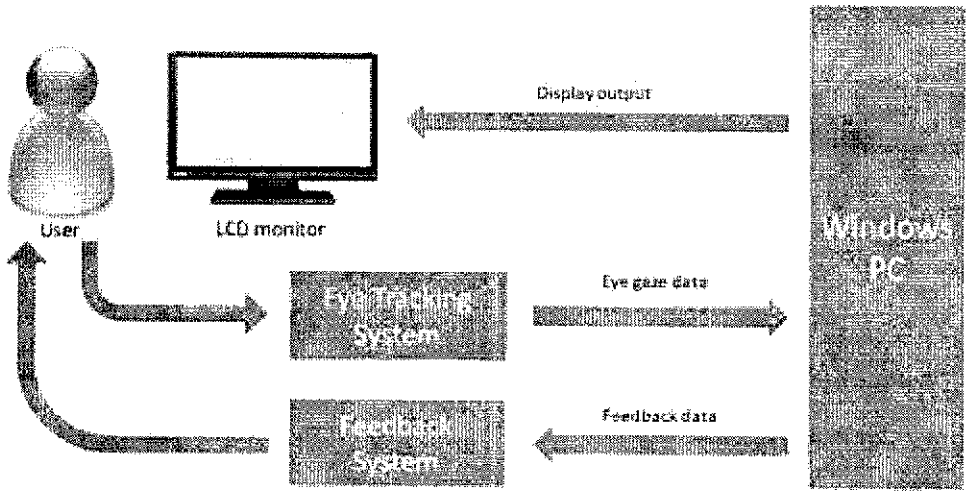

Figure. 1. Screenshot of the experiment and system

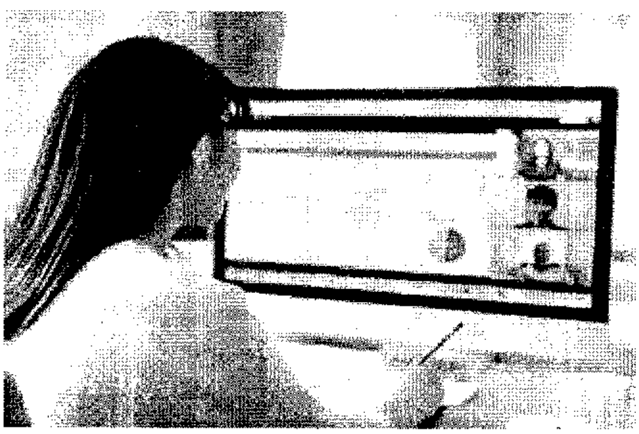

Figure. 2. Video call during an experiment

III. EXPERIMENT

Subjects had a video call while remaining home for long time initially, that indicated simple Skype was utilised and it was been connected all along. After that they employed our new approach, and compared these two lifestyles (Fig. 2). They all mentioned that they felt uncomfortable the first one, and that the system reduced the unpleasant sensation. It was established that the system reproduced the ambience of natural living room to a certain degree.

IV. CONCLUSION

With the use of video calls, we've developed a virtual living room system to moderately link individuals who live far apart. An experimental system was constructed and it could reproduce relationship at natural living room. In the future, we want to use Beacon data to predict a person's activity and not only reveal if the other is there, but also what and where they do it in real time.

REFERENCES

[1] Sultana, M., Campbell, K., Jennings, M., Montero-Odasso, M., Orange, J. B., Knowlton, J., ... & Bryant, D. (2021). Virtual Reality Experience Intervention May Reduce Responsive Behaviors in Nursing Home Residents with Dementia: A Case Series. Journal of Alzheimer's Disease, 84(2), 883-893.
[2] Lapid, M. I., Koopmans, R., Sampson, E. L., Van den Block, L., & Peisah, C. (2020). Providing quality end-of-life care to older people in the era of COVID-19: perspectives from five countries. International psychogeriatrics, 32(11), 1345-1352.
[3] Groom, L. L., McCarthy, M. M., Stimpfel, A. W., & Brody, A. A. (2021). Telemedicine and telehealth in nursing homes: an integrative review. Journal of the American Medical Directors Association, 22(9), 1784-1801.
[4] Niemelä, M., Van Aerschot, L., Tammela, A., Aaltonen, I., & Lammi, H. (2021). Towards ethical guidelines of using telepresence robots in residential care. International Journal of Social Robotics, 13(3), 431-439.
[5] Li, C. Z., Borycki, E. M., & Kushniruk, A. W. (2021, October). Connecting the world of healthcare virtually: a scoping review on virtual care delivery. In Healthcare (Vol. 9, No. 10, p. 1325). Multidisciplinary Digital Publishing Institute.
[6] Brydon, A., Bhar, S., Doyle, C., Batchelor, F., Lovelock, H., Almond, H., ... & Wuthrich, V. (2022). National survey on the impact of COVID-19 on the mental health of Australian residential aged care residents and staff. Clinical Gerontologist, 45(1), 58-70.
[7] Perion, J. J. (2021). Tovertafel: Evaluating the Benefits of a Novel Multi-sensory Intervention for Nursing Home Residents with Dementia (Doctoral dissertation, The University of Toledo).
[8] Pimlott, N., Agarwal, P., McCarthy, L. M., Luke, M. J., Hum, S., Gill, S., & Heisey, R. (2021). Clinical learnings from a virtual primary care program monitoring mild to moderate COVID-19 patients at home. Family practice, 38(5), 549-555.

An advanced Nursing homes activity tracking for Elderly Care support

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Abstract:

A lot of nursing home residents suffer health issues such as pressure ulcers, night walking and incontinence. Previous research shows that these issues have a clear link with motion patterns of patients during bedtime. This paper examines if unobtrusive activity tracking can be done in the bed via accelerometers on the mattress. We show that, with enough training on accelerometer data from variable conditions, a high accuracy can be achieved.

Keywords: CNN, Elderly Care, Incontinence, Machine Learning, Nursing homes

1. INTRODUCTION:

Nursing home residents often suffer from health issues during bedtimes such as pressure ulcers, incontinence, and night-time wandering. These health issues not only affect the resident itself but also burdens the care personnel with an increased workload. Preventing these health issues would relieve the pressure and increase the well-being of residents. Human activity tracking has proven to be an effective way to detect and aid with such health issues. Data from a previous study showed that sensors attached to the mattress can indicate bed movements. [1]

More than 50% of the residents in long-term care settings experience incontinence [2]. Previous studies have explored how sleep agitation and incontinence events are correlated. These studies show that around half (49%) of the incontinence events are proceeded or succeeded by agitation [3]. Half of those happened before the wetness event and the other half directly after the wetness event, showing that there is a correlation between agitation and incontinence.

Pressure over longer periods in the same body area can result in pressure-ulcers. Current research also suggests that also pressure ulcers are very common in nursing homes, with incident rates ranging from 8.8% to 29.9%. The healing of each of these pressure ulcers per day is estimated to cost between €1.71 - €470.49 dependent on the severity of the ulcer (four stages). [4] An ulcer with a mild severity (stage 1-2 will heal within weeks). More severe ulcers on the other hand can take months until they are fully healed. Prevention of these ulcers would significantly lower these costs and increase the well-being of the resident. The best preventive measures consist of removing or redistributing the pressure in these areas of the body. The study in [5] showed that a two-hour repositioning interval should be the minimum for patients at risk.

Accordingly, in recent years, a lot of research has been done to do activity recognition, e.g. to do sleep quality prediction [6]. However, these approaches use worn sensors, which could be obtrusive and annoying for the user. Some other studies have used body-worn accelerometers to do activity recognition via a wearable [7] or a

ISSN:0975-3583,0976-2833 VOL12, ISSUE03,2021

smartphone [8]. Most of these studies use deep learning approaches, such as a Convolutional Neural Network (CNN) to classify the movements. Other conventional approaches manually extract features and select few to further use them for classification. This latter method has proven to be less efficient. [7]

This paper aims to use a cost-effective tri-axial accelerometer to aid care personnel with their caregiving tasks and in turn, increase the well-being of the residents. Additionally, these accelerometers must be unobtrusive so that they do not cause any discomfort for patients. We discuss the approach of unobtrusive in/out of bed detection and in-bed movements to aid with the previously mentioned health issues. In the second section, we discuss the data collection procedure and various settings that were used. In the third section, we discuss the results of our accelerometer and CNN based approach for activity tracking in the bed. Conclusions are drawn and future directions are pointed in the last two sections, respectively.

2. Methodology

To validate whether the movements from patients can be tracked via an accelerometer on the mattress, we must sample/capture data from different test subjects and use Machine learning (ML) algorithms to detect the user actions. In this section, we first discuss the data capturing methodology and we furthermore discuss how data processing is done.

a) Activities must be detected

To cope with the previously mentioned health issues, we must check the feasibility to detect different kinds of actions.

These activities are as mentioned below.

- In/out of bed event detection: Detecting if a resident is in or out of bed could not only be used for night wandering but also for fall detection. It can also be used to determine the starting point for other activities like agitation and movements. To detect the in/out of bed detection we divide the in and out of bed action into different sub-actions. The in-bed detection will consist of the sit-down movement followed up by a lie-down movement. On the other hand, the out of bed detection will first have a sit-up action succeeded by the stand-up action.
- Agitation event detection: As there is a direct link between agitation and incontinence, detecting agitation might indicate that there is a need for an intervention.
- In-bed movement event detection: Tracking in bed movements, e.g. a movement from the back to the side position, could help with preventing pressure ulcers. Once the in-bed event has happened, an in-bed movement should be detected for patients with risk. If a resident at risk does not move within two hours, he must be moved manually to another position to relieve the pressure point and thus preventing pressure ulcers.

b) Data collection

To gather the accelerometer data, an Android app was made. This app requires the user to do a series of movements in the bed and samples the accelerometer data. The movements are as follows: 1. Do nothing 2. Sit down 3. Lie down on the back 4. Sit up 5. Stand up These actions are performed in a loop by a participant to sample data of these movement. This cycle is done a few times in a row per participant to get enough data. This cycle is shown in Figure 1. In a single movement, 200 accelerometer data points (x, y, z) are captured over 4 seconds. Via a beep in the smartphone application the participant knows when to do the next motion.

ISSN:0975-3583,0976-2833 VOL12, ISSUE03,2021

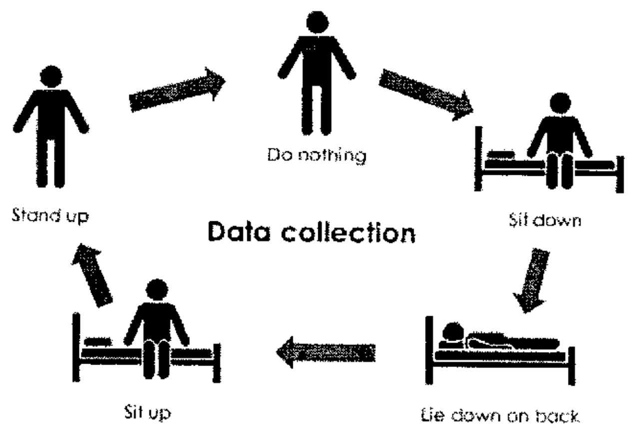

Figure1. Matrix of confusion for one location's validation set

To capture data, some variability aspects must be considered. Firstly, we need to consider the sensor position relative to the resident. To see the influence of the position we take 10 cycles on 4 positions on the bed. After this, we randomly place the sensor in between the points and get 10 cycles again to validate if also this can be detected. Secondly, another consideration that we should make is that each bed is different. Thus, data needs to be captured on different beds. Twenty to thirty cycles of data are captured from different people, doing the actions on different bed settings, to see if the model can still classify the data. Thirdly, we investigated the effect of adding three new actions to the existing 5 actions described previously.

The three other movements are:

1. Roll from back to the side

2. Roll from side to back

3. Move arms and legs slightly (agitation).

c) Data processing

A convolutional neural network is used to classify the actions. We also investigate how the previously mentioned variabilities affect the machine learning model. With each variability a new model is created. The first step is to pre-process the data samples which are the 200 samples per single motion. In this pre-processing step we scale the data to the unit variance. This to make sure that they are in the same range and haven an equal dominance as feature inputs. The scaled data is then reshaped to fit as input for the CNN. As each sample includes the x, y and z axis of the accelerometer it will reshape it to a 3 by 200 array. The data is then split into training data, test data, and validation data. If an additional location or bed setting is tested, extra observations are used as validation data, else 80% training data, 10% test data, and 10% validation data is used.

As CNN we use a simple channel 1D convolutional network. The CNN model consists of two 1D convolutional filter layers with 64 filters, a dropout layer, a max-pooling layer, a flatten layer, and two dense layers of which the last one is the SoftMax function to provide the final classification of the movement.

3. RESULTS

After sampling the data from all the test subjects, we want to process this data to see the effectiveness of CNN models for the task at hand.

a) CNN for activity detection from a single individual using a single sensor

As an initial investigation, data from one person without any variability was used. This data was sampled with the same phone and each time on the same location. 10% of the data is used as test data and 10% as validation data, the rest of the data is used as training data. When training the model with the training and optimizing via the test data, the model provided an accuracy of 100% on the test data.

The validation dataset (10%) is used to verify if the trained model is correctly classifying the data. In Figure 2 we can see the confusion matrix of this validation set. This shows that the model also has a 100% accuracy upon the validation data.

ISSN:0975-3583,0976-2833 VOL12, ISSUE03,2021

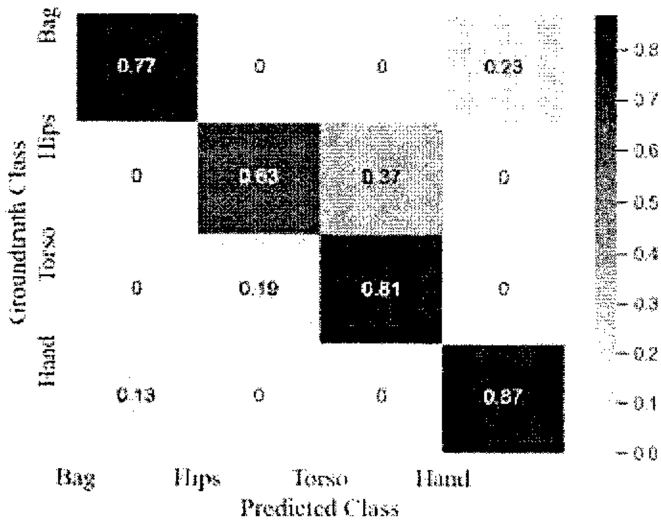

Figure 2. Confusion matrix of a location's validation set

b) Reproducibility between sensor positions on the same bed

As the location of the sensor might change on the same bed in a real nursing home, we train the model on four different sensor placements on the mattress. On each location, 10 cycles of data were sampled. After training on the accelerometer data from these locations, we reach an accuracy of 97.5%.

As a validation set, samples from a fifth independent location on the mattress is used. On this location also 10 cycles of data are sampled. The confusion matrix for the fifth location can be found. The used model was the trained model using the other four locations. It shows an accuracy of 92%. This shows that the model, trained on multiple locations of the bed, is still able to still classify data on other locations with slightly lower accuracy.

c) Reproducibility on different participants

Data from four participants, with each their bed setting, was sampled. Twenty cycles of each person were sampled and used as input for the model. An accuracy of 91.25% is reached on the test data. To check if the model is usable on a new bed, we train the model with data from three people with different bed settings and use 10 cycles of the fourth person as validation data. An accuracy of 93 % is reached when training with the data from three people. When validating this model with the data from the fourth, we reach an accuracy of 46%.

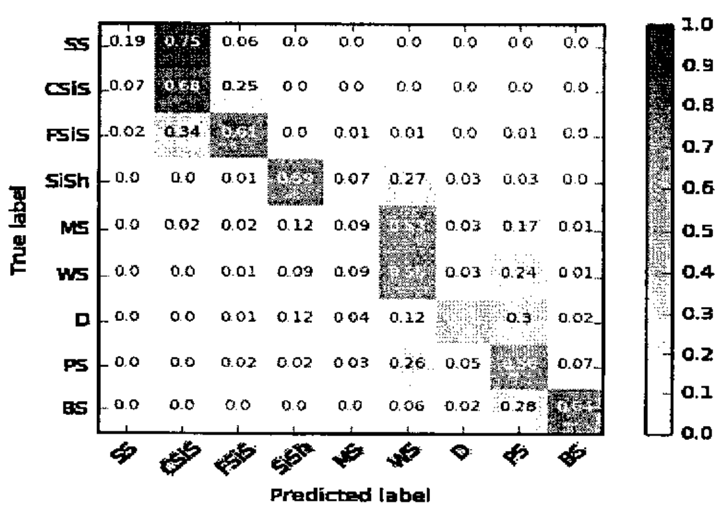

Figure 3. Confusion matrix of one bed used in a model trained on four beds

As seen on the confusion matrix in Figure 3, only some of the actions are correctly classified. The model was trained by data from four independent individuals, not only the bed type and person will be variable but also the smartphone orientation and type of smartphone which might have different accelesensors will be variable.

If we repeat the experiment, but with seven different bed settings (all have been sampled for 20 to 30 cycles) instead of three, the model achieves an accuracy of 90.80%. When validating this model on an independent eighth bed (10 cycles) an 82% accuracy is achieved. These results indicate that if the model would be trained with a lot more data on different environments, the model might have an even better performance.

To be able to detect more health issues, there is a necessity to detect more actions. The three extra actions (see section II) were also performed for 30 cycles. Together with the data from the single location they were used to train a new model to detect more activities. This shows that it is also possible to detect other movements in the bed. The validation of this model was done with 10% of the data.

4. CONCLUSION

In this paper, we investigated if human activity tracking can be done by using unobtrusive sensors in the bed. This to aid nursing home residents with their care needs and nursing staff with their care tasks. We have shown that it is possible to classify human actions in a bed by using a 1D convolutional network. On a single location in a single bed, an accuracy of 100% is reached. When adding more movements to the system it has a slightly lower accuracy of 96%. If more locations are considered on a single bed, we reach an accuracy of 92%. This shows that human activity tracking is possible even with variable environments if there is enough data.

5. FUTURE WORK

Data collected from more subjects may aid in designing a robust activity classification system. To increase the accuracy of the system even further, hyper parameter optimization can be done on the different layers of the CNN model. Also the influence of sensor orientation on the accuracy has to be checked. To validate if motions can be tracked from the elderly, measurements must be done on real subjects in nursing homes to get accurate data. These can be converted to recommendations for the nursing staff. A specifically designed embedded system can be made to capture accelerometer data, running inference model of this so developed CNN on that in real-time will be the ultimate goal.

REFERENCES

[1] Collier, S., Monette, P., Hobbs, K., Tabasky, E., Forester, B. P., & Vahia, I. V. (2018). Mapping movement: applying motion measurement technologies to the psychiatric care of older adults. Current psychiatry reports, 20(8), 1-8.

[2] Airlie, J., Forster, A., & Birch, K. M. (2022). An investigation into the optimal wear time criteria necessary to reliably estimate physical activity and sedentary behaviour from ActiGraph wGT3X+ accelerometer data in older care home residents. BMC geriatrics, 22(1), 1-14.

[3] Uslu, G., Unal, B., Aydın, A., & Baydere, S. (2022). One-Class Classification Approach in Accelerometer-Based Remote Monitoring of Physical Activities for Healthcare Applications. In Integrating Artificial Intelligence and IoT for Advanced Health Informatics (pp. 9-23). Springer, Cham.

[4] Sankar, S., Srinivasan, P., & Saravanakumar, R. (2018). Internet of things based ambient assisted living for elderly people health monitoring. Research Journal of Pharmacy and Technology, 11(9), 3900-3904.

[5] Rasul, M. G., Khan, M. H., & Lota, L. N. (2020, September). Nurse care activity recognition based on convolution neural network for accelerometer data. In Adjunct Proceedings of the 2020 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2020 ACM International Symposium on Wearable Computers (pp. 425-430).

[6] Althobaiti, T., Katsigiannis, S., & Ramzan, N. (2020). Triaxial accelerometer-based falls and activities of daily life detection using machine learning. Sensors, 20(13), 3777.

[7] Hua, A., Quicksall, Z., Di, C., Motl, R., LaCroix, A. Z., Schatz, B., & Buchner, D. M. (2018). Accelerometer-based predictive models of fall risk in older women: a pilot study. NPJ digital medicine, 1(1), 1-8.

[8] Klakegg, S., Opoku Asare, K., van Berkel, N., Visuri, A., Ferreira, E., Hosio, S., ... & Ferreira, D. (2021). CARE: Context-awareness for elderly care. Health and Technology, 11(1), 211-226.

[9] Biagetti, G., Crippa, P., Falaschetti, L., & Turchetti, C. (2018). Classifier level fusion of accelerometer and sEMG signals for automatic fitness activity diarization. Sensors, 18(9), 2850.

[10] Nascimento, L. M. S. D., Bonfati, L. V., Freitas, M. L. B., Mendes Junior, J. J. A., Siqueira, H. V., & Stevan, S. L. (2020). Sensors and systems for physical rehabilitation and health monitoring—a review. Sensors, 20(15), 4063.

ISSN:0975-3583,0976-2833 VOL12, ISSUE05,2021

A Robot based Nursing care estimation and controlling patients Arms

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Abstract - The demand for robotics to tackle the problems resulting from the ageing society is increasing. For the safety of a dual-arm transfer robot which can lift and move a care receiver from a bed to a wheelchair or the back, this paper proposes a novel control strategy for motion control. The robot arms and the subject being held by the robot constitute a strong coupling system which is under-actuated and nonlinear. To solve the above problem, we divide the manipulation of the system into posture adjustment of the subject in holding and arm-position adjustment when the arms leave the subject for an instance to avoid friction. The posture adjustment of the subject was realized by using a sliding mode control method, while a neural network was introduced to build the control model and identify the parameters, and impedance control was introduced in arm-position adjustment. The effectiveness of the control strategy was confirmed by numerical simulation.

Index Terms - posture adjustment, arm-position adjustment, sliding mode control, impedance control.

I. INTRODUCTION

With the advent of an aging society, the demand for human interactive robots that can help on-site caregivers in nursing humans, particularly the elderly, is increasing. Among the nursing care tasks, patient transfer, such as lifting and moving a bedridden care receiver from a bed to a wheelchair or the back, is one of the most physically taxing tasks in nursing care service [1]. Many kinds of transfer devices and robots have been proposed and developed [2], but although some of them have been commercialized, they are not widely used in nursing care facilities, homes as well as hospitals. The reasons include the long time required for their use, the difficulty of attaching slings, the risk of dropping, and the mental and physical discomfort of the care receiver. In addition, it was reported that the physical burden of the caregiver is not reduced in many cases by using transfer lifts [3].

A few dual-arm nursing care robots have been developed. For instance, the RIBA robot was designed to conduct transfer tasks and succeeded in transferring a human between a bed and a wheelchair, using human-type arms (Fig. 1). It has sufficient power to lift up a human weighing over 80 kg and soft tactile sensors on its surfaces to detect and recognize the contact with the subject being held [4].

ISSN:0975-3583,0976-2833 VOL12, ISSUE05,2021

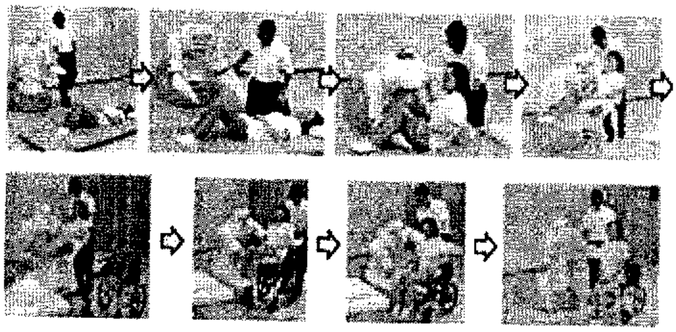


Fig. 1 Transfer motions of RIBA robot

In the case when the system is under-actuated during transfer task, the robot and the subject being held constitute a complex nonlinear system, increasing the risk of the instability. Motion control of the robot arms is a whole-arm manipulation, which uses the entire robot arms to handle the subject without shape or force closure [5]. As an external force, gravity was treated as a virtual actuating force [6]. Although the modeling of gravity increases the difficulty of the trajectory planning, it can effectively increase the dimension of the workspace [7].

Many researchers have shown strong interests in wholearm manipulation, especially in the field of nonprehensile manipulation. For example, a single-DOF planar drop robot developed by Mori [8] controlled the translation velocity, angular velocity and direction of the ball using a whole-arm manipulation strategy. Dafle in his article [9] introduced an external driver to model gravity, external contact force, as well as dynamic arm movement to realize the dexterous action of a manipulator. Yamawaki et al [10] conducted a trajectory planning research and built a control strategy for sliding a polygon object by using stochastic programming. Batz et al [11] used a 6-axis industrial robot to capture a sphere by using trajectory prediction and contact point selection.

However, the above researches cannot meet the requirements for dynamic operation of the subject being held, who can be modeled by a multi-link object. Onishi [12] pointed the requirements, conditions as well as difficulties of the operation of a multi-link object. Zyada et al [13]-[16] introduced a multi-link rigid model manipulated by two cooperative manipulators. However, although researches on dual-arm operation have been carried out, no research has been reported on the prevention of friction between the subject and the robot.

The static and dynamic friction of the contact surface plays a pivotal role in the stable operation of a large object using robot arms. One of the main obstacles is the difficulty of mathematical modelling of the complex frictional effects in the manipulation. However, friction must be prevented since it may hurt the skin of the subject. To solve this problem, this paper proposes a novel control strategy. Firstly, the manipulation is divided into hold state and release state, i.e. the posture adjustment of the subject in holding and the arm-position adjustment when the arms leave the subject for an instance to avoid friction. Control law is switched according to the states. In the hold state, the approximate term of a neural network adaptive control law approximation model was designed to achieve a precise control, while in the release state, an impedance controller has been designed to ensure the comfort of the subject.

ISSN:0975-3583,0976-2833 VOL12, ISSUE05,2021

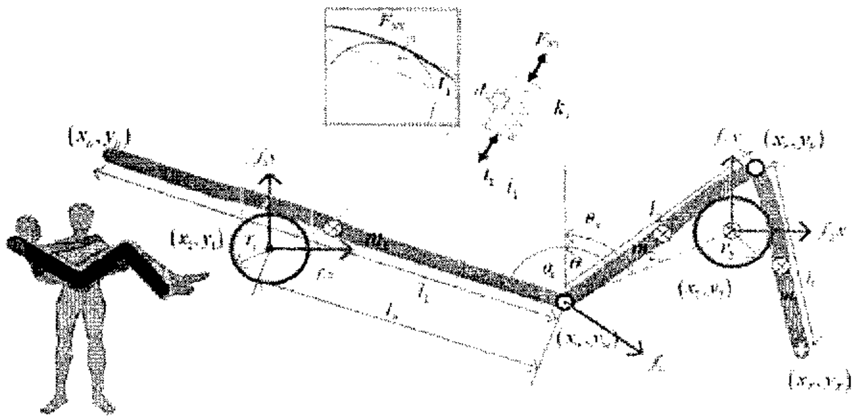


Fig. 2 Schematic diagram of the system

II. SYSTEM DESCRIPTION

To simplify the discussion, we assume that: 1) The robot arms A_j (j = 1,2) are driven only by vertical and horizontal forces, without rotation. 2) The pose of the object can be identified by the magnitudes and directions of contact forces which are detected by tactile sensors on robot arms. 3) The robot arms are rigid, while the object is flexible. 4) There is no sliding due to high friction between the object and the robot arms. 5) The motions of the object and robot arms are in-plane motions in x and y directions.

The schematic diagram of the system is shown in Fig. 2. The object is simplified by a three-link model L_j (i = 1,2,3) with passive joints. The masses, inertia, and length of the links are expressed by m_i,j_i,l_i the position of the extreme point of links is (x_h,y_h), (x_w,y_w), (x_k,y_k), (x_f,y_f). The angle from the positive y-axis of link 1 and link 2 are θ_1, θ_2. The force between L_1, and L_2 is f_a, the deformation of link i is t_i, l_a is the relative position.

The links that model the subject are manipulated by the robot arms which have masses m_{ja} and radius r_j. (x_j,y_j). The driving force of the arms is (f_{jx},f_{jy}). To build a reliable approximate dynamic model, the following assumptions are made: 1) The centroid of link 2 and link 3 as the same as arm 2. 2) The angle from the positive y-axis of arm 2 as same as L_2 3) There are no centrifugal and Coriolis forces. 4) The links are rigid.

The static equation of the system is $G_{eq}(x) = T_{eq}$, can be expressed as

$$\begin{cases} f_1^{hl}y + f_2^{hl}y = (m_1 + m_2 + m_3)g \\ f_1^{hl}x = -f_2^{hl}x \\ m_1 g(l_a - l_1)\sin(\theta_1) = T_2 - T_1 \\ m_1 g(l_2\sin(\theta_2) + l_a\sin(\theta_1)) = T_3 + T_4 \end{cases} \quad (1)$$

Where

$$\begin{cases} T_1 = (m_2 g + m_3 g - f_2^{hl}y)(l_a\sin(\theta_1) + l_2\sin(\theta_2)) \\ T_2 = f_2^{hl}x((l_2)\cos(\theta_2) - l_a\cos(\theta_1)) \\ T_3 = f_1^{hl}y(l_2\sin(\theta_2) + l_a\sin(\theta_1)) \\ T_4 = f_1^{hl}x((l_2)\cos(\theta_2) - l_a\cos(\theta_1)) \end{cases} \quad (2)$$

ISSN:0975-3583,0976-2833 VOL12, ISSUE05,2021

G_{eq} (x) can be obtained by (1) and (2)

$$\mathbf{G}_{eq}(\mathbf{x})=\left[f_1^{hl}x, m_1^a g+f_1^{hl}y, f_2^{hl}x, m_2^a g+f_2^{hl}y\right]^T. \quad (3)$$

The dynamic equilibrium can be expressed as

$$\begin{cases} (f_1^{ml}y\sin(\theta_1)+f_1^{ml}x\cos(\theta_1))l_3=T_a \\ T_a=-f_a\cos(\theta_1+\theta_2-pi/2)l_1 \\ f_1^{ml}y=m_1\ddot{y}+f_a\cos(\theta_2) \\ f_1^{ml}x=f_a\sin(\theta_2)+m_1\ddot{x} \\ f_2^{ml}y=(m_2+m_3)\ddot{y}-f_a\cos(\theta_2) \\ f_2^{ml}x=-f_a\sin(\theta_2)+(m_2+m_3)\ddot{x} \end{cases} \quad (4)$$

M_{eq} (x) Xis given by

$$\mathbf{M}_{eq}(\mathbf{x})\ddot{\mathbf{x}}=\left[f_1^{ml}x,\ f_1^{ml}y+m_1^a\ddot{y},\ f_2^{ml}x,\ f_2^{ml}y+m_2^a\ddot{y}\right]. \quad (5)$$

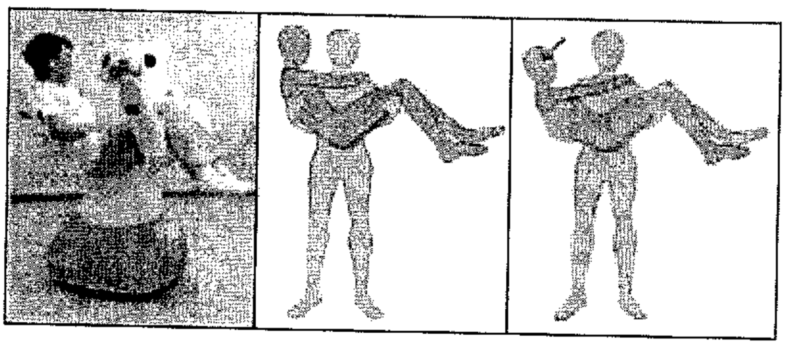


Fig. 3 Schematic diagram of subject posture adjustment

III. ADAPTIVE SLIDING MODE CONTROLLER

A. Control targets

As shown in Fig. 3, the control target is to make the robot mimic the movements of humans when they are holding people under the guidance of the control system.

Model-based control law requires greater switching gain to compensate model errors [17]. To reduce the switching gain and weaken the chatter of the system [18], a neural network control strategy for the system with unknown parameters is presented. The generalization and the robust property of the neural network have been confirmed in many fields [19], which can implement approximating nonlinear functions with arbitrary accuracy by regulating variable weight connection [20].

B. System state variables and ideal dynamics model

The input is $\boldsymbol{\tau}=[f_{1x}, f_{1y}, f_{2x}, f_{2y}]^T$. Take position and velocity of robot arm 1 as the coordinate origin and the subject position is $\mathbf{x}=[x_1, y_1, x_2, y_2]^T$, dynamics model can be transformed into

$$\mathbf{M}^*(\mathbf{x},\mathbf{Q}_t)\ddot{\mathbf{x}}+\mathbf{C}^*(\mathbf{x},\dot{\mathbf{x}},\mathbf{Q}_t)\dot{\mathbf{x}}+\mathbf{G}^*(\mathbf{x},\dot{\mathbf{x}},\mathbf{Q}_t)=\boldsymbol{\tau}, \quad (6)$$

ISSN:0975-3583,0976-2833 VOL12, ISSUE05,2021

Where M*, C*, and G* are considered as a continuous but unknown. M* is a positive definite matrix. The desired trajectory X_d (t) of the system is a bounded function of time 2 . The approximate dynamic model of the system can be provided as

$$\mathbf{M}_s(\mathbf{x})\ddot{\mathbf{x}} + \mathbf{C}_s(\mathbf{x},\dot{\mathbf{x}})\dot{\mathbf{x}} + \mathbf{G}_s(\mathbf{x},\dot{\mathbf{x}}) = \boldsymbol{\tau} \quad (7)$$

The tracking error is given by $\mathbf{e}(t) = \mathbf{x}_d(t) - \mathbf{x}(t)$, and the sliding mode surface can be designed as follow

$$\begin{cases} \mathbf{s} = \dot{\mathbf{e}} + \mathbf{c}\mathbf{e} \\ \mathbf{c} = diag\{c_1, c_2, c_3, c_4\}, \quad c_i > 0 \end{cases} \quad (8)$$

By designing the control law as

$$\begin{cases} \boldsymbol{\tau} = \mathbf{Y}_s + \mathbf{v} \\ \mathbf{Y}_s = \mathbf{M}_s(\ddot{\mathbf{x}}_d + \mathbf{c}\dot{\mathbf{e}}) + \mathbf{C}_s\dot{\mathbf{x}} + \mathbf{G}_s + \dot{\mathbf{M}}_s\mathbf{s}/2 \end{cases} \quad (9)$$

We have the Lyapunov function as

$$L = \mathbf{s}^T\mathbf{M}\mathbf{s}/2 \quad (10)$$

By evaluating the derivative of (10), we have

$$\begin{aligned} \dot{L} &= \mathbf{s}^T\left(\mathbf{M}_s(\ddot{\mathbf{x}}_d + \mathbf{c}\dot{\mathbf{e}}) + \mathbf{C}_s\dot{\mathbf{x}} + \mathbf{G}_s + \frac{1}{2}\dot{\mathbf{M}}_s\mathbf{s}\right) - \mathbf{s}^T\tau \\ &= \mathbf{s}^T\left(\mathbf{Y}_s - \mathbf{Y}^* + \mathbf{Y}^*\right) - \mathbf{s}^T\tau \\ &= \mathbf{s}^T(\mathbf{Y}) - \mathbf{s}^T\left(\tau - \left(\mathbf{Y}_s - \mathbf{Y}^*\right)\right) \\ &= -\mathbf{s}^T\left(\mathbf{v} - \left(\mathbf{Y}_s - \mathbf{Y}^*\right)\right) \\ &= -\mathbf{s}^T(\mathbf{v} - \boldsymbol{\varepsilon}_s) \end{aligned} \quad (11)$$

From (11) we get

$$\mathbf{Y}^* = \mathbf{M}^*(\ddot{\mathbf{x}}_d + \mathbf{c}\dot{\mathbf{e}}) + \mathbf{C}^*\dot{\mathbf{x}} + \mathbf{G}^* + \dot{\mathbf{M}}^*\mathbf{s}/2 \quad (12)$$

IV. IMPEDANCE CONTROL OF MECHANICAL ARM

The above control law is formed for the system, the posture of the subject can be adjusted when the robot arms are in contact with the subject. However, it is difficult to adjust the position of the subject relative to the robot arms. Therefore, in this section, the method of adjusting the arm-position is proposed and simulated. As shown in Fig. 4, the controller mimics the movements of humans when they are holding the subject.

System adjusted the arm-position by release the subject, when the system in the released state, the subject is disengaged, the gravity is considered as a virtual drive for the subject to restabilize the system. To reduce contact impact, an impedance control strategy is required.

At the state of release, there is no force between the subject and the robot arms, then the dynamic equation of the system can be expressed as

ISSN:0975-3583,0976-2833 VOL12, ISSUE05,2021

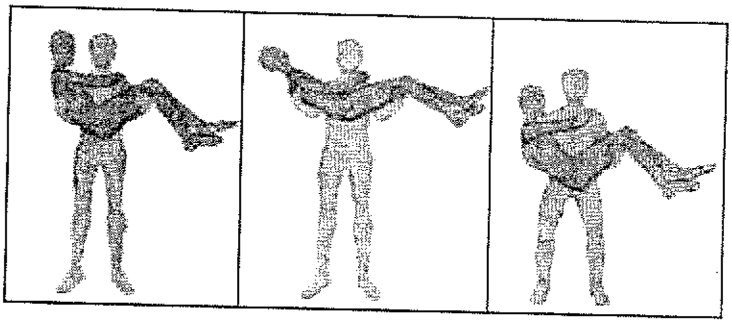
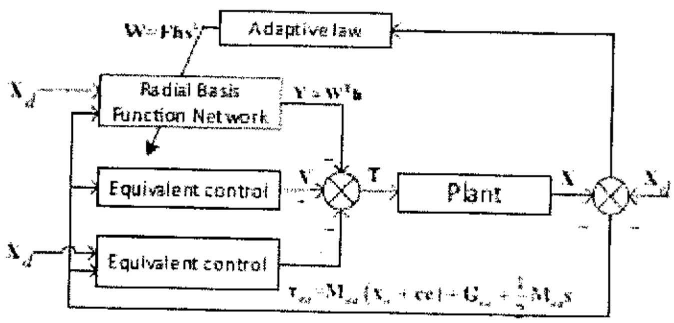


Fig. 4 Schematic diagram of arm-position adjustment

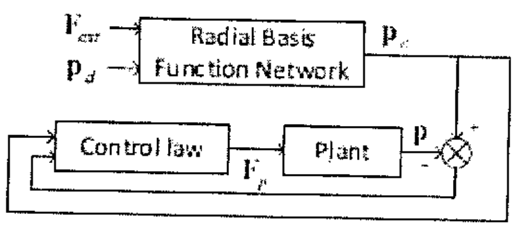
Where M is an inertia matrix, F_{ext} is the external force, and F_p is the input force.

V. NUMERICAL SIMULATION

The method introduced in this paper is applied to the model build by ADAMS, with system parameters shown in Table 1, which is applied for the simulation. Additionally, the controller is established by MATLAB as shown in Fig .5. Simulation are carried out, the first set is shown in Fig. 6, for the whole process of the system, the trajectory of robot arms and human body in the process of manipulation are obtained. The contact force on human body at different stages in the process of manipulation is shown in Fig. 7.



a. Adaptive controller



b. Impedance controller

Fig.5 Closed loop system with controller

TABLE I PHYSICAL PARAMETERS OF THE SYSTEM

ISSN:0975-3583,0976-2833 VOL12, ISSUE05,2021

	Parameters		
Symbol	$i=1$	$i=2$	$i=3$
$m_i[Kg]$	40	10	10
$J_i[Kgm^2]$	2.7	0.13	0.13
$L_i[mm]$	900	400	400
$r_i[mm]$	35	35	--

The first set shown in Fig. 6 is a realization of arm-position and posture adjustment through switching the adaptive and implement controllers. Firstly, the subject is accelerated along the vertical direction to separate the robot arms and the subject within 0.5 seconds. Secondly, the robot arms are deceleration to separate from subject, then robot arms can without contacting the subject, therefore adjust the relative position between the subject and robot arms. Finally, reduce the speed of the manipulator and the subject is accelerated by gravity, the subject re-contact with the manipulator, and there is a velocity difference at the moment of contact, the system is re-stabilized under the influence of impedance control and gravity of the subject, impedance control stabilize the system and reduce the impact force between the robot arms and the subject at the same time. We can observe that the actual trajectory of the restabilized system cannot follow the ideal trajectory perfectly, cause of the robot arms adjust its trajectory according to impedance control to ensure the conformance of human, reduce the impact force produced by re-contact.

The contact forces of whole simulation process are given as Fig. 7, we can see the impact of the moment of re-contact and how fast impedance control slows down this force.

ISSN:0975-3583,0976-2833 VOL12, ISSUE05,2021

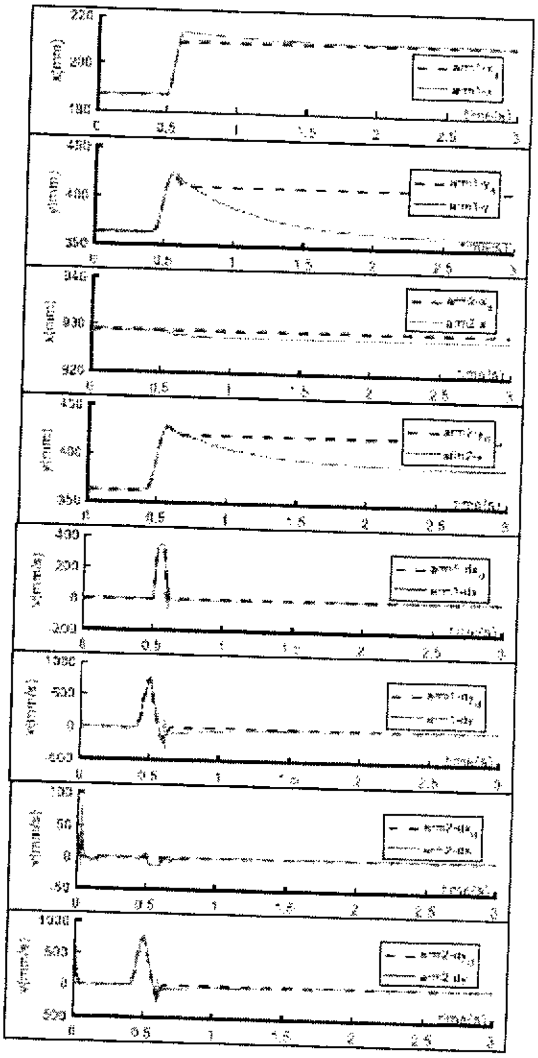


Fig. 6 Position and Velocity tracking of robot arms

ISSN:0975-3583,0976-2833 VOL12, ISSUE05,2021

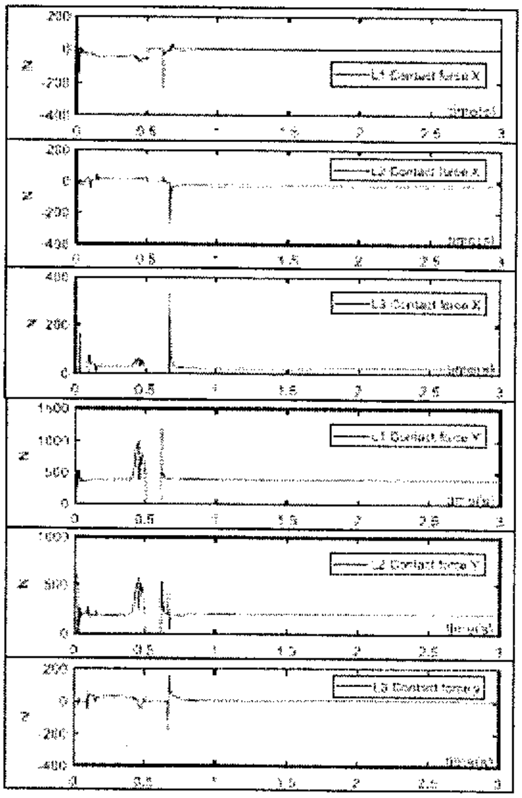


Fig. 7 Contact force between human body and robot arms

VI. CONCLUSION AND RECOMMENDATIONS

A novel control strategy to manipulate a multi-link objects that models a subject who is held by a dual-arm nursing care robot. The manipulation was divided into posture adjustment of the subject in holding and arm-position adjustment when the arms leave the subject for an instance to avoid friction. A neural network was introduced to build the control model, in which gravity is modeled as a virtual drive to the subject in the model. The posture adjustment was realized by using a sliding mode control method and impedance control was introduced in arm position adjustment.

The control law is switched according to the station. In the hold state, an approximate term of the neural network adaptive control law is used and in the release state, an impedance controller is introduced to ensure the comfort and safety of the subject. The effectiveness of the proposed method was confirmed by a numerical simulation.

REFERENCES

[1] Agraz, C. N., Pfingsthorn, M., Gliesche, P., Eichelberg, M., & Hein, A. (2022). A Survey of Robotic Systems for Nursing Care. Frontiers in Robotics and AI, 9.

[2] Mukai, T., Hirano, S., Yoshida, M., Nakashima, H., Guo, S., & Hayakawa, Y. (2011, September). Whole-body contact manipulation using tactile information for the nursing-care assistant robot riba. In 2011 IEEE/RSJ International Conference on Intelligent Robots and Systems (pp. 2445-2451). IEEE.

[3] Ding, M., Ikeura, R., Mori, Y., Mukai, T., & Hosoe, S. (2013, November). Measurement of human body stiffness for lifting-up motion generation using nursing-care assistant robot—RIBA. In SENSORS, 2013 IEEE (pp. 1-4). IEEE.

[4] Liu, Y., Chen, G., Liu, J., Guo, S., & Mukai, T. (2018, December). Biomimetic design of a chest carrying nursing-care robot for transfer task. In 2018 IEEE International Conference on Robotics and Biomimetics (ROBIO) (pp. 45-50). IEEE.

ISSN:0975-3583,0976-2833 VOL12, ISSUE05,2021

[5] Sun, M., Nakashima, H., Hirano, S., Matsuo, K., Ding, M., Jiang, C. A., ... & Qin, G. (2013, July). Adaptive user-centered design for safety and comfort of physical human nursing–care robot interaction. In International Conference on Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management (pp. 365-372). Springer, Berlin, Heidelberg.

[6] Chen, T. L., & Kemp, C. C. (2011). A direct physical interface for navigation and positioning of a robotic nursing assistant. Advanced Robotics, 25(5), 605-627.

[7] Liu, Y., Yin, Y., Jiang, Z., & Guo, S. (2021). Motion Analysis and Tactile-Based Impedance Control of the Chest Holder of a Piggyback Patient Transfer Robot. Journal of Healthcare Engineering, 2021.

[8] Chen, M., Wu, J., Li, S., Liu, J., Yokota, H., & Guo, S. (2021). Accurate and real-time human-joint-position estimation for a patient-transfer robot using a two-level convolutional neutral network. Robotics and Autonomous Systems, 139, 103735.

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

A detailed review: A association between nursing staff and omissions

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Abstract

Aims: To identify the most often missed nursing care in acute adult inpatient wards, and to establish whether there is a link between nurse staffing and missing care.

Background: In-hospital mortality, for example, has been linked to low nurse staffing levels in studies. To complicate matters, it has been suggested that the lack of enough nurse staffing may be shown more directly by the omissions of nursing care (also known as "missed care," "care left undone," or "rationed care").

Data Sources: For quantitative studies examining the link between understaffing and missing care, we turned to the Cochrane Library, CINAHL, Embassy, and Medline databases. Key journals, personal libraries and reference lists of papers were scanned for relevant articles.

Review Methods: The studies were identified by two reviewers. The quality assessment was based on the quality rating criteria for studies reporting correlations and associations developed by the National Institute for Health and Care Excellence. The study's concept, frequency of compassion fatigue, and measurements of relationship were all abstracted. Narrative was used in the synthesis process.

Results: Subjective accounts of missing care were collected from 18 research. Nearly a third of all nurses admitted to neglecting certain aspects of patient care. One of the strongest links between greater rates of missed care and lower nurse staffing levels was discovered in 14 different research investigations. Adding support employees to the team did not seem to lessen the amount of care that was missed.

Conclusions: Hospitals with low Registered Nurse staffing are more likely to report missing nursing care. An indication of nurse staffing adequacy is missed care. A closer look is needed to see whether the correlations found are in fact failures.

KEYWORDS: Care left undone, hospital, implicit rationing and missed care, nursing staff, quality, skill mix, systematic review and workforce.

1. Introduction

There is a substantial body of data linking hospital nurse staffing levels with better patient outcomes. The length of a patient's hospital stay and other circumstances may all have an impact on how well they do after they leave the hospital. Missed nurse care is now being investigated as a factor in poor patient outcomes. A possible indication of hospital nursing care quality is missed care according to the researchers. It is important to gain a detailed knowledge of an influence of nurse staffing on patient safety in light of worldwide estimates of a shortage of nurses by 2025. Worldwide interest in finding out how hazardous staffing in a hospital affects the mechanisms and all potential results also exists.

2. Literature survey

Low nurse staffing levels have been linked to a higher death rate in hospitals. However, this research has had a considerable influence and has been used to push for greater nurse staffing levels, including statutory minimums, although the causal relationship between nurse staffing levels and outcomes remains contested. For the vast majority of patient outcomes, causality can only be inferred in a limited and indirect way.

Since a study found an association between missing nursing care and worse patient outcomes, the term "missed nursing care" (KNL) has gotten a lot of attention. Investigations of possibly preventable fatalities in hospitals show how nursing staff omissions may have major negative repercussions. Patients' vital signs, early symptoms of deterioration, communication of aberrant observations and/or a sufficient reaction are usually related with unnecessary fatalities in the hospital according to research.

Because of this, it has been proposed that nurse staffing levels affect mortality rates by omitting vital treatment, such as monitoring to detect and prevent deterioration. Nurses may be forced to participate in what is known as "implicit rationing" if they are unable to accomplish all required care tasks due to their heavy workloads. As a good indicator that could more sensibly indicate issues arising from low staffing before they are detected through poor outcomes, missed nursing care has been proposed as a potential quality indicator linked to the adequacy of nursing staffing.

- The National Institute for Health and Care Excellence's safe staffing recommendations for adult hospital wards highlighted the importance of nurse staffing in ensuring patient safety.
- It has been noted by the National Institute for Health and Care Excellence that additional research is needed on measures that reflect more directly the influence of nurse staffing on patient outcomes.

How should the findings be used to influence policy/practice/research/education?

- It is possible to use missed care as an indication of the quality of the care that is being provided.
- One way to minimise missing treatment is to keep personnel numbers at an acceptable level.

Nursing activities may be difficult to evaluate and are frequently not regularly gathered by healthcare providers, thus although evidence on the link between nurse staffing levels and patient outcomes is vast and carefully reviewed, research on missing nursing care is relatively limited. There are, however, an increasing number of researches looking at the connection between a shortage of nurses and patient harm. There have been previous studies that looked at variables connected to missing care, but no comprehensive investigation of the connection with staffing has been conducted.

3. Methodology

It was the goal of this study to identify the most often missed nursing care tasks in acute hospitals' adult inpatient wards and to evaluate whether missed care is associated with a nurse staffing shortage.

Two questions guided the review to reach the aims:

1. As reported by staff, patients, or administrative statistics, what are the most often neglected nursing care activities in adult inpatient wards in acute care hospitals?

2. What are the correlations between nurse staffing levels and missed care in acute hospital adult inpatient wards?

- **Design:**

Study participants were asked to identify the correlation between nurse staffing levels and skill mix and missing treatment in general medical/surgical wards in acute care hospitals.

NICE's guidelines for the development of public health were followed in conducting the review of the study (2012). We chose this method since we expected much of our study to be observational.

- **Search methods**

Nurse staffing literature was thoroughly examined and reviewed, and further searches were conducted for particular keywords linked to missing care (missed care and unfinished care, implicit rationing and care left undone). Databases of grey literature were searched in the CEA registry and the CDSR and CDSR databases as well as Medline containing In-Process and NHS EED and HEED (including the HMIC database and those held by the National Institute for Health and Care Excellence [NICE]). Only articles published after 2006, when the phrase "missed care" was first used by Kalisch in his research, were considered for the search (2006). Searches of academic journals, personal libraries, and reference books were performed by hand. Up till June 2016, the first round of searches had been conducted. Even though we can only be certain that our coverage was complete up to June 2016, further research during the final writing of the report revealed that no significant additional studies had been published since then.

It was our intention to include primary research articles that examined the relationship between nurse staffing, such as RN hours per patient day or the nurse-to-patient ratio, and missing or delayed care in acute hospital wards, as well as the ratio of RN to all hands-on caretakers. There were no studies included that were conducted just in highly specialised units with unusual personnel (such as an ICU). Omissions (e.g. medication mistakes) were omitted from studies reporting composite error rates if the rate of omissions could not be distinguished from other errors. Prospective or retrospective observational studies, cross-sectional analyses, and longitudinal investigations were among options we investigated.

Initially, just one reviewer (AR) screened the titles and abstracts for their relevancy. Studies that were found to be relevant were selected by two reviewers who worked separately to examine the list of candidates. Initial discrepancies on the inclusion of research were modest; disagreements were addressed via discussion (1 study in 18 required any discussion).

A total of 11,269 sources were turned up throughout our investigation. A total of 127 papers were selected as needing additional evaluation after removing duplicates and a quick screening for relevance (title only). A second round of abstract screening yielded 57 papers that were maintained for a full text examination. According to a thorough review, 40 papers were deemed ineligible for inclusion because of their type (e.g., a discussion or review) (N = 7); not measuring the associations between nurse staffing (N = 25); not adult medical/surgical wards (N = 1); reporting medication errors without distinguishing errors due to delayed or omitted administration from those due to administering the wrong drug or dosage (N = 7) (see Figure 1).

- **Data abstraction Data**

Sample parameters (staff and patient size), staffing metrics (prevalence of nursing chores missed), and association/effect measurements were all abstracted. Whenever feasible, we obtained the precise p value and the point estimate, as well as the confidence interval. In cases where the information supplied by the authors was insufficient, we included the information that was available.

- **Synthesis**

The way missing care was measured and the questions that were asked varied amongst instruments. "number of necessary nursing tasks for patients withheld or otherwise not performed in the last seven working days," "frequency of care missed on unit by all of the staff (including yourself)," and "on your most recent shift, which of the following activities [13-item list] were necessary but left undone because you lacked the time to complete?" ". Table 2 provides a breakdown of the elements. In the QTDS, patients were asked whether any of the six aspects of discharge information was requested but was not provided.

Since there are many different methods for determining missed care (e.g., the number of elements in each instrument and the time period in which missed care occurred), we ranked the frequency with which missed care items were reported in order to compare the relative frequency across research. We estimated missing care if other research have done so using the same tool.

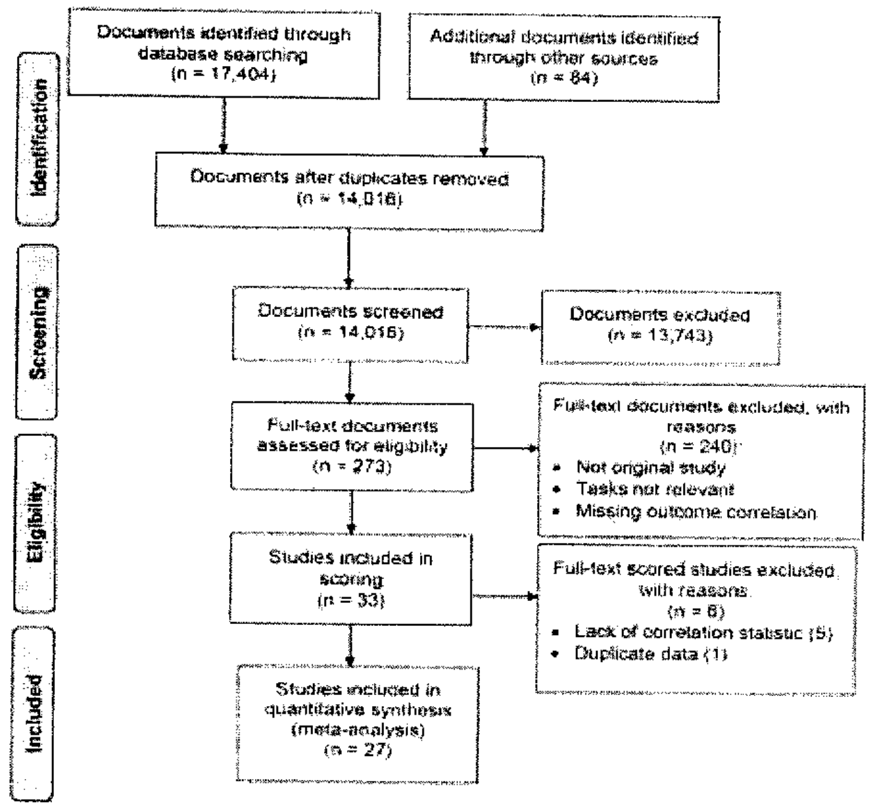

FIGURE 1. Study selection flow chart

Each item's average rank. A scale rating of "always," or "often," was deemed a sign of "missed care." In order to avoid overemphasising items from instruments used in just one research, we only included data from instruments that have been used in numerous studies or studies with a large sample of hospitals (10+) and nurses (1,000+). This ensured that the findings would not be impacted by previous research that used a unique instrument with a limited sample size. Unclassified care items were categorised as clinical, planning and communication or unclassified based on RN4Cast factor analysis (Bruyneel et al., 2015). At least three separate groups all agreed that the same item should be placed in one of two categories. Rankings were transformed to centiles such that the highest-scoring item was always 100 and the lowest-scoring item was always 0 in order to generate a similar statistic. Analyzing variance using Kruskall–Wallis (nonparametric) analysis of variance was used to compare the positions of the candidates (Minitab v 17.3).

4. RESULTS

This review included eighteen papers that fulfilled the inclusion criteria. As a result of the large national representative samples of hospitals and nurses, seven studies were rated as having good external validity. The level of bias in all of the studies was at least considerable (internal validity). Table 1 provides an overview of the studies that were included. Every study was cross-sectional. From 232 to 31,627 registered nurses were included in the study, with the majority being the smallest possible sample size (RNs).

In spite of the fact that some included healthcare support workers (HCSW) such as nursing assistants and certified vocational nurses in the nursing profession. Nurse to patient ratio (12 studies), nursing hours per day per patient (NHPPD or RNHPPD) (three studies) or the number of patients cared for in the past shift were all used to report staffing levels (three studies). There were four studies that looked at the skill mix. Six other studies utilised data from the RN4Cast project, including one for England, one for Germany, one for Sweden, and one for Switzerland (Schubert et al. 2013). Although these publications focus on different elements, there is a lot of overlap and single country data is nested in the multi-country analysis, thus these seven studies are not completely independent.

Table 1 Summary of included studies.

Reference	Study design	Interventions	Results	*p*	Quality score
			Trauma and burns		
Clifton 1985 [72]	RCT, 2 weeks, n = 20 severe head injury inpatients	isoenergetic EN ~3500 kCal Group 1: 1.5 g P/kg Group 2: 2.6 g P/kg	nitrogen intake (g/kg) Group 1: 0.24(0.04) vs. Group 2: 0.42(0.09)	<0.01	O
			nitrogen loss (g/kg) Group 1: 0.36(0.08) vs. Group 2: 0.49(0.11)	<0.01	
			nitrogen balance, body weight, serum albumin, creatinine-height index, lymphocyte count	NS	
Demling 1998 [67]	RCT, 3 weeks, n = 15 rehabilitation inpatients post severe burns	oral diet with supplement drink Group 1: 1.3 - 1.5 g P/kg Group 2: 1.7 - 2.0 g P/kg	protein intake (g/kg) Group 1: 1.4(0.1) vs. Group 2: 2.1(0.2)	<0.05	+
			weight gain (kg/week) Group 1: 0.59(0.09) vs. Group 2: 1.22(0.05)	<0.05	
			able to complete physiotherapy without fatigue at week 2 (score 10) Group 1: 3(1) vs. Group 2: 6(1)	<0.05	
			able to complete physiotherapy without fatigue at week 3 (score 10) Group 1: 5(1) vs. Group 2: 8(2)	<0.05	
			non-protein energy intake, initial weight loss, mortality, infections, hospital LOS	NS	
Huang 1990 [73]	RCT, 2 weeks, n = 60 acute head injury inpatients	non-isoenergetic EN Group 1: 1.5 g P/kg with energy 30 - 35 kCal/kg Group 2: 2.0 - 2.5 g P/kg with energy 1.9 xBEE Group 3: 2.5 - 3.0 g P/kg with energy 1.9 xBEE	protein intake (g P/kg) Group 1: 1.4(0.06) vs. Group 2: 2.2(0.03) vs. Group 3: 2.6(0.06)	<0.01	O
			weight loss (%IBW) Group 1: 11.8(1.8) vs. Group 2: 4.2(1.0) vs. Group 3: 8.1(1.0)	<0.01	
			albumin, ferritin, creatinine height index, lymphocytes, GCS on discharge, 6-month outcome	NS	
Larsson 1990 [64]	RCT, 8 days, n = 39 trauma or burn inpatients	isoenergetic PN Group 1: 0 g P/kg Group 2: 0.6 g P/kg Group 3: 1.2 g P/kg Group 4: 1.6 g P/kg Group 5: 1.9 g P/kg	nitrogen balance (g) Group 1: −13.8(0.5) vs. other groups (Group 2: −6.0(0.6); Group 3: −3.1(2.5), Group 4: −4.0(1.0), Group 5: −4.5(1.0))	<0.001	+
			urinary nitrogen loss (g) at day 8 Group 1: 14.3(1.4) and Group 2: 12.5(1.4) vs. other groups (Group 3: 23.3(3.2), Group 4: 25.1(1.5), Group 5: 30.7(1.5))	<0.05	
			nitrogen retention (%) at day 8 Group 1 vs. other groups (Group 3: 38.7(15.9), Group 4: 44.5(5.4), Group 5: 27.1(3.4)), Group 1 vs. Group 2 NS	<0.05	
			urea (mmol/L) at day 8 Group 1: 4.6(0.7) and Group 2: 7.1(1.3) vs. other groups (Group 3: 12.1(2.4), Group 4: 11.0(2.4), Group 5: 10.4(1.2))	<0.01	
			glucose, creatinine, body weight, albumin, urea, muscle ATP, urinary 3-methyl histidine excretion	NS	
Serog 1982 [66]	RCT, 12 days with crossover (3 days each), n = 24 severe burns inpatients	isoenergetic EN ~4000 kCal Group 1: ~2 g P/kg Group 2: ~4 g P/kg	nitrogen intake (g) Group 1: 23.12(0.85) vs. Group 2: 40.07(1.35)	<0.001	++
			nitrogen balance (g) Group 1: −0.09(2.89) vs. Group 2: +19.33(1.87)	<0.001	
			nitrogen output, weight, energy intake, energy expenditure, respiratory quotient	NS	
Twyman 1985 [62]	RCT, 10 days, n = 21 head injury inpatients	isoenergetic EN ~3000 kCal Group 1: 1.5 g P/kg Group 2: 2.2 g P/kg	nitrogen balance (g) Group 1: −3.23(0.59) vs. Group 2: 1.6(0.58)	0.006	+
			cumulative nitrogen balance (g) Group 1: −31.2(5.31) vs. Group 2: 9.2(4.91)	0.04	
			protein intake (g P/day) Group 1: 1.5(0.0) vs. Group 2: 2.2(0.1)	<0.0001	
			energy intake	NS	
			urinary urea nitrogen (g/day) Group 1: 21.9(0.52) vs. Group 2: 26.3(0.55)	0.03	
Wolfe 1982 [74]	RCT, 6 days with crossover (3 days each), n = 6 severe burns inpatients	isoenergetic EN or PN ~40 kCal/kg Group 1: 1.4 g P/kg Group 2: 2.2 g P/kg	plasma leucine oxidation (µmol/kg) Group 1: 56 vs. Group 2: 76	<0.05	O
			protein synthesis, protein catabolic rate, protein balance, oxygen consumption, respiratory quotient	NS	
			Critical illness		
Greig 1987 [70]	RCT, 1 week, n = 9 septic inpatients on parenteral nutrition	isoenergetic PN ~2250 kCal Group 1: 1.19 g P/kg Group 2: 2.29 g P/kg	protein oxidation (kCal/kg) Group 1: 4.7(0.6) vs. Group 2: 8.3(1.1)	<0.05	+
			urea (mmol/L) Group 1: 7.3 +/− 2.8 vs. Group 2: 8.4 +/− 1.2	<0.05	
			nitrogen balance, glucose, fatty acids, insulin and triglycerides	NS	

 FNS

RN4CAST, a study of 31,627 nurses from 488 hospitals in 12 European countries, found that nurses who cared for more than 11 patients had a 26% higher risk of leaving care undone than nurses who cared less than 6 patients (OR = 1.26; 95 percent CI = 1.23–1.29). Further multi-country studies utilising the number of care items missed as the result of this research showed this strong relationship (Ausserhofer, et al., 2014; Bruyneel, et al., 2015). In England (Ball, et al., 2014) and Sweden (Ball, et al., 2016), statistically significant relationships between reduced staffing and greater levels of missed care were reported; however, findings from Germany (Zander, et al., 2014) and Switzerland (Schubert, et al., 2013) were more ambiguous. Nurses caring for 6.1 or less patients had a 66% reduced risk of missing care than nurses caring for 11.7 or more patients in England (OR = 0.34, 95% CI 0.22–0.53). In Sweden, shifts with fewer than six patients per RN were related with a 53% decrease in the likelihood of care being left unattended (OR = 0.47, p .001). Each extra patient per nurse was associated with a 3% increase in reports of missed patient surveillance, skincare, and on-time delivery of medicine (OR = 1.03 p .01), although there were minor but significant relationships in the reverse way, indicating no overall link. The patient-to-nurse ratio was only related with missing care in an uncorrected model in Switzerland, however. The link was no longer significant when probable confounders were taken into account, although there was still a substantial correlation between nurse-perceived staffing adequacy and patient outcomes.

In other nations, the same thing happened. A cross-sectional study of 3,037 RNs in South Korea revealed that the RN4CAST measure (OR = 1.03; p .001) showed a 3 percent increase in the likelihood of care left undone for every extra patient (p .001). (Cho and colleagues, 2016) It was shown that higher nurse-to-patient ratios (1:7 vs. 1:17) were related with fewer missing nursing care (b = 0.136; p.02) (Cho et al., 2015) (Cho et al. At 12 Italian hospital units, a smaller patient load was linked to fewer missed care opportunities (OR = 0.91; p .05). Most nursing duties had weak negative associations with nurse staffing levels in Kuwait, with educating patients/families having the largest link (r =.12; p .005). Moderate or high bias risk was found in all of the research included.

More patients meant more missed treatment, according to a survey of 4,861 nursing personnel in 10 hospitals in the United States (b = 0.015; p .001). For the study of the human brain. A second study indicated that fewer patients missed care when nurses worked longer shifts each day (b = 0.45; p =.002). This is based on the findings of Kalisch et al. (2011). As a result, we could not determine whether or not these investigations were really independent. Similar results were found in lower-quality research, although the results were more contradictory. The total number of missed nursing care points increased by 2.1% in oncology units across nine hospitals (p .05) for every additional patient cared for by RNs and HCSWs, and a single hospital study found a weak positive correlation between the number of patients per nurse and the number of missed care points (r =.246, p .000). """""""""""""""""""""" At contrast, a research conducted in two hospitals in the United States and Lebanon (Beirut) revealed that the number of patients treated was not a significant predictor of missed treatment.

A high or moderate risk of bias was detected in research based on patient accounts, however the findings were mixed. Findings from an investigation of 729 patients in two US hospital systems showed no link between patient claims of missing treatment and the number of nurses on duty per patient day (r =.14, p =.02). No correlation was identified between RNHPPD non-overtime hours and patient reports of receiving essential discharge information (b = 0.05, p =.74) in a survey of four US hospitals.

5. DISCUSSION

Many nations have researched the correlation between "missed care" and nurse staffing levels in hospitals. All the studies we found utilised subjective measures of missing care, with most relying on nurses' retrospective recollections. Missed appointments were common, according to the data. Planning and communication aspects were more often reported as missing than clinical care, despite the fact that complaints of missing critical clinical procedures and patient monitoring/observation were remained commonplace.. Almost all studies indicated a link between greater rates of missed care and lower nurse staffing levels. RN staffing levels have been the focus of most investigations. However, one research indicated that when HCSW staffing levels were very high, the degree of missing care decreased. This contradicts the findings of other studies that found no benefit or a negative impact from larger numbers of support workers.

The relationship between nurse staffing numbers and patient safety results has long been hypothesised to be one of the driving forces for the growing interest in missed care nursing. An essential aspect of the argument that these relationships between staffing and outcomes are causal is the idea that inadequate staffing leads to high mortality through missing chances to recognise and prevent deterioration (Clarke & Aiken, 2003; Griffiths, et al., 2016). However, despite growing interest in utilising missing care as a leading quality indicator, existing subjective metrics based on sporadic survey do not easily adapt themselves to regular quality monitoring.

Staffing levels are unlikely to have a direct impact on poor outcomes such as death on the kind of care that patients most commonly report being missing, such as conversing with and consoling them. It's possible that the lack of attention to these areas of care is due to a focus on clinical treatment due to personnel shortages, but other, less noble motives, such as deference to medicine, have been mentioned as well (Papastavrou et al., 2014). Despite this, the observed levels of clinical care omission remain high. The relative relevance of the care that is neglected is not taken into account when using broad measurements of missing care. Missed care is not all of the same importance, and the influence on a patient's prognosis will differ according to this (Recio-Saucedo et al., 2017). Direct evidence of missed clinical treatment mediating the association between staffing and mortality is lacking, despite evidence that missed care mediates the relationship between staffing levels and measures of patient satisfaction and falls (Jones et al., 2015).

Studies evaluated here typically suggest a link between staff levels and missed care, but none investigated an association between staff numbers and any objective assessment of care. Despite the fact that nurse reports of missing care are linked to poor patient outcomes, it is not apparent to what degree these reports correspond with real omissions of care. Studies that failed to reveal significant relationships were smaller and had a greater risk of bias, while those that relied on patient accounts did not convincingly support the findings of studies that relied on nurse reports. Comparisons across research are hampered by the wide range of measurement procedures and analytical techniques used. One study's "dramatic" impact size (Ball et al., 2016) may be extrapolated to get a range of 89% to 75% decrease in the likelihood of patients reporting missing care in better-staffed units. This is because of a reported 66% drop in chances. Although there may be a link between reported missing care and staffing levels, it seems that most missed care cannot be ascribed to insufficient staffing.

6. CONCLUSION

While reported missed care is associated with nurse staffing levels and such reports may indeed be indicators of inadequate nurse staffing, there is no research demonstrating associations with objective measures of care. The extent to which the relationships observed in these studies represent actual omissions of care and the consequences of such failures, remains largely investigated. Given the potential consequences of missed care, its incidence/ prevalence may serve as an indicator of care quality and maintaining adequate staffing levels is a mechanism to avoid missed care. While the association between staffing and missed care is substantial it is unlikely that most care omissions are directly linked to staffing levels only. Reports of missed care cannot in themselves be used to track nurse staffing adequacy, although changes in the rate or frequency or reports could indicate nurse staffing problems. Future research should focus on objective measures of missed care on patient outcomes.

REFERENCES

[1] Sworn, K., & Booth, A. (2020). A systematic review of the impact of 'missed care'in primary, community and nursing home settings. Journal of nursing management, 28(8), 1805-1829.

[2] Recio-Saucedo, A., Dall'Ora, C., Maruotti, A., Ball, J., Briggs, J., Meredith, P., ... & Griffiths, P. (2018). What impact does nursing care left undone have on patient outcomes? Review of the literature. Journal of clinical nursing, 27(11-12), 2248-2259.

[3] Bukoh, M. X., & Siah, C. J. R. (2020). A systematic review on the structured handover interventions between nurses in improving patient safety outcomes. Journal of nursing management, 28(3), 744-755.

[4] Redfern, O. C., Griffiths, P., Maruotti, A., Saucedo, A. R., & Smith, G. B. (2019). The association between nurse staffing levels and the timeliness of vital signs monitoring: a retrospective observational study in the UK. BMJ open, 9(9), e032157.

[5] Mandal, L., Seethalakshmi, A., & Rajendrababu, A. (2020). Rationing of nursing care, a deviation from holistic nursing: A systematic review. Nursing Philosophy, 21(1), e12257.

[6] Smith, G. B., Redfern, O., Maruotti, A., Recio-Saucedo, A., Griffiths, P., & The Missed Care Study Group. (2020). The association between nurse staffing levels and a failure to respond to patients with deranged physiology: a retrospective observational study in the UK. Resuscitation, 149, 202-208.

[7] Greenwood, N., Menzies-Gow, E., Nilsson, D., Aubrey, D., Emery, C. L., & Richardson, A. (2018). Experiences of older people dying in nursing homes: a narrative systematic review of qualitative studies. BMJ open, 8(6), e021285.

[8] Korb-Savoldelli, V., Boussadi, A., Durieux, P., & Sabatier, B. (2018). Prevalence of computerized physician order entry systems–related medication prescription errors: A systematic review. International Journal of Medical Informatics, 111, 112-122.

[9] Randles, R., & Finnegan, A. (2022). Veteran help-seeking behaviour for mental health issues: a systematic review. BMJ Mil Health, 168(1), 99-104.

[10] Panagioti, M., Khan, K., Keers, R. N., Abuzour, A., Phipps, D., Kontopantelis, E., ... & Ashcroft, D. M. (2019). Prevalence, severity, and nature of preventable patient harm across medical care settings: systematic review and meta-analysis. bmj, 366.

An electronic equipment-based nursing homes using "care dog" device

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Abstract - This article highlights the innovative concept and practical benefit of converting an intelligent automobile into an electronic "nursing dog" for a nursing home. The system was pre-analyzed. Then we constructed a software platform based on ARM core STM32F103 single chip microcomputer control automated control system, comprising the primary programme of automatic control, sensor data processing, voluntary obstacle avoidance, and robotic arm grasping method. The system also uses three communication technologies: wireless WIFI, Bluetooth, and infrared.

Finally, the system's stability and practicality were validated by collaborative debugging of the equipment's photovoltaic-assisted power production, autonomous driving, remote control, video transmission, and robotic arm intelligence. Grabbed and awaited relevant research.

Keywords: *STM32; photovoltaic; PID control; manipulator*

I. Introduction

Robots are now extensively employed in various sectors as mechanical structures that mimic human actions. Robots are high-tech products that combine several disciplines such as mechanical design and automated control. Researchers employ numerous sensors to acquire exterior information for the robot to increase its capacity to cooperate with the external world. Its huge and comprehensive data gathering, non-contact measurement, and wide application range make the vision sensor one of the most significant sensors. In recent years, increasing numbers of robots have been fitted with vision systems to improve intelligence and support the development of autonomous mobility technology.

The nursing home's computerised "dog buddy" technology may provide considerable physical and mental joy. It employs green energy solar power and can partially replace conventional accompanying dogs, overcome their drawbacks such as expensive training expenses, lengthy training time, and excrement pollution, and meet the goal of energy saving and emission reduction. It employs a cell phone for remote control and may aid older persons with bad legs. It employs the robotic arm's intelligent grasp to help the elderly and the camera image capture and WIFI data transmission module to monitor their safety in real time.

With precise remote control, solar auxiliary power supply, robot arm grasping, and video transmission, the basis is laid for future replacement of conventional escort dogs. The computerised "accompanying dog" equipment will someday penetrate our everyday lives, improving the quality of life and enjoyment of the elderly. Using STM32F103ZET6 as the control core, the following work was done:

Engineered the STM32F103ZET6 microcontroller-based electronic "accompany dog" device's construction. The concept of photovoltaic-assisted power production is presented.To complete obstacle detection and remote control, the technique of composite detection of many sensors is adopted, and the comprehensive processing technology of multiple sensors is researched.

With the use of three-dimensional stereo vision, the robot arm can swiftly gather two-dimensional information about the item, and the design may be based on real manufacturing. It can self-set the grasping technique and gripping object characteristics to achieve 360-degree intelligent gripping.

II. Design Scheme

The functions are independent of each other, allowing for future development. Figure 1 depicts the system's general block diagram.

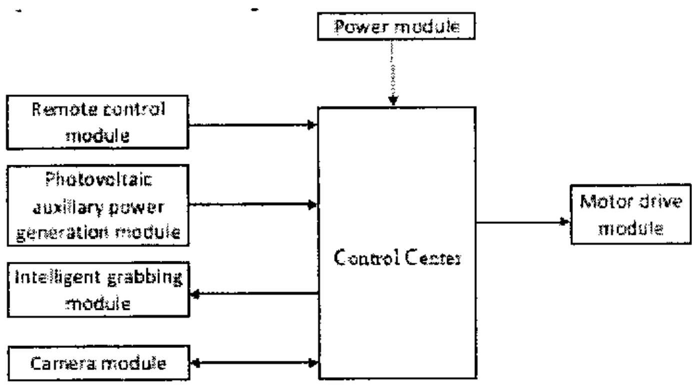

Figure 1. Overall system block diagram

III. Working Principle And Performance Analysis

A. Working principle and performance analysis

A solar photovoltaic panel, a controller, and a battery make up the majority of the photovoltaic auxiliary power supply module. In order to power the electronic "dog companion" equipment, the battery serves as the primary source of energy. Battery life may be extended and energy saved while also reducing emissions using a solar photovoltaic panel when sunshine is available. Due to environmental conditions including light intensity and temperature, a maximum power point tracking (MPPT) is needed for solar panels in order to verify that they operate normally and efficiently.

Using two solar photovoltaic panels linked in series, the auxiliary power supply module used in this work has each output power of 5V / 250mA, as illustrated in Figure 2.

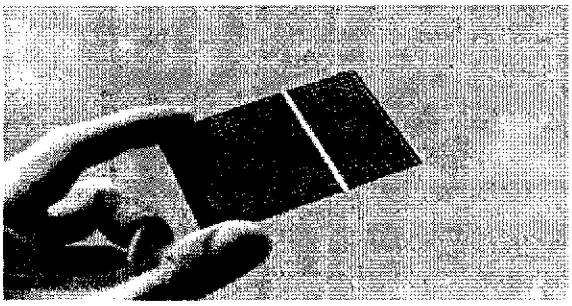

Figure 2. Solar photovoltaic panels

Selecting an SPV1040 dc-dc converter to monitor the greatest power point and increase solar energy's conversion efficiency is done to maximise solar energy's use.

B. Remote control module

Using an Android phone as the Bluetooth remote control device's control terminal, you'll need to download an APP to your phone and use it to move the Bluetooth remote control device.

Instead of using a standard remote control, this approach creates communication control software for mobile phones. As long as the APP is running, pressing the control key can conveniently control the device to move forward, backward, turn left, and turn right, saving hardware costs and improving anti-interference performance.

C. Camera acquisition module

A lens, an image sensor, a PCB board, and a DSP chip are the essential components of the camera. During the time the subject is illuminated, the image sensor collects a charge proportional to the intensity of the light, which is discharged regularly to form an electrical signal that represents a frame of picture. This electrical signal is turned into a digital picture signal by the analog-to-digital converter, which then sends it to a single-chip computer for further analysis.

D. Degrees of Freedom Robotic Arm Module

For the 6-DOF mechanical arm, the most important components are an aluminium alloy bracket and an aluminum alloy claw. The robot arm can execute a variety of tasks when connected to a controller. An automated tool that can mimic the movements of human hands and arms in order to grip, transport, or operate tools in accordance with a predetermined process.

PWM servo and bus servo versions of the 6-DOF robot arm are available. The bus servo version is used in this piece of equipment. Six high-precision digital servos and controllers are included in the system. The PC graphical interface may be used to debug and save operations, and it can perform tasks such as grabbing things. Figure 3 depicts the 6-DOF mechanical arm bus servo version.

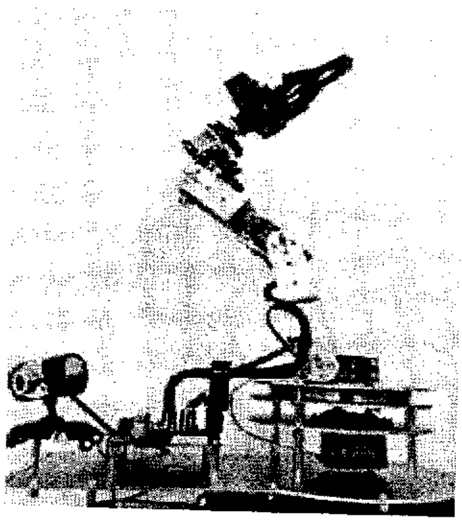

Figure 3. Manipulator bus servo

IV. Theoretical Design Calculations

A. *PV module parameter selection*

1) *Chip Introduction*

(1). Structure and working principle of SPV1040

The ST company's SPV1040 is a solar charger IC. It has an MPPT algorithm built-in, which makes use of the Perturb & Observe method. As a result of this, the charger's input impedance may be dynamically adjusted so that it perfectly fits the solar cell. The system's total energy efficiency and the efficiency of the transmission of energy between the battery and the battery.

Table 1 Charger status displayed by LED

Charging state	Describe	ST_1	ST_2
Charging	Precharge and fast charge	Bright	Extinguish
Charging completed	Charging current lower than I_{EOC}	Extinguish	Bright
Waiting	Input voltage below VBAT - 50mV	Extinguish	Extinguish
Over - under temperature	The temperature is not within the setting range too high or too low	Bright	Bright
Battery extraction	It is not possible to detect that the battery output voltage drops to V_{BAT} and $T_{BATTERY}$ has expired	Bright	Bright
Charging timeout	T_{PRECH} or $T_{FASTCHG}$ detected has expired	Bright	Bright

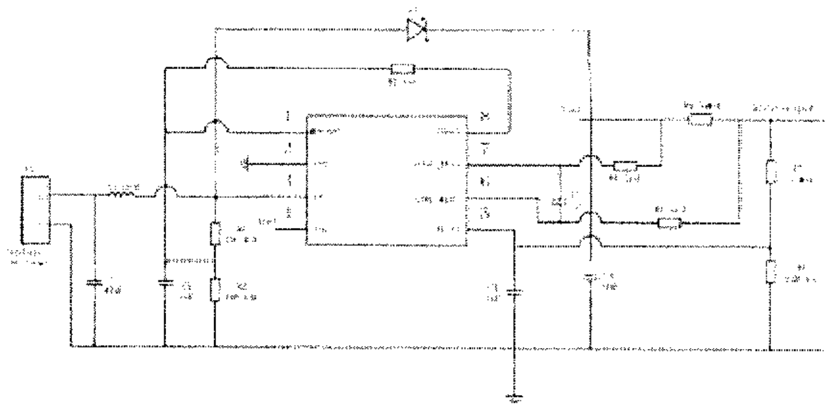

Figure 4. Solar panel boost circuit

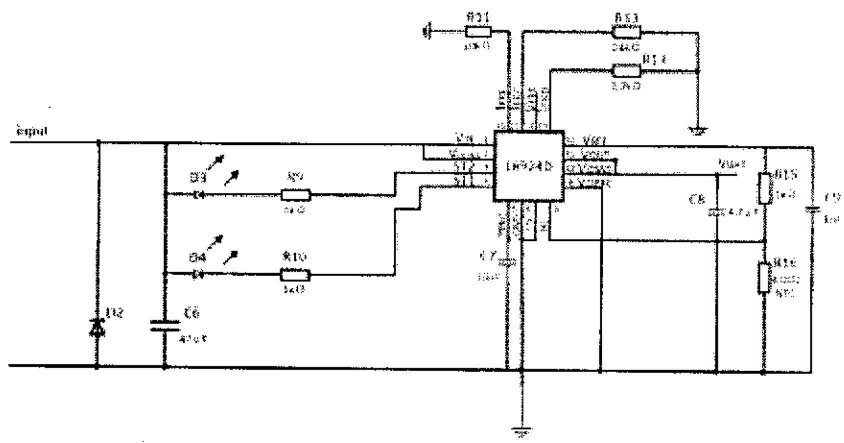

Figure 5. Lithium battery charge management circuit

Setting a low voltage The VOPRG terminal may be used to set the output voltage. A floating VOPRG outputs 4.1 volts, whereas a grounded VOPRG outputs 4.2 volts. Charging current may be set to remain constant. The IPRG terminal should be connected to GND through a resistor RPRG (R13 in Figure 5). The constant current charging current value ICHG may be changed by setting RPRG, and its size is calculated by the formula (4.1).

$$R_{PRG} = V_{BG} * \frac{K_{PRG}}{I_{CHG}} \quad (4.1)$$

Setting a consistent charging current is the first step. It is recommended to leave the VPRE terminal unconnected and to use the factory preset pre-charge voltage of 2.8 V. Pre-charge RPRE and pre-charge voltage are set to default values of 2.8 V in the RPRE and RPRE, respectively. In this case, volts is the grounded end value. An equation is used to calculate the RPRE value (4.1).

$$R_{V_{PRE}} = R_{PRG} * \frac{V_{PRETH}}{V_{PRETHdefault}} \quad (4.2)$$

Pre-charging at 10% of the continuous charge current is standard. Adding a resistor between IPRE and ground or the reference voltage VREF will set the pre-charge current value. The pre-charge current should be set higher than the default value, and a resistor should be connected between IPRE and ground. Equation calculates the additional resistance RPRE (4.1).

$$R_{PRE} = \frac{V_{BG}}{\frac{I_{PRECH}}{K_{PRG}} - \frac{V_{BG}}{R_{PRG}}} \quad (4.3)$$

A resistor is put between IPRE and the reference voltage VREF, lowering the pre-charge current value. When it comes to access resistance, we may use Equation to figure it out (4.1).

$$R_{PRE} = \frac{V_{PEF} - V_{BG}}{\frac{V_{BG}}{R_{PRG}} - \frac{I_{PRECH}}{K_{PRE}}} \quad (4.4)$$

Among them $V_{REF} = 1.8V$, $K_{PRE} = 950$, $V_{BG} = 1.23V$.

Constant voltage charging current can be considered complete when it reaches IENDTH. Connecting a resistor REND to the IEND terminal will allow you to connect IENDTH to GND. For REND's resistance, we may use equation (4.5).

$$I_{ENDTH} = V_{MIN} * \frac{K_{END}}{R_{END}} \quad (4.5)$$

Among them V_{MIN} is 50mV, K_{END} is constant 1050

B. *Information fusion of obstacles*

An APP on a smartphone or tablet may be used to take control of the device. The camera can avoid impediments by utilising its remote control device, which is controlled by the central processor and mobile phone app, when it detects an obstruction in its path. Various sensors are used to process different sorts of obstacles. They mostly employ ultrasonic, laser, infrared and other measures at that time.

These inexpensive and easy-to-use ultrasonic sensors have evident flaws in their practical application, such as a lack of focus and the inability to gather information about barriers' boundaries or distances. Directivity of the infrared light is excellent but it can only tell whether there are obstacles and cannot tell how far away they really are.

A mix of infrared photoelectric sensor, ultrasonic sensor, and camera capture is used to identify obstacles in this design.

C. *Ultrasonic sensors*

HC-SRO4 satisfies the standards of this article in every way. The time-of-flight technique of ultrasonic range is used in this design.

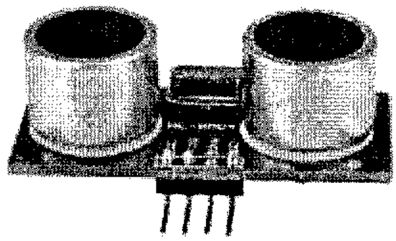

Figure 6 . HC-SRO4 ultrasonic sensor

Figure 6 depicts the ranging module's physical layout. The transit time technique is used to measure the speed of a vehicle. The range module receives a transmission signal from the main controller. The echo signal is first detected after the ultrasonic waves are sent by the module. An echo signal is picked up by this device, which then passes it to a single-chip microprocessor. The microcomputer then uses this information to determine how far away an obstacle is by pausing its programme and measuring the time difference t between sending and receiving an echo. (4.6) shows the computation formula:.

$$D = \frac{c\Delta t}{2} \qquad (4.6)$$

c is equal to 331.4 m/s, which is the sound speed in air at normal pressure.

1) In addition, a portion of the sound waves may be communicated straight from the transmitter to the receiver after the ultrasonic sensor has transmitted ultrasonic waves. Ultrasonic sensors may also produce a so-called "blind zone" by transmitting a portion of the ultrasonic waves straight from transmitter to receiver, rather than waiting for an obstruction to be present or an obstacle to be present, which forms a blind zone. It's as simple as that:

2) Set the suitable distance between the transmitting and the receiving sensors;

3) 3) Use software to optimise. Calculate the arrival time of the interference wave depending on the location of the receiving/transmitting ultrasonic sensor during software processing. Interference may be efficiently prevented by disabling the interrupt at this time, which means the received signal data is lost.

4) Most of the ultrasound will skip the impediment if it is less than the length of the ultrasound. The ultrasound's distance information will be inaccurate at this point, and the results cannot be relied. As a result, we decided to use infrared photoelectric sensors as a secondary detecting method.

D. Infrared photoelectric sensor

To determine the item's location, the infrared photoelectric sensor measures the amount of infrared light reflected off the object.

The infrared light emitted by the sensor is reflected by the object and received by the sensor after it emits infrared light. Judging the strength and existence of light received, the target is identified. The HJ-IR2 photoelectric sensor is displayed in Figure 7 of this text. High and low level digital signals are sent out by the sensor as long as it is operational. In addition, the sensor is not sensitive to sunlight and may be utilised in the daytime without converting from digital to analogue.

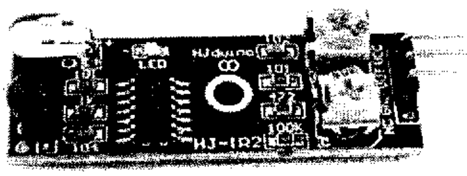

Figure 7 . HJ-IR2 infrared detection module

The ultrasonic sensor and infrared photoelectric sensor work together to identify obstacles in this design. Figure 8 illustrates the sensor configuration mode.

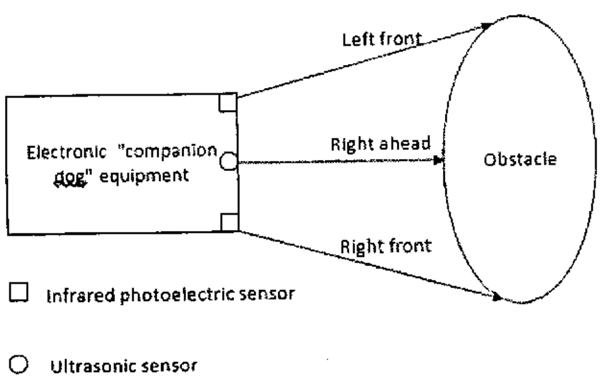

Figure 8. "Companion Dog" Sensor Setting

The gadget travels normally if the three sensors are unable to detect any obstacles. There are three ways in which the ultrasonic sensor detects obstacles:

1) There is no obstacle information on the left and information on the right, then:

$$d=\min(d_R, d_C) \quad (4.7)$$

At this time, the device runs near the obstacle and turns left;

2) There is no obstacle information on the right side and information on the left side, then:

$$d=\min(d_L, d_C) \quad (4.8)$$

At this point, the device runs near the obstacle and turns right;

3) There is obstacle information on both sides;

At this point the device backs off a certain distance and turns left

E. Robot Arm Configuration

1) Overview of steering gear

The motor is controlled by the control circuit board, which receives the signal from the signal line. Upon deceleration, the motor transmits to the output steering wheel through a sequence of gear sets. The position feedback potentiometer is attached to the servo's output shaft. The position feedback potentiometer is powered by the rotation of the steering wheel. The control circuit board receives feedback from the potentiometer through a voltage signal. There is a halt in the route and speed to the destination. Control signal to control circuit board to motor rotation to gear set deceleration to steering wheel rotation to position potentiometer to control circuit board feedback.

TBS-2701 digital servo, TBSN-K15 digital servo, and TBS-K20 servo make up the mechanical arm PWM servo version. TBSN-K15 digital anti-burning steering gear is used on the robot arm claw, for example. We utilise TBSN-K15 digital servos on the claws since the servo will stall if the claws need to grab anything. There are also digital servos, such as the TBS-2701 model, and servos, such as the TBS-K20 model. The robotic claw arm is one of them.

V. Innovation And Application Value

A novel electronic "accompanying dog" gadget has been created by combining photovoltaic power generation technology, remote control technology, video transmission technology, and intelligent grasping technology of the robotic arm.

Its innovations are:

1) Lithium-ion batteries can last longer if they are helped by photovoltaic power production, reducing the need for lithium battery replacement. It also saves energy and has environmental benefits.

2) Instead of a standard remote control, this system utilises a mobile phone-based communication control programme. It's easy to regulate the device's operation, save money on hardware, and increase anti-interference performance by hitting the control key when the APP is operating at all times.

3) Real-time video monitoring is possible, as is photo documentation of the immediate surroundings, thanks to the device's camera and WIFI data transfer module. It's possible to keep an eye on the well-being of the elderly by analysing the surrounding environment using the video footage that's been archived.

4) 6-degree-of-freedom Robotic arm intelligent grasping: The robotic arm may significantly enhance the quality of life of the elderly and the happiness index of the elderly by adapting the gripper size to the size of the item.

VI. Summary

"Humanistic care and concern for the weak have become the dominant theme in society. As the percentage of the population over the age of 65 rises, it is more important than ever to pay attention to the physical and mental well-being of the elderly. Elderly individuals in nursing facilities are less happy since they don't have the company of their children. In the past, accompanying dogs had to undergo extensive training that was costly and time-consuming, and they had to feed and drink Lazars on a regular basis, consuming not only food but also excrement. While "energy saving and emission reduction" is a popular tagline, it does not include the requirement for cleaning.

A few benefits may be gained as a result of the nursing home's electronic "care dog" technology

1) First, a solar panel can automatically charge the lithium battery, extending the battery's life and reducing costs and environmental damage; second, it can convert solar energy into electrical energy to power equipment, greatly reducing up energy consumption; and third, it can convert solar energy into electrical energy to power equipment.

2) This feature makes it easier for the elderly with limited mobility to regulate the electronic companion dog's actions.

3) Video transmission may also be used to monitor the health and safety of the elderly in real time.

4) The remote control module and the robotic arm's intelligent grasping module may work together to make everyday tasks easier and more precise.

Finally, the electronic "escort dog" is concerned about the physical and mental health of disadvantaged groups in terms of humanities and improves the happiness index of the daily life of the elderly; it can not only provide more convenience to the elderly's daily life, but also help their families monitor the elderly's safety. It's a win-win situation since it conserves food and reduces pollution. Because of the lower production costs, it can be used more widely in the economy. The nursing home's electronic "care dog" technology may increase the elderly's happiness quotient as well as their everyday lives, and can be extensively employed in their daily lives.

References

[1] Kårefjärd, A., & Nordgren, L. (2019). Effects of dog-assisted intervention on quality of life in nursing home residents with dementia. Scandinavian journal of occupational therapy, 26(6), 433-440.

[2] Fujisawa, H., Kumasaka, T., & Arakida, M. (2019). Influence of Animal Assisted Therapy Using Dog for Patients with Stroke and Examination of Nursing Care. International Medical Journal, 26(2).

[3] Enlund, K. B., Brunius, C., Hanson, J., Hagman, R., Höglund, O. V., Gustås, P., & Pettersson, A. (2020). Dog owners' perspectives on canine dental health—a questionnaire study in Sweden. Frontiers in Veterinary Science, 7, 298.

[4] Care, D. (2018). The Family Dog: Influence of Parents on Children's Concepts of Responsible. Children, Dogs and Education: Caring for, Learning Alongside, and Gaining Support from Canine Companions, 71.

[5] Powell, L., Edwards, K. M., McGreevy, P., Bauman, A., Podberscek, A., Neilly, B., ... & Stamatakis, E. (2019). Companion dog acquisition and mental well-being: A community-based three-arm controlled study. BMC Public Health, 19(1), 1-10.

[6] Karlberg, S., & Eriksson, H. (2020). Animal Assisted Interventions-Professionals Embrace the Power of the Dog. Klickerförlaget Göteborg AB.

A ZigBee protocol-based Security and alarm monitoring system at nursing homes

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Abstract—A ZigBee-based security monitoring and alarm system was presented in this study to reduce nursing home staff responsibilities. This method can keep tabs on five different aspects of an old person's health, including their urine in bed, their ambulation, their falling, their posture, and any bathroom accidents. First, the system's overall structure was explained, and then each function module was examined in further depth. For testing purposes, Beijing's Sijiqing elderly home put a monitoring system to the test and found it to be effective.

1) INTRODUCTION

As the world's most populous developing nation, China's ageing population is putting enormous strain on the country's infrastructure and institutions [1]. The "Thirteenth Five-Year Plan" for elderly care identifies a critical gap in the current state of the intelligent aged care business. Many colleges and research institutions are urged to use the newest technology to items for the elderly in the nation that actually assist them. Nursing homes are becoming more and more frequent in the home care service for the elderly. Nursing homes maximise the efficiency of existing institutions for the elderly by bringing together those in need of care. The paucity of nursing personnel and heavy workloads are ongoing issues, resulting in omissions in the everyday care of the elderly. Nurses' workloads and accident sizes will be reduced significantly if new technology is employed to monitor senior mishaps that are expected to occur in their everyday activities.

Numerous studies have been carried out by local and overseas research organisations and businesses on nursing home security monitoring devices. Anti-falling airbags for the elderly have been developed by the Chinese University of Hong Kong and Prog Corporation of Japan [2].

The safety monitoring technologies used in nursing homes across the world have obtained comparable outcomes, but the high cost and poor practicality have hampered their marketing.

It is difficult to address the needs of elderly people since most of the appropriate items have just one function.

Safety monitoring systems for the elderly have been suggested in this study, and a systematic safety monitoring programme for nursing homes has been developed to minimise costs and enhance the quality of care.

2) SYSTEM OVERALL SOLUTION

A. Related Technology Introduction

Using ZigBee technology, you can send and receive data wirelessly across short distances at a cheap cost and with little complexity [9]. Network topologies in the ZigBee network include star, tree and mesh. There are three kinds of nodes in the ZigBee network: coordinator, router and terminal. A wireless full-coverage local area network may be set up in nursing homes to gather monitoring data.

A Linux-based operating system, Android is mostly utilised in mobile devices. Android is the most popular mobile operating system in the world, and it provides efficient technological support for human existence.

B. System Structure

The wireless network security monitoring system is separated into three primary components: the hazardous condition detection alarm terminal, the wireless network communication system, and the security monitoring information management system, as shown in Fig 1. Fig 1.

A toilet timeout detection alarm terminal, an ambulation and urination detection alarm terminal, a falling-detector alarm and regional placement terminal, and a hand-held alarm reminder terminal comprise the risky state detection alarm terminal. In the event of an accident, the hazardous state detection terminal sends out an alarm to alert the elderly to the dangers they face. ZigBee technology is used in wireless network information systems that comprise coordinators, routers, and terminals. The nursing home's hazardous status detection alarm terminals may be connected to the network. Because it transmits both alarm data to the monitoring centre and the instructions from the centre to several terminals at the same time, it serves as a safety net for data exchange. The PC programme that runs the monitoring centre is the hub for collecting, storing, and distributing information. In order to remind nursing staff to process the data submitted through wireless network transmission, it parses the data, saves it in the database, and then shows it on the monitoring interface for the staff. The Android-based remote monitoring programme is a mobile phone application. In order to keep an eye on the elderly's daily routine, it may access the monitoring center's data and show it on a mobile phone client.

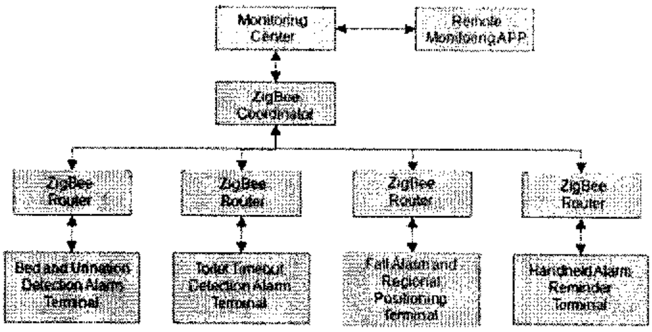

Figure 1. System architecture

III. ALARM TERMINAL DESIGN FOR DANGEROUS STATE

The activities of daily living for the elderly in the bathroom often comprise a variety of different types of toileting, bathing, and laundry. Toileting and bathing are the two most dangerous activities for children. Detecting whether or not an elderly person has entered the restroom and distinguishing between toilet behaviour and other behaviours after they enter the restroom are all parts of the toilet timeout alarm's function. It also records how long the elderly person stays in the restroom and compares the corresponding time threshold based on the type of activity to determine whether or not an alarm should sound. Elderly people may also submit an alert if they feel sick while using the bathroom. To warn the nursing staff in case of an emergency, all the detection data, dwell duration, and alarm information may be broadcast over a network.

The toilet timeout detection alarm terminal's primary control chip is the CC2530. According to the amount and complexity of terminal data, this chip is able to match the functional needs. CC2530 is also a wireless network communication chip. Without the need for extra processing chips, the terminal can do data processing and communication integration. A diffuse infrared photoelectric switch is selected by an infrared sensor (E18-D80NK). Its range of detection may be changed to suit the user's requirements.

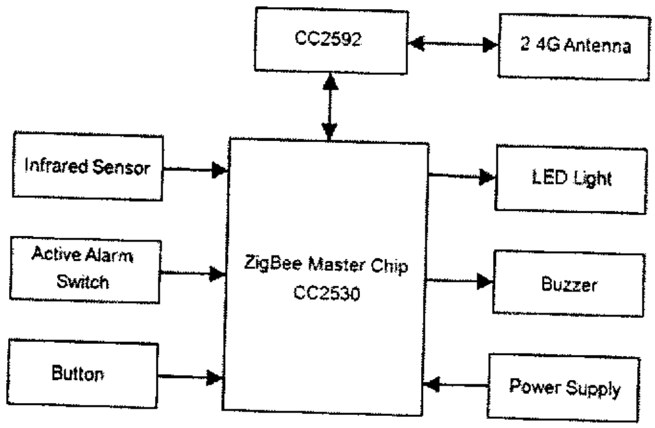

Figure 2. Hardware block diagram

After determining if the two infrared sensors inside and outside the bathroom door are activated, the sensors are triggered in order to determine that an old person has entered the restroom, and if the sensors are not triggered, then the terminal does not do any therapy. The timer begins to count down as soon as the elderly person enters the bathroom. The buzzer will ring and the terminal will send an alert message over the ZigBee wireless network to notify the nursing staff of the elderly's predicament if they remain in the lavatory and click the alarm button. Depending on the behaviour, a different time threshold is assigned. The length of time spent in the bathroom by senior citizens is then compared to a predetermined cutoff point. The nursing team is alerted if the time limit is exceeded. The timer stops recording and transmitting to the monitoring centre the time spent in the restroom by the elderly when they depart without exceeding the time threshold.

A. Ambulation and Urination Detection Alarm Terminal

It is primarily designed to prevent the elderly from leaving their beds at night, as well as the elderly who are half-disabled from falling from their beds while no one is looking. The urine detection alarm is primarily designed to alert nursing personnel to the urination of elderly patients who are either partially or completely handicapped. There are five different ways to use it. First, it is able to determine the health state of the elderly when they get out of bed and while they are still in bed.

Second, the alarm alerts the nursing staff if an old person leaves their bed in an unusual state.

Third, it has the ability to weigh and record the weight of old individuals. Fourth, it may be discovered in time and the senior urinates in bed might be frightened. When an older person has a problem, it sends out a preemptive alert. The wireless network may be used to send detection, weight, and alarm information to the host computer and alert the nursing staff.

The primary control chip, pressure and humidity sensors, an active alarm, network connectivity, and other components make up the majority of the terminal hardware. In Fig 3, you can see the entire hardware diagram.

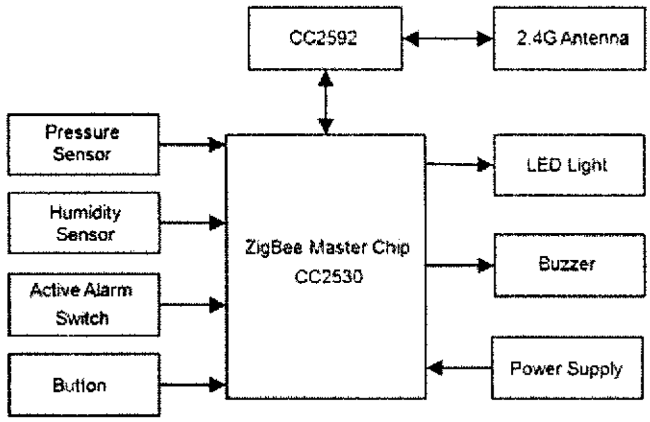

Figure 3. Hardware block diagram

In order to detect ambulation, four resistance strain pressure sensors are used. The HX711 chip circuit converts the acquisition result to A/D and reads the weight information from the CC2530 chip.

The resistance of the humidity sensor pad varies dramatically when it comes into contact with a moist item or water. For example, the circuit is intended to transform its resistance change value into a voltage change value and then the voltage comparison chip LM393 compares the detecting voltage with the specified threshold to determine whether the sensor is wet or not, thereby identifying whether the elderly is wet or dry.

The resistance of the humidity sensor pad varies dramatically when it comes into contact with a moist item or water. For example, the circuit is designed to convert its resistance change value into a voltage change value and then the voltage comparison chip LM393 compares the detection voltage with the set threshold to determine whether the sensor is wet or not, thus determining whether the elderly is peeing or not.

As the patient moves away from the bed, the off-bed detection procedure begins, followed by data collection and comparison with the patient's previous weight to determine if there has been an increase or reduction. To determine if an elderly person has been successfully transitioned to an on-bed state, the data is compared to the threshold value and communicated to the host computer as an increase in the elderly person's weight. As a result of exceeding the threshold, the elderly are considered to be in an off-bed state rather than an on-bed one. The timing and circumstances of a patient's departure from the bed dictate whether or not the nursing staff should be notified.

The initial step in urinary detection is urination detection. Sensor humidity exceeds the predefined threshold, and an alert is sounded to notify the nursing staff of this fact. Otherwise, the terminal will not function.

To make it easier for the elderly to use, an active alarm is placed next to the bed. Elderly people may touch the active alert button if they are feeling unwell or have other concerns.

B. Falling Alarm and Regional Positioning Terminal

The likelihood of a fall in the senior population is quite high. After a fall, if help does not arrive quickly, it might have catastrophic ramifications. Consequently, the terminal contains a fall detection function (which can effectively assess whether the old falls or not) and an interior and outdoor area positioning function to gather the senior's location data. There should be an easy-to-wear device that older people may use to request aid from nursing staffs.

Using a wireless network, medical personnel may be alerted of a patient's position, their fall, and other relevant data.

STM32, CC2530, MPU6050, GPS, and a power supply are just a few of the components that make up the terminal's hardware. For interior location and wireless communication, we utilise the CC2530 chip; for outside positioning, we use the GPS module; and for detecting falls, we use the MPU6050 module. The STM32 chip is the primary control chip.

The experimental measurements show that when the human body falls, the acceleration of each axis varies, as does the attitude angle. There is no connection between the yaw angle and the direction in which the body is falling. The pitch angle changes dramatically as a person falls forward and backward, and the extreme condition changes by 90 degrees. The roll angle changes dramatically when a person falls to the left or right, and the extreme condition changes by 90 degrees.

As a result, the first criteria for the fall is the total static acceleration (TSA), and the second criterion for the fall is the bigger of the pitch angle and the roll angle. Fig 6 depicts the detection flow diagram.

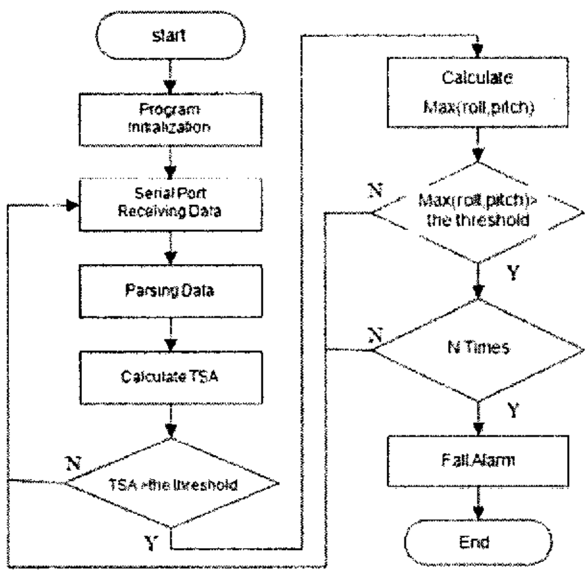

Figure 4. Fall detection process

RSSI-based wireless positioning is used inside in this work. Traditional placement can only be used in an open setting inside. To get a more precise placement impact in the senior apartment's complicated internal environment, more tuning is required. It is sufficient to know the exact location of the elderly in order to meet their genuine demands. Nurses will know whether an older person is in danger when they arrive in this area. To accomplish regional positioning, regional divisions have been created.

As an example, consider a floor of the Sijiqing Nursing Home. There are a variety of amenities on this level, including lobbies, offices, conference rooms, restaurants, and restrooms. Determine the effective area of the elderly's interior activities by first establishing a coordinate system for the real-world indoor environment.

Because each corridor is many tens of metres long, a rectangular space with a width of 2.65 metres and a length of 1 metre is employed as a minimal positioning area despite the narrow width of the corridor. You'll get close to centre if the four-point placement results fall within this range. Because the room, the bathroom, and the duty room all have limited square footage, the four-point placement method is used to choose a single, central location. The two-dimensional plane area of a big interior facility, such as a hall or a restaurant, is split into a number of regions based on their size and form.

The GPS module's longitude and latitude are used to calculate the outdoor's location. Longitude and latitude are analysed by the algorithm before being mapped to the outside of the senior apartment's outside space. In spite of the GPS module's inaccuracy, it just needs to fulfil the regional positioning criteria for the line of sight range, and because outside environments are comparatively sparse, the outdoor positioning area is split into an even broader one.

C. Handheld Alarm Reminder Terminal

All three of the devices described in the preceding section are aimed at identifying older people who are in a risky condition. Accidental alarm information has to be sent to the alarm reminder terminal in order for the nursing team to locate and rescue elderly people as quickly and effectively. Receiving various types of alarm information, showing alarm information on the screen, vibrating to notify nursing staff that an accidental alarm has occurred, letting the monitoring centre know the alarm processing status, and cancelling the alarm once the accident processing is complete are some of the specific functions of this terminal.

The nursing staff acknowledges receipt of the alarm information by pushing a button on the handheld alarm terminal, and the terminal transmits confirmation information to the host computer programme via the wireless network once it has received the information. The nursing team will respond to the event once they have received the necessary information. Pressing the button again will turn off the alarm after it has completed processing.

IV. WIRELESS NETWORK

A. Wireless Network Hardware Design

There are coordinators, routers, and terminals in the wireless network, which employs ZigBee technology. Network components such as the alarm terminal, finding route, common routing path, and coordinator/monitoring centre are all linked through the terminal node.

In a ZigBee network, the coordinator is the only device that performs both of these roles. In the first place, the complete wireless network must be established and maintained. Secondly, the higher layer software receives and parses information supplied by the route or terminal and distributes it to the route or terminal. This is accomplished by collecting and distributing the information provided by the route or terminal. Figure 5 depicts the coordinator's organisation.

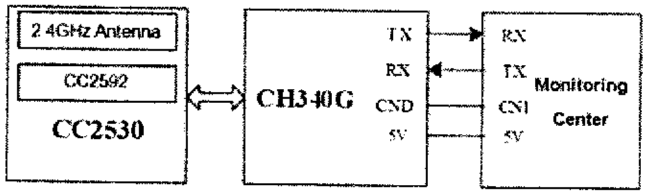

Figure 5. Coordinator hardware structure

Coordination centre master chip utilises CC2530 chip, while communication interface with monitoring centre uses CH340 chip, which can convert CC2530's TTL serial port into monitoring center's USB port.

The ZigBee network's middle layer is routing. Additionally, it aids in the addition of new devices to the network by relaying information from other nodes. Each route is furnished with indications to remind the staff while debugging and working, while preserving the serial debugging interface for it. Figure 6 depicts the typical routing device's structural diagram.

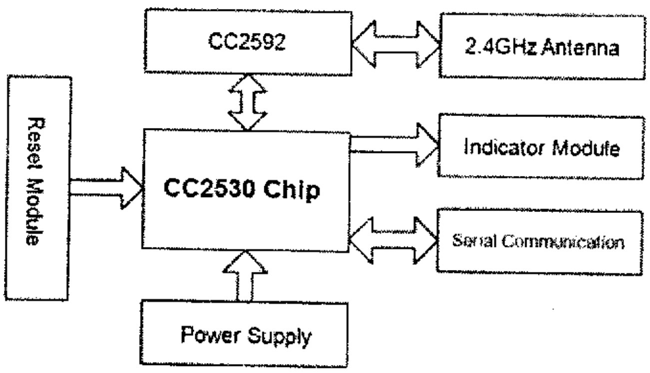

Figure 6. Ordinary routing device hardware structure

B. Principles of Wireless Network Implementation

The full ZigBee wireless network setup may be summed up as follows:

[1]. Nodes may join the network once it has been established by the coordinator.
[2]. To increase the network's reach, the router is added to the mix.
[3]. As a result, it is connected to the network.

When the wireless network is successfully built, the router and the terminal are able to join the network. As soon as an alert is produced, the alarm terminal transmits an alarm message to a coordinator, indicating the sensor's current condition.

V. SECURITY MONITORING INFORMATION MANAGEMENT SYSTEM

a) Database

MySQL is a relational database management system that is geared for small-scale databases. Aside from the fact that it is open source, it has a better storage speed and query speed than other database systems. Hence, the wireless security monitoring system's data base is built around it.

Elderly information, alarm information, equipment information, nursing information, weight information, location information, and location comparison library are all part of the security monitoring system's "entity" section.

b) Monitoring Centre Host Computer Software

The host computer software for the monitoring centre is written in C# using the Microsoft Visual Studio 2015 platform. Basic information management, alarm information inquiry, and alarm display are the three sub-modules inside this module.

There is a basic information management module that focuses on the overall condition of the elderly apartment, basic information about the elderly, different alarm terminal devices, and the information of the nursing staff.

The database will hold all of the alert data produced by the safety monitoring system. Nursing personnel and family members may more clearly see the elderly's inadvertent alert scenario with the use of this module.

Because of its central role in the monitoring centre's overall computer software architecture, the alarm display module is also the most often utilised feature. The module keeps track in real time of the area covered by the senior apartment's security monitoring system. The senior residential setting is shown in the interface map.

c) Android Mobile Applications

The creation of a mobile application software will break through the limits of the local area network and view the everyday lives of the elderly in the nursing homes anytime, anywhere.

According to the functional requirements, the mobile phone application is separated into five major interfaces, login interface, main interface, map locating interface, physiological parameter interface, alert recording interface.

VI. SYSTEM EXPERIMENT VERIFICATION

The application demonstration was place in the Beijing Sijiqing Nursing Home after different types of detection alarm terminals and wireless network equipment were developed. When the test is done, the tester mimics the previous situations to see whether they work. To activate the alarm, the tester hits the alarm button on the terminal. The toilet timeout alarm has been set to go off after 20 seconds. It sounds an alert when the tester stays in the bathroom for more than 20 seconds. Water is dripped on the sensor pad to replicate the urinating detecting function. By leaving the bed as usual, the tester is able to do the test. Testers are used to mimic falls in order to test the fall detection system. The approach used for regional placement involves having the tester roam around with the terminal to several indoor and outdoor locations and count just once in each location. Table 1 shows the statistical success rates for each test after it was run 100 times.

TABLE I. MONITORING SYSTEM ALARM FUNCTION TEST RESULT

Test type	Test method	Test times	Alarm times	Success rate
Actively alarm	Pressing button	100	100	100%
Toilet alarm	Toilet timeout	100	99	99%
Urination alarm	Dripping water	100	93	93%
Ambulation detection	Leaving bed	100	98	98%
Fall alarm	Falling	100	94	94%
Position alarm	Move out of rage	100	100	100%

Nursing homes may use this technology to monitor senior residents' safety since it has an accuracy rate of over 90% for numerous hazardous state detection alerts.

VII. CONCLUSION

Building an application platform for an elderly security monitoring system that monitors ambulation, urination and falls is the goal of this research in order to suit the specific demands of nursing facilities. All monitoring data may be sent wirelessly to the monitoring centre, where it will be received by the nursing staff and dealt with as soon as possible. The monitoring centre data may be accessed using the mobile client. Security monitoring has finished its demonstration in nursing homes and delivered an aged safety monitoring programme with several facets and a systemic approach, reducing labour costs and raising the degree of intelligence in nursing homes.

REFERENCES

[1] Li, Y., Xu, Y., Lv, Y., & Wang, J. (2019, August). A Web Based Security Monitoring and Information Management System for Nursing Homes. In International Conference on Intelligent Robotics and Applications (pp. 72-81). Springer, Cham.

[2] Flores-Martin, D., Rojo, J., Moguel, E., Berrocal, J., & Murillo, J. M. (2021). Smart nursing homes: Self-management architecture based on iot and machine learning for rural areas. Wireless Communications and Mobile Computing, 2021.

[3] Yang, C., Wang, W., Li, F., & Yang, D. (2022). A Sustainable, Interactive Elderly Healthcare System for Nursing Homes: An Interdisciplinary Design. Sustainability, 14(7), 4204.

[4] Antonopoulos, C., Napieralski, A., Łeczycki, P., & Alvarez, J. (2019). A Health Care System Using ZigBee Based WSN. Journal of Network and Information Security, 7(1), 15-19.

[5] Martins, H., Gupta, N., & Reis, M. J. C. S. (2020, December). A Non-intrusive IoT-Based Real-Time Alert System for Elderly People Monitoring. In International Summit Smart City 360° (pp. 339-357). Springer, Cham.

[6] Mujčić, E., & Drakulić, U. Using ZigBee Based Wireless Sensor Networks for Wireless Monitoring of Base Life Functions.

[7] Fard, H. S., Town, S. N., Yengikand, A. B., Niknami, E., & Allahyari, J. Smart Home Automation Systems and Technologies Based On the Internet of Things.

[8] Sapci, A. H., & Sapci, H. A. (2019). Innovative assisted living tools, remote monitoring technologies, artificial intelligence-driven solutions, and robotic systems for aging societies: systematic review. JMIR aging, 2(2), e15429.

[9] Hung, L. P., Hsieh, N. C., Lin, L. J., & Wu, Z. J. (2021). Using Internet of things technology to construct an integrated intelligent sensing environment for long-term care service. International Journal of Distributed Sensor Networks, 17(12), 15501477211059392.
[10] Ramya, P. S., & Nandan, D. (2020). Analysis of security issues and possible solutions in the internet of things for home automation system. In Soft Computing: Theories and Applications (pp. 825-836). Springer, Singapore.

A Random Search Algorithm on Multi constraint Nursing practice with scheduling

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Abstract:

The role of nursing practice scheduling is to improve the quality of nursing teaching in hospitals, and to provide a certain degree of job security for nursing practice. In a certain sense, the problem of the nursing scheduling is a combinatorial optimization problem under multiple constraints, and the current nursing practice scheduling problem has many constraints. At the same time, with the increase of intern departments in recent years, the internal scheduling of hospitals is becoming more and more complex. On this basis, this paper proposes a mathematical model of multi constraint nursing practice scheduling. The main purpose of this model is to meet the needs of most members of the nursing practice scheduling, using intelligent algorithm to solve the problem of multiple constraints in practice scheduling, to achieve the purpose of scheduling some nursing interns. This algorithm is conducive to the optimal scheduling of nursing scheduling.

Keywords: Intelligent algorithm; nursing; internship; scheduling; multiple constraint problems.

1. Introduction

Nursing practice plays a very important role in nursing students. It represents a process of transition from theoretical knowledge to practice for nursing students, and is an important stage that many nursing students must go through. It represents the close relationship between the relevant theoretical knowledge acquired by nursing interns and the real nursing diagnosis. In China's large and medium-sized hospitals, hospitals have arranged targeted work for nursing interns, which is also part of the hospital. The hospital is a place where a variety of projects, such as prevention, medical care and health care, are integrated, and interns from many colleges and universities and professions are received every year. Because of the large number of interns, at the same time, there are obvious differences in the requirements for each intern, there are also some differences in the requirements of internship time. However, the resources of each department in the hospital are limited, and the traditional manual nursing practice scheduling method makes the task very severe. Especially in view of the current research on multi-constraints of nursing practice scheduling, some scholars proposed an intelligent algorithm to solve the multi-constraints of nursing practice scheduling problem.

2. Nurse Scheduling Problem

At present, the nursing work plays a very important role in the whole hospital. It is easy to see the nurses in any department. At the same time, nurses take on special tasks in medical practice, which is the basis of the whole hospital operation. In China, the shortage of nurses is very serious. This phenomenon has attracted wide attention

ISSN:0975-3583,0976-2833 VOL12, ISSUE04,2021

from all walks of life. Because nurses are in a special environment for a long time, they may come into contact with a variety of patients anytime, anywhere. Nursing itself has to bear multiple pressures and burdens because of the long-m stress of mental work or the impact of scheduling. Based on this, scientific management of medical staff, effective control of hospital care costs is a hot topic. Under the influence of the current nursing workload and irregular shift system, the interests of hospitals and nurses are affected to some extent. In order to ensure the quality of nursing is not affected, and to reduce the cost of hospital care, the establishment of a reasonable nursing practice scheduling model is of great significance. The research on nurse scheduling problem abroad is earlier than that in China. In a certain sense, mainly some simple manual scheduling, so the lack of a certain optimization mechanism. Shen Yindong, on the basis of literature review on nurse scheduling abroad, used the matrix vector method to evolve the constrained nurse scheduling problem. But the model has strong Western characteristics in the process of building, and there are great differences between the domestic situations.

3. Nursing Practice Scheduling Model

The problem of nursing practice scheduling based on intelligent algorithm refers to arranging the students of different schools in a specific period of time corresponding to the students' majors, and making each schedule can meet the specific constraints of each practice. The main constraints are as follows: first, students take part in practical activities every week. Second, students must go to the Department during the internship period. Third, the avoidance of departments should not occur during the internship. Fourthly, the practice nurses must be in the process of making the practice section. Fifthly, for similar departments, the practice nurses can only go to one. Six, the staff arrangement of the practice section should be stable. Seventh, it is necessary for some departments to make arrangements for them as far as possible. The above constraints are all constraints that may arise in the process of data processing.

- **The model of scheduling**

In this paper, we can describe the scheduling model of a single intern, and calculate it from a certain point of time, that is, the first day of internship as the internship time. On this basis, according to certain rules randomly selected departments, among them, each practice between departments have an obvious feature, that is, practice can be divided into one week department, two weeks department, three weeks department. That is to say, the internship time can be divided into 1 week, 2 weeks and 3 weeks, as shown in Table 1. Based on this, in order to ensure that each department in a specific period of time will be arranged for internship nurses. In addition, the same type of internship departments need to be avoided, that is, the same intern nurses are not allowed to enter the same type of departments. For example, the operating room and the interventional operating room in the hospital belong to the same kind of departments, and the psychiatric department 1 and the psychiatric department 2 belong to the same department, namely the psychiatric department. We can express the collection of departments by D, the concentration of interns by S, and the burden of departments by B.

Table 1. The nurse scheduling

	Day 1			Day 2			...	Day 7			Number of shifts
Shifts	M	E	N	M	E	N	...	M	E	N	
Nurse 1							...				6
Nurse 2							...				7
Nurse 3							...				7
Nurse 4							...				7
....	...	...	...	...	...	...	...	...	...	...	...
Nurse J							...				6
Number of nurses assigned	15	18	13	13	18	13	...	13	14	13	314

- **Algorithm Design**

ISSN:0975-3583,0976-2833 VOL12, ISSUE04,2021

Research on nurse scheduling problem based on random search algorithm. Random search algorithm refers to the need to randomly search a suitable department from the Department set D into the corresponding intern time series, until the scheduling time saturation. The following is the description and study of multiple constraints in nursing practice scheduling based on stochastic search intelligent algorithm: Firstly, one student S1 (strati, endi, ti) is selected randomly from the set S of interns, and the initial Ti = starti is divided into three subsets: D1, D2 and D3. Secondly, we randomly select a department from the set of interns S and conduct a validation test. If the conditions meet, they will be filled in the internship sequence, which contains the following control conditions: When the value of ti% 6 is zero, it is necessary to select randomly from the set {2, 3} in the set D1 of the required departments. If each department cannot meet the constraints, then it is necessary to randomly select from the Department subset D3. How can it still not meet the requirements of the constraints, we need to take $k_i = 1$ as the condition for random extraction, how can it still not meet the constraints, and then analogy, continue to randomly extract in D3. If it still does not meet the constraints, then continue to "+1" on the time point. When ti%3=0 is used, it should be selected randomly in D1 and ki=3 as the limiting condition. If the condition is not satisfied, the random selection is continued in D3; if it is still not satisfied, the analogy is continued.

4. Results

In a sense, random algorithm is an intelligent algorithm based on conditions and extended rules. This algorithm has certain characteristics, that is, random search algorithm can be regarded as a solution tree in fact, and finally can get a solution to the scheduling problem. A total of 300 nursing interns were counted by manual mode scheduling, as shown in Figure 1.

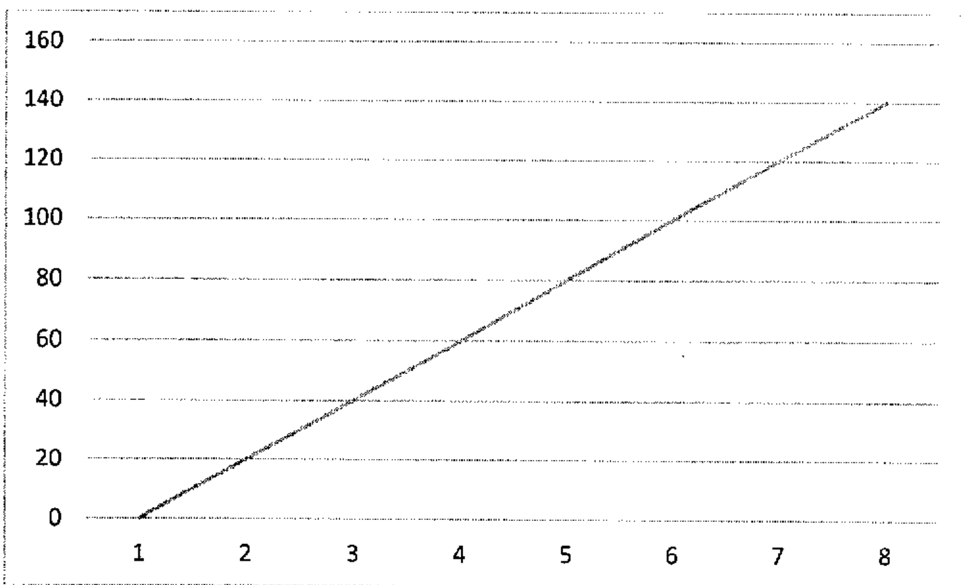

Figure 1. The scheduling time on random algorithm

According to Fig. 1, we can see that the traditional scheduling method consumes too much time when dealing with the scheduling problem. It only takes a few minutes to realize the scheduling problem for hundreds of interns, whic greatly improves the scheduling efficiency. For the balance of scheduling, there is still no complete set of criteria to measure it. After the practice of this method, the interns in the Department have basically achieved the balance, and the effect of the practice has also been improved. It reflects from the side that the algorithm based on random search can solve the constrained problem of the practice scheduling.

5. CONCLUSION

Nursing interns scheduling problem has been plagued by the hospital nursing interns scheduling problem, on a single intern scheduling problem is relatively simple, but on the whole hospital interns scheduling problem, it is a very serious problem. The traditional scheduling problem is to use the principle of filling in the schedule of different lengths, so as to achieve the principle of the shortest idle time. In a certain sense, the researcher optimizes the scheduling work from the management point of view, and improves the scheduling model. To a certain extent, it solves the contradiction between the imbalance of human resources and patients' expectations.

ISSN:0975-3583,0976-2833 VOL12, ISSUE04,2021

REFERENCE

[1] Nasir, J. A., & Kuo, Y. H. (2020). A decision support framework for home health care transportation with simultaneous multi-vehicle routing and staff scheduling synchronization. Decision Support Systems, 138, 113361.

[2] He, C., & Shi, Y. (2019, October). Workforce Scheduling and Routing for Home Health Care Services. In Proceedings of the 3rd International Conference on Computer Science and Application Engineering (pp. 1-5).

[3] Turhan, A. M., & Bilgen, B. (2022). A mat-heuristic based solution approach for an extended nurse rostering problem with skills and units. Socio-Economic Planning Sciences, 101300.

[4] Decerle, J., Grunder, O., El Hassani, A. H., & Barakat, O. (2019). A memetic algorithm for multi-objective optimization of the home health care problem. Swarm and evolutionary computation, 44, 712-727.

[5] Du, G., Zheng, L., & Ouyang, X. (2019). Real-time scheduling optimization considering the unexpected events in home health care. Journal of Combinatorial Optimization, 37(1), 196-220.

[6] Liu, W., Dridi, M., Fei, H., & El Hassani, A. H. (2021). Solving a multi-period home health care routing and scheduling problem using an efficient matheuristic. Computers & Industrial Engineering, 162, 107721.

[7] Chen, P. S., & Zeng, Z. Y. (2020). Developing two heuristic algorithms with metaheuristic algorithms to improve solutions of optimization problems with soft and hard constraints: an application to nurse rostering problems. Applied Soft Computing, 93, 106336.

[8] Yagmur, E. C., & Sarucan, A. (2019). Nurse scheduling with opposition-based parallel harmony search algorithm. Journal of Intelligent Systems, 28(4), 633-647.

[9] Belkhamsa, M., Jarboui, B., & Masmoudi, M. (2018). Two metaheuristics for solving no-wait operating room surgery scheduling problem under various resource constraints. Computers & Industrial Engineering, 126, 494-506.

[10] Abadi, M. Q. H., Rahmati, S., Sharifi, A., & Ahmadi, M. (2021). HSSAGA: designation and scheduling of nurses for taking care of COVID-19 patients using novel method of hybrid salp swarm algorithm and genetic algorithm. Applied Soft Computing, 108, 107449.

[11] Lim, H. T., Yong, I. S., & Ng, P. (2019, September). Imperative Selection Intensity of Parent Selection Operator in Evolutionary Algorithm Hybridization for Nurse Scheduling Problem. In International Conference of Reliable Information and Communication Technology (pp. 235-244). Springer, Cham.

A comparison between proactive and Unremitting robot assistance using collaborative tasks in Nursing care

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Abstract* - The lack of care for an elderly population is a challenge for our society. Robotics and other cutting-edge technology may help in this situation. Adapting these technologies for use in health care is critical if they are to be widely adopted and utilised in daily life. To help caregivers during the transfer of a patient simulator to the lateral position, a robot manipulator was positioned near a nursing bed and two modalities of contact with the robot were compared and evaluated in this case study. Proactive and continual assistance behaviours are distinguished. As opposed to the continuous technique, the proactive method only begins when it is visually determined that a patient should be pushed into the lateral position utilising a Wizard of Oz experiment setting. Overall, the research found that a robot's constant assistance behaviour was chosen by the participants.

***Index Terms*—robots, human-robot interaction, manipulators, public healthcare**

I. INTRODUCTION

Caregiving will become more difficult as the world's population becomes older and more dependent on others [1]. Since there is a scarcity of nursing personnel, it is essential to develop solutions to alleviate the situation as much as possible. Nursing care is promoting new technologies since they have the capacity to address the issue at hand.

There are, however, a number of issues that need to be addressed with the adoption of modern technology in patient care.

It is necessary for technological engineers to work closely with caretakers in order to accurately represent their demands and the needs of their patients [2]. When it comes to nursing, a lack of technological expertise means that the desire to make things easier and more efficient is even greater.

It is the mission of the Nursing Care Innovation Center to evaluate and create novel nursing care technologies, taking into account the demands of caregivers, in order to improve the quality of life

ISSN 2515-8260 Volume 08, Issue 04, 2021

for the elderly. At the Clusterkonferenz 2018, an Innovation Center presentation with more than 400 carers got a very good response, suggesting that robots in the nursing industry may be extremely well accepted [3]. For the sake of reassurance, caretakers were also questioned about their requirements and wishes throughout this presentation.

Figure. 1: pro-active support (left), and ongoing support (right) (right).

A high level of acceptability for a human-robot cooperation system is dependent on a number of factors. Questions such as "how" and "when" are particularly important (see Fig. 1). An integrated development and the good feedback from the caregivers for this system [3] took into consideration the issue of how.

It was suggested that a speech-recognition system be installed as soon as possible in order to begin working with the robot. Nevertheless, it is shown in [4] that a human-initiated support system is not the most effective method to accomplish the activity, even if the caregiver prefers to have control over the robot. Proactive assistance was shown to be more beneficial. If you're looking for a certain result, you'll have to choose your setting. Continual assistance is a possible alternative that has to be investigated in the context of nursing care in the case outlined above.

Because of this, the benefits and drawbacks of a proactive and continuous robot-interaction strategy to cooperate during a particular nursing activity are contrasted and explored in this research. During the patient's shift to the lateral position, the caregiver's job is to keep the patient stable so that tasks that need two hands, such as cleaning the bed or caring for wounds, may be completed. The preferred temporal form of robot help is examined in this study. The issue is whether the robot should be proactive, or should it assist on a constant basis? A Wizard of Oz-themed usability research is done to solve this question. Figure 1 depicts the implementation of the two support options that were discussed.

II. RELATED WORK

A *Human-Robot Collaboration*

HRI (Human-Robot Interaction) situations involving collaboration are becoming more important. Although industrial settings for teamwork in factories now account for the bulk of research, robotic home helpers and space robots are also on the horizon. As the need for assistance in caregiving tasks grows, it is more important than ever to look at HRI apps that are specifically tailored for this situation. In this scenario, direct manipulation of people is a unique feature that has been primarily studied for surgical purposes.

The robot's ability to perceive its surroundings in a safe manner, particularly while operating on its own, is also a major issue. As a result, several safety requirements, such as the ISO/TS 15066 for collaborative robots, were established and published. It is feasible to prevent collisions in the first place if the robot's surroundings is seen visually.

It is possible to safely initiate activity and movement in a research using a Wizard of Oz arrangement. Visual input is provided via a 2D camera video stream.

B *Interaction Fluency*

The importance of time in nursing care necessitates that interaction fluency be improved for a satisfactory user experience. Interaction fluency itself aims to maximize cooperation throughout a shared activity. There are a number of measures that may be used to measure fluency, including the amount of time it takes to complete a given job.

Use of both subjective and objective measurements is the focus of this study. Although the subjective measurements are used to assess how fluent a specific interaction was perceived by the public, objective metrics are used to measure the real idle and active periods of both the robot and human while they were doing a job. When comparing three distinct models for initiating robot activities, subjective metrics such as performance, use characteristics, and subjective preference were employed as a subset of the questions proposed. "Human-initiated," "robot-initiated reactive," and "robot-initiated proactive" were the three strategies examined. There are a few noteworthy changes between, which are cited as inspiration for this paper: Since it was shown to be the least effective, this research does not include methods started by humans. Only proactive and ongoing techniques are investigated for this reason The robot could not fail to fulfil the job as specified, since that is what this research was looking at: help during patient placement. This scenario also involves the robot and caregiver working together on the same job. As a last point, it is crucial to note that such a research has not yet been undertaken in the context of nursing.

III. SYSTEM DESCRIPTION

An environment where a robot and a caregiver may operate side by side in the same time and area was created to test various forms of robotic assistance. Details of this system are outlined in this section.

A *Platform*

Franka Emika Panda is the robot used in this system. This robot has seven degrees of freedom (DOF) of mobility, which allows it to execute a variety of tasks in a wide range of environments. Because of its more than one hundred sensors, the Panda delivers a highly smooth performance while also being very precise and steady. The robot may be stopped with a desired force thanks to the force detection.

ISSN 2515-8260 Volume 08, Issue 04, 2021

It is possible to halt movement at a chosen moment in this system by using sensors that detect the patient's touch with the device. Fig. 1 shows a contact location between the manipulator and the patient simulator, where an additional cushion was provided.

B *Domain and Task Representation*

Due to a shortage of qualified caretakers, new technology is being introduced to make the job easier and more efficient for those who are already working in the industry.

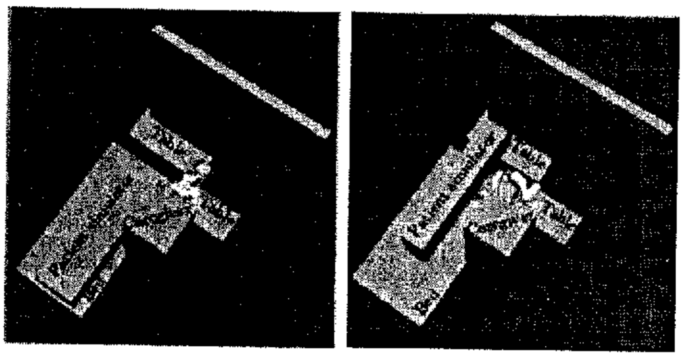
The chore of situating the patient is one of the most promising for both the relaxation of the caregiver and the efficiency of care. Caregivers are needed to move the patient to this position on a regular basis to carry out various tasks, such as inspecting wounds, cleaning the bed, or bandaging the patient. There are times when a second caregiver is needed to aid with chores like the ones cited in this article; however, in most circumstances this person is not accessible. If you don't have access to positioning pillows, another option is to use a sling instead. There are several reasons why, in most situations, carers are unable to complete a job with both hands, since the other is utilized to keep the patient in place, slowing down the process and increasing their workload.

In the case of immobile patients, the use of robots to fulfil the holding role is a potential alternative. Robots need to know when and where they should execute their tasks, and must avoid colliding with both patients and caregivers in order to be widely accepted. The human is in charge of moving the patient, while the robot is in charge of stabilizing him or her.

C *Robot Action Implementation*

There are three pieces to the robot's control system; a camera, a joint position controller using MoveIt, and a Cartesian impedance controller based on Franka Emika Example Controllers.

Fig. 2 shows how collision objects were manually added to the planning scenario without any additional vision detection of the surroundings to prevent collisions with either the surrounding environment or the people near the manipulator. These are able to adjust to the patient's box.



Collision object in start position — Collision object in hold position

Figure. 2: Manually set collision items near the robot manipulator in start (left) and hold (right) positions following patient contact.

It is utilised to plan and execute autonomously to a slightly changed joint state objective at the edge of the bed for continued support. Then, the controller is modified to the \sCartesian impedance controller. The end effector may be moved forward and backward along a predetermined route thanks to this controller. This approach is meant to predict the patient's back position as accurately as possible. While executing, here controlled by hand, this path, the external force on the end effector, computed by the Franka Control Interface, is also monitored. The movement stops and the collision objects are updated in the planning scene if this exceeds the set contact threshold (Fig. 2).

Action selection: In order to avoid the caregiver getting the impression that the robot is taking too long to respond, a scene analysis seems to be a viable solution to this issue. If the robot can identify I the patient's lateral position and (ii) the patient's real position and orientation in relation to the touch surface, it should be able to perform the necessary tasks.

For example, the caretaker may avoid the robot or a consistent gap can be maintained between the robot and the surface. As a result, the robot knows which assistance activities to do. I Based on (ii) the caregiver's activities, a support action's best time may be determined. When using the proactive technique, the work is started as soon as feasible so that the nurse does not have to wait long for robotic assistance. As soon since the nurse enters the room, the assistance begins, as this strategy is flexible enough to adjust to the nursing scenario. When it comes to keeping an accurate distance from its patient, the robot has to be able to constantly modify its trajectory and avoid the nurse at all costs. It is also necessary to recognise the existing condition precisely (ii). The engagement and task execution would be smoother and more pleasant if there was no trigger technique initiated by the caregiver, such as voice recognition.

Proactive technique began by a robot (P): Once the robot recognises that the caregiver has begun turning the patient, the first policy is launched. A contact with a patient causes the robot to stop moving until it is above the patient's bed, at which point it continues to advance towards the patient until it senses a collision and then stops, keeping the patient in place. In this strategy, the robot goes in a straight path until a collision is detected, rather than following the patient's indicated course.

IV. USER STUDY

This research investigates how a nurse and a robot may work together in a meaningful manner when they do a nursing activity (moving from supine to lateral position) at the bedside via the use of a robot's interaction approach. For nursing personnel, robotic support devices will play a significant role over the next several decades. Nursing personnel, on the other hand, must be comfortable with the robots' working ideas before they can collaborate effectively. This study compared two operational concepts in order to find the best one. A patient simulator was used in this study. Furthermore, the research was conducted as a Wizard of Oz study, in which a human was remotely controlling the robot's inability to do certain activities.

The experiments outlined in III-C are being tested.

A *Study Design*

A within-subjects study was conducted to see whether carers were happy with the robot's working mode. The robot's behaviour was the independent variable in this research, and the two conditions were P and C. (Sec. III-C).

Nursing personnel had to do the identical action in all three scenarios: turn the patient simulator to the side and wait for the robot to come and hold it in place so that the carers could release it.

We didn't care which strategy was used first, thus a random sequence was chosen and displayed to the carers.

A Wizard of Oz research was used since the study's primary goal was to determine whether or not the two techniques offered by the authors were relevant and wanted by the nursing staff. Some functions of this scene analysis were remotely controlled and carried out by a person in order to replicate it. In the proactive technique, the human hits a button in the teleoperation centre, which begins the movement of the robot to the starting location, and once it reaches its target, the robot commences the movement until collision with the patient is detected. When employing the continuous technique, a button is pressed to activate the robot's movement to the beginning position, and the person in the teleoperation centre uses a joystick to direct the robot's movement as it interpolates the new needed position based on the speed and force of the joystick.

B *Setup*

A teleoperation centre and a live lab were used for the investigation because of the Wizard of Oz arrangement. The teleoperation centre is used to operate the simulated system components for the Wizard of Oz research.

Activation of the actions and the anticipation of the patient's rotation with the manipulator end effector in continuous case are two examples of these It's from here that we pick our circumstances and measure our times, as well.

Bedroom: In the bedroom, as depicted in Fig. 3, there is a bed on which the patient simulator is placed, a robot arm situated 25 centimetres above the bed, a monitor showing the caregivers which method is being used and when they can begin as well as when the process is complete, a camera showing data to the operator in the teleoperation centre and, finally, two marks in the floor indicating when the process is complete..

The first mark shows where the caregiver should wait for the monitor to indicate that the procedure is ready to begin (screen turning green). The second identifies the place in the process flow from which the operation must be performed. For optimal cooperation, it is situated at a distance of 2.20 metres from the beginning position mark and 60 cm from the robot.

On pressing either "proactive" or "continuous," a clock was started and displayed in the GUI to keep track of how long the study took in the teleoperation centre. A red screen appeared in the caregiver's bedroom to indicate which method was going to be tested, but after fifteen seconds this screen turned green, indicating that the caregiver's method had been evaluated. The proactive and continuous methods were engaged by clicking on the "stabilise" and "continuous route" buttons.

The joystick used to operate the robot in the continuous method was a Novint Falcon 3D Touch Haptic Controller. The aim of utilising the joystick was to decide the new location the robot had to go to. When the speed and force of the controller were applied, an interpolation between the several specified places was created.

ISSN 2515-8260 Volume 08, Issue 04, 2021

Lastly, using the information supplied by the camera in the bedroom, the operator in the teleoperation centre was able to detect the caregiver as well as the robot and initiate each necessary step.

Procedure: For the investigation, the two circumstances specified in III-C were used, each of which lasted no more than 10 minutes.

Immediately after each condition, a 5-minute questionnaire should be completed. The experiment lasted little more than 30 minutes in all.

Patient simulator in a bed was the focus of the caretaker's efforts. Robot manipulator next to bed helped in this duty by maintaining patient in secure posture by supporting by holding them.

To begin, the carers received a brief introduction outlining the purpose of the research (to identify which strategy was best for the caregiver). The steps to be taken were also outlined and shown for the audience's benefit. Detailed instructions were provided to participants, including the fact that this was a Wizard-of-Oz research.

The caretakers positioned themselves at the specified start position and following the start signal, after the screen of the monitor went green, they moved the patient simulator from the supine to the lateral position on the bed. The patient simulator was then stabilised by the robot. After that, they were asked to fill out a survey to rate their experience. The same method was repeated twice. " Changes were made to the robot's support services. Prior to the experiment, the individual was shown a red screen with the method's name on it on the monitor. The execution time was recorded for each run. To wrap things off, the caregivers were invited to fill out a demographics survey and rate the support ideas they were most familiar with.

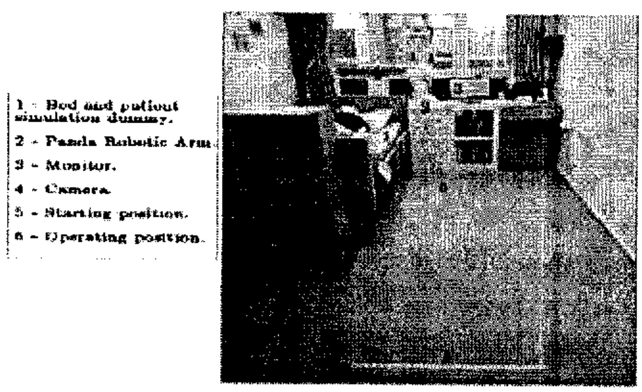


Figure. 3: Setup of the bedroom.

Measurements: As a way to compare both circumstances, objective and subjective measures were collected. Specifically time and questionnaires were used.

1) *Time:* In all scenarios, both the robot and the caretaker's idle periods were recorded, as well as the total time needed to complete the operation. The start signal set the timer in motion. When the condition (contact of the manipulator with the patient) ended, the total execution period was immediately halted. The amount of time spent in idle mode was recorded manually.

2) *Questionnaires:* With this research, a preset questionnaire was developed from [4] for the purpose of collecting the nursing staff's opinion and comments.

No personal information other than age and gender is collected by the questionnaire, which includes the same question in both scenarios. However, all information is kept confidential.

How helpful the robot was in the work, the efficiency and fluency of cooperation, how natural the interaction seemed, whether the task division was equal, and any remarks the participants wished to give were some of the questions that were asked. A further question was posed concerning the impression of robot aid, and the individuals were asked to choose which situation they preferred.

V. RESULTS

Seven caregivers participated in the research, two of whom were men and five of whom were women. They were between the ages of 32 and 60. (mean: 50.3, standard deviation: 9.6).

A two-sided paired T-test was used to compare the two circumstances.

A *Objective metrics*

Multiple time stamps were collected and analysed after the research concluded in order to compare the two approaches.

The impact of the circumstances on the total execution time is first investigated. Total execution time may be shown in Figure 4, based on the given circumstance. There is a significant reduction in total execution time, t(6) = 4:46, and p =:004. Figure 5 (a), t(6) = 11:38, p :001, shows that under the continuous situation, human idle periods are much reduced. Figure 7 depicts the robot's idle moments (b).

B *Subjective metrics*

Participants were asked to respond to seven-point Likert scales using a number between 1 (strongly disagree) and 7 (strongly agree), as detailed in IV-D2 (strongly agree). Participants were given the option of leaving comments in a blank space, and demographic information was also included.

The findings of the questions on the quality of engagement. Using a one-sided pair-TTest, the mean values of the replies were calculated and compared to each other. There was a significant difference in the quality of the interaction between the two methods (t(6) = 2:39, p = 0.027).

A two-sided paired T-Test is used to examine correlations between subjective judgments and objective measures. According to Fig. 5, there is no correlation between subjective assessments and the robot-idle time. The connection between subjective assessments and total execution times is negative, t(6) = 2:88, p =:014.

t(6) = 0:93, p =:394. There is no link between age and the quality of interaction rating.

The caregivers choose which strategy they preferred after a series of questions and answers. Of the seven caregivers, five (71 percent) picked proactive, one was unconcerned about either option, and the last caregiver was agnostic.

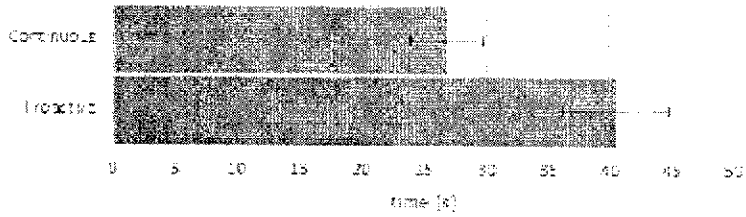


Figure. 4: Finish time for each condition. Error bars denote SD

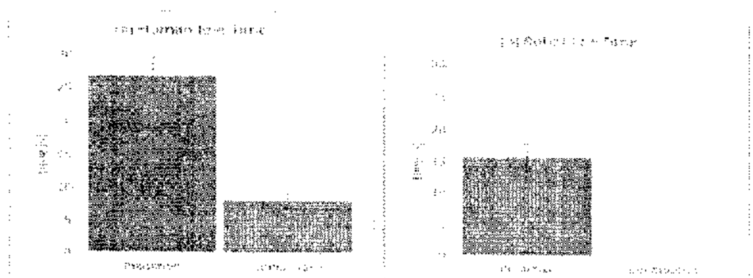


Figure. 5: Idle moments for humans and robots. Error bars denote SD

For each situation, an open-ended question was posed regarding how people felt about robots helping them Table I shows the qualitative assessment of this question, where amount refers to the number of times the item is stated. A "helpful" robot was described as "too sluggish" and "too passive" by those who encountered it. The following is how the proactive action of the supposed robot was described in the German translation:

M, 52: "The robot's motion is excessively slow."

M, at the age of 59, says, "You're not active enough."

If W, 50, had to work alone, "[...] it would be a tremendous benefit."

The continuous support robot was described as "useful" but also as "uncertain to collaborate with." In its German version, the ongoing behaviour of the seen robot was described as follows:

W, 45 "It's a little strange at first."

"Fluently, time-saving." — M, 52

TABLE I: Question: "How did you perceive the help behaviour?"

Category	Quantity	
	Proactive	*Continuous*
Cooperative	0	1
Helpful	2	5
Safe	1	0
Too inactive	2	0
Too slow	6	0
Uncertainty in the cooperation	1	3
Unhelpful	0	1
Other	1	1

VI. DISCUSSION

The data supports the premise that caregivers prefer the continuous strategy over the proactive one. From both objective and subjective measurements, it is possible to draw this conclusion. Chapter V-A demonstrates how much quicker the continuous technique is in completing the work. In addition, the nursing staff will have to wait significantly less time for the robot to arrive. This means that the caregiver will be able to do any other work in a shorter period of time since they will be able to free up their hands sooner. In chapter V-B, the quality of interaction is demonstrated by the subjective assessments. Qualitative findings suggest that a nurse and robot working together continuously increases their level of apprehension about using this new technology. Typical assistance in this activity do not facilitate the process of "mobilizing to the lateral position," which may account for this.

As indicated in V-B, the majority of participants preferred the continuous technique when asked whether the robot should help once or continually. Despite the fact that caretakers liked the continuous strategy over the proactive one, they also noted that it had to be improved since it first seemed a little unnerving to them. When they arrived to the bed for the research, several of them were surprised to find that the robot was already moving.

During support activities in human-robot cooperation, robots are shown to predict the best feasible support position at all times, according to the research, and are therefore rapidly ready to assist. As a result, further study is needed in this area as well.

VII. CONCLUSION

It was the goal of this article to determine whether strategy, proactive or continuous, was preferable for aiding the caregiver in getting the patient to the lateral position. The proactive method relies on the robot to help only after they had brought the patient to the lateral position.

Results suggest that the continuous technique is preferable to other methods, despite the need for future enhancements to decrease uncertainty during cooperation. In the end, this might lead to a more efficient and effective technique for reducing the burden and stress of nursing care. These findings might be tested in other domains, such as manufacturing, in the future.

REFERENCES

[1] Lu, L., Wang, H., Reily, B., & Zhang, H. (2021). Robust real-time group activity recognition of robot teams. IEEE Robotics and Automation Letters, 6(2), 2052-2059.

[2] Ajaykumar, G., Stiber, M., & Huang, C. M. (2021). Designing user-centric programming aids for kinesthetic teaching of collaborative robots. Robotics and Autonomous Systems, 145, 103845.

[3] Lanza, F., Seidita, V., & Chella, A. (2020). Agents and robots for collaborating and supporting physicians in healthcare scenarios. Journal of biomedical informatics, 108, 103483.

[4] Mišeikis, J., Caroni, P., Duchamp, P., Gasser, A., Marko, R., Mišeikienė, N., ... & Früh, H. (2020). Lio-a personal robot assistant for human-robot interaction and care applications. IEEE Robotics and Automation Letters, 5(4), 5339-5346.

[5] Zhang, Y., Tian, G., Zhang, S., & Li, C. (2019). A knowledge-based approach for multiagent collaboration in smart home: From activity recognition to guidance service. IEEE Transactions on Instrumentation and Measurement, 69(2), 317-329.

[6] Gerłowska, J., Skrobas, U., Grabowska-Aleksandrowicz, K., Korchut, A., Szklener, S., Szczęśniak-Stańczyk, D., ... & Rejdak, K. (2018). Assessment of perceived attractiveness, usability, and societal impact of a multimodal robotic assistant for aging patients with memory impairments. Frontiers in neurology, 9, 392.

[7] Lin, C. H., Wang, K. J., Tadesse, A. A., & Woldegiorgis, B. H. (2022). Human-robot collaboration empowered by hidden semi-Markov model for operator behaviour prediction in a smart assembly system. Journal of Manufacturing Systems, 62, 317-333.

[8] Chen, M., & Decary, M. (2020, January). Artificial intelligence in healthcare: An essential guide for health leaders. In Healthcare management forum (Vol. 33, No. 1, pp. 10-18). Sage CA: Los Angeles, CA: SAGE Publications.

[9] Werner, C., Moustris, G. P., Tzafestas, C. S., & Hauer, K. (2018). User-oriented evaluation of a robotic rollator that provides navigation assistance in frail older adults with and without cognitive impairment. Gerontology, 64(3), 278-290.

[10] Helbig, R., Metzing, S., & Latteck, Ä. D. (2022). Shaping Quality of Life with Nursing Assistance. A Grounded Theory Approach to Nursing Care for People with Physical Disabilities and Interactions with Carers in Long-Term Care. Journal of Long-Term Care.

A random forest-based class imbalance analysis in Nurse Care Activity

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***Abstract-** Because nurse care activity identification has a high class imbalance issue and intra-class variability depending on both the subject and the receiver, it is a novel and demanding study topic in human activity recognition (HAR). To address the issue of class imbalance in the Heiseikai data, nurse care activity dataset, we used the Random Forest-based resampling approach. A Gini impurity-based feature selection, model training, and validation using Stratified KFold cross-validation are all part of this technique. Random Forest classification yielded 65.9 percent average cross-validation accuracy in categorising 12 tasks performed by nurses in both laboratory and real-world contexts.. This algorithmic pipeline was created by the "Britter Baire" team for the "2nd Nurse Care Activity Recognition Challenge Using Lab and Field Data."*

***Keywords:** Activity recognition; Nurse care; Accelerometer; Feature selection; Stratified KFold cross-validation; Random Forest.*

I. INTRODUCTION

Human activity recognition has emerged as a prominent issue in active research during the last several years (HAR).

Machine Learning, Machine Perception, Artificial Intelligence, Ubiquitous Computing and Human-Computer Interaction are just few of the fields that fall under this umbrella. The goal of activity recognition is to identify a person's activities based on observations of the person and the environment around them. With HAR, people's daily routines may be observed via the analysis of data acquired from a variety of sensors on them and their immediate surroundings.

Remote monitoring of patients' activities or the activities of old individuals at home is the primary focus of this research in health care applications. However, certain nurses' actions in the hospitals are overlooked, which might have several benefits, such as automated record production, monitoring compliance with care routines for a specific patient, and identifying risk behaviours that need special attention, among others.. It's a difficult area of study since, in contrast to other forms of activity recognition in which users conduct an action on their own, nurses perform the majority of actions on patients. Intra-class variability arises as a result of this, which is influenced by both the subject and the patient getting treatment. The goal of "The 2nd Nurse Care Activity Recognition Challenge Using Lab and Field Data" is to investigate the feasibility and limitations of adopting activity recognition using movement and location in this field.

Nurses are tasked with completing 12 tasks in the lab and in the real world as part of this assignment. There is a significant probability of missing labels during studies in the actual world since nurses are always at work. Data from both training and testing environments are included in training data, however testing data is derived only from data obtained in the actual world.

The most difficult part of this project is using laboratory data to develop real-world models and bridging the model gap. That's why, in Section 2, relevant activity recognition works are recognised, and then important works and research needs are given. Heiseikai data, nurse care activity data set are briefly discussed in Section 3. Section 4 explains our suggested technique in great detail. Problems and difficulties associated with this data collection are discussed in this section. In addition, the measures performed as a result of these circumstances are briefly described. Section 5 presents the outcomes of several algorithms. In addition, we do a thorough analysis of the data using the model we selected. Section 6 concludes the paper with suggestions for further research.

II. RELATEDWORKS

In the field of activity recognition, there have been several studies, particularly in the area of mobile activity recognition. There are, however, relatively few studies on the identification of nursing activities. This year, a challenge to recognise nursing activities was organised and several teams engaged in it, with encouraging outcomes. Different characteristics and basic classifiers, such KNN, were suggested.

Motion capture and meditag sensors were used. Skeletons may be represented using a spatiotemporal graph, which was introduced. Aside from voice recognition and natural language processing, Hidden Markov Models (HMMs) and Conditional Random Fields (CRFs) may also be employed in activity detection since they are sequential data. Mobile activity recognition might benefit from an approach known as "bag of features". Creates histograms from feature-extracted data by using that data as input. This strategy, however, necessitates the division of data. Data gathered in a controlled laboratory environment has poor performance in real-world situations. There are a wide range of activity durations and class imbalances in real-world situations, both of which may impede machine learning algorithms. For machine learning algorithms, over fitting is a typical concern. It's a good idea to use Random Forest to prevent over fitting your model. An ensemble of decision trees is known as a Random Forest. Bootstrapping is the process of creating multiple decision trees from a small portion of a dataset. After then, make judgments based on the remaining information and follow the results of a vote by the people. Bagging is the name given to this procedure. It has decent generalization ability and is less prone to over fitting since it doesn't operate with the whole data set at once and takes decisions from multiple randomly generated forests. Random Forest has been used in a number of studies on human activity identification. Using a Random Forest method, the authors of were able to correctly categorise 93.44 percent of human activities. Using a linear forward feature selection technique and a Random Forest-based methodology.

Table 1: Nurse Care Activity Data Set

Principal Category	Activity Name (Principal)	Label in Dataset	Activity Name (Sub)
A	Help in Mobility	1	Guide (from the front)
		2	Partial Assistance
		3	Walker
		4	Wheelchair
B	Assistance in Transfer	5	All Assistance
		6	Partial Assistance (from the front)
		7	Partial Assistance (from the side)
		8	Partial Assistance (from the back)
C	Position Change	9	To Supine Position /To Right Lying Position
		10	To Left Lying Position
		11	Lower Body Lifting
		12	Horizontal Movement

It is difficult for machine learning algorithms to classify data that is unbalanced. This issue has been addressed in the literature. Class imbalance is a prevalent concern in the medical field. Many diseases are only seen briefly, and as a result there may be few samples available. Other successful strategies for dealing with uneven data include up sampling the minority class and down sampling the majority class, using a high cost on the majority class and a low cost on the minority class. [We opted to use Random Forest for this dataset since it is so lopsided based on all of previous studies. In contrast to these approaches, ours uses both up sampling and down sampling, as well as oversampling prior to filtering, this is a major distinction between the two.

III. DATA SET

The Kyushu Institute of Technology's Smart Life Care Unit in Japan gathered the test results. Data was gathered from a Japanese care facility. In the lab, 2 people participated who are professional nurses. In the actual world, 47 people took part in the experiment, however only the training and testing data of six nurses and three test nurses are included in this challenge. The data set consists of care actions that nurses undertake at the Care facility. Mobility support, transfer assistance, and position change are the three main categories of activities. Table 1 shows the many subcategories of these activities.

To obtain the data, the accelerometer sensor in the smartphone and motion capture sensor was utilised however only the accelerometer data is accessible for this challenge. The wristband that held the smartphone in place was worn on the right arm. The data is sampled at a rate of 60 hertz (Hz). No pre-processing procedure is performed to this data. The field data collection, in particular, has a large number of unlabeled observations. Also, the activity labels in this dataset are heavily skewed. Each segment of the test data set must be predicted by an activity id model that incorporates both the lab and field data sets.

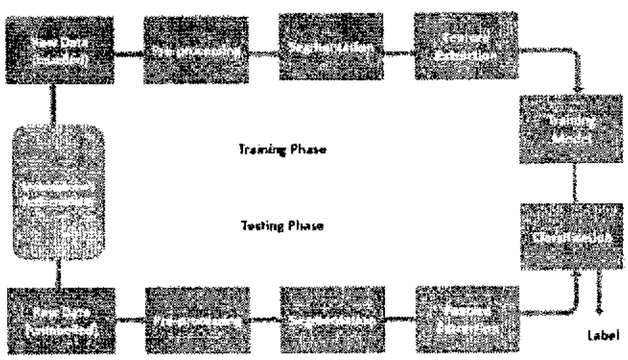


Figure 1: Basic Structure of Nurse Care Activity Recognition System.

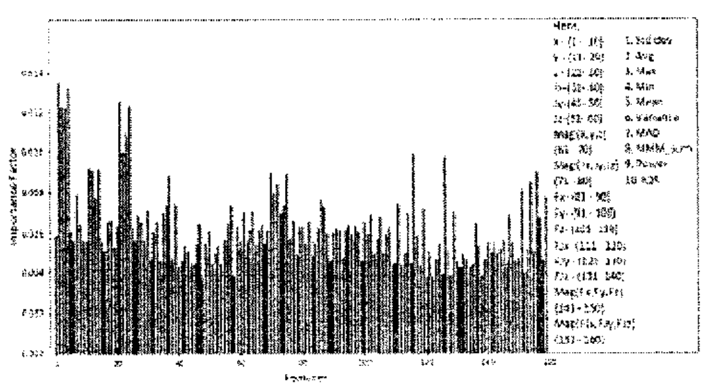


Figure 2: Feature Importance Plot.

IV. METHODOLOGY

Raw sensor data may be analysed in a number of methods that are well-established in the scientific community. According to Fig. 1, this process begins with pre-processing raw sensor data, which includes segmentation, feature extraction, and classification.

Body acceleration, gravitational acceleration, and noise are all components of a single accelerometer signal. Noise filtering and the separation of body and gravity acceleration are necessary before the segmentation approach can be used. Given that this data set consists only of body acceleration, the pre-processing step employs a low pass Butterworth filter with a cutoff frequency of 20 Hz in order to remove any noise. Different segmentation approaches may be used to extract meaningful information from a continuous stream of data in order to enhance the relevant features of the signal. The sensor signal must first be broken down into smaller time intervals known as windows. A sliding window approach, with windows of constant length and zero overlap, was utilised to split the signal in this case. There is little to no pre-processing required for this windowing technology, which makes it ideal for real-time applications and easy to implement.

A triaxial accelerometer was employed in this experiment. A three-dimensional axis model is used to visualise the data. We used the triaxial data to derive jerk, magnitude, and frequency domain signals to better identify the various nursing actions. So, the data set now has 16 input columns: x, y, z, Jx, Jy, Jz, Mag(x, y, z), Mag(Jx, Jy, Jz), Fx, Fy, Fz, FJx, FJy, FJz, Mag(Fx, Fy, Fz), Mag(Jx, Jy, Jz) (FJx, FJy, FJz).

As a result of these 16 columns, we calculated the mean, median absolute deviation (MAD), weighted average (WA), and standard deviation of 10 characteristics, including energy and IQR. As a result, there are 160 vectors in the feature space.

An essential part of activity identification and analysis is the selection of features. Every characteristic is not equally important, and some variables may be completely unnecessary. Using feature selection to prevent overfitting, increase accuracy, and decrease training time is a three-pronged approach to reducing the amount of data needed to train an algorithm.

On the basis of Gini impurity, we narrowed down the key characteristics. Fig. 2 illustrates the relative relevance of all the characteristics by way of a bar chart. Here, the percentage significance of the most essential qualities is shown against each feature's relative relevance. In order to rank and compare characteristics, this importance is determined for each individual attribute in the dataset. Attribute split points are weighted according to the number of observations they are responsible for in order to determine the relevance of a particular tree. The Gini index is used to determine the points at which to divide the sample.

All of the decision trees in the model are then averaged to get a total of the feature significance factors. Finally, 72 features were chosen among 160 characteristics based on their relevance. These results show that the top 10 attributes are as follows: average, mean, standard deviation, minimum, maximum, minimum, maximum, avg(z), variance, and variance (FJy).

We see data as a precious resource, and we want to make full use of it. Only the piece of data designated for training may be used for model training if we use the train-test split. As the quantity of training data grows, so does the quality of the models. Cross-validation is a possible solution to this problem. Data sets are partitioned into N subsets using cross-validation. During training, the N-1 split is employed, with the remainder of the split being used for testing. Using a different split each time, the model goes over the data set N times.

For both training and testing purposes, we utilise all of the data points available.

A model's performance may also be improved by using cross-validation to test it on additional, previously untested data points. KFold and Stratified KFold are two of the most often used algorithms for dividing data in cross-validation. While cross-validation is still used, the class distribution within the data set is retained in both training and testing splits when using the Stratified KFold approach.

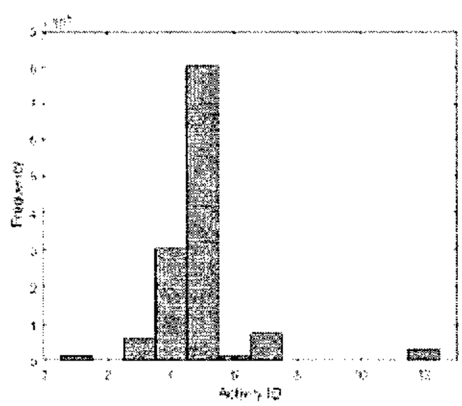
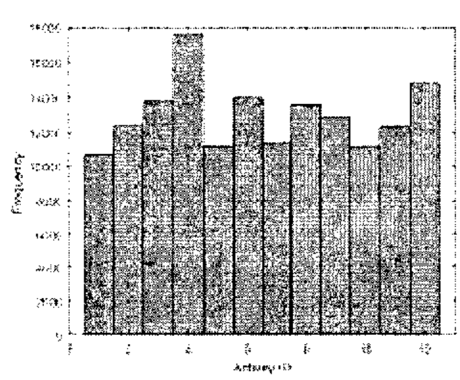


Figure 3: Field Data Histogram Plot



ISSN 2515-8260 Volume 08, Issue 04, 2021

Figure 4: Lab Data Histogram Plot

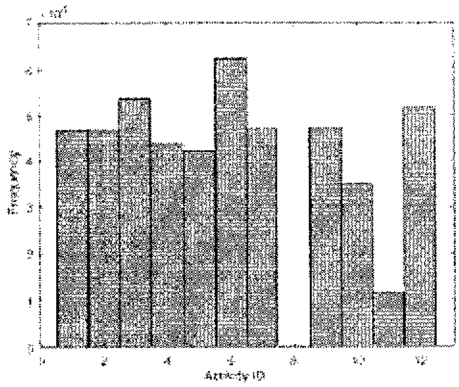


Figure 5: Field Data Histogram Plot (After Resampling)

When there is a large amount of data, Stratified KFold performs better than KFold. This can be seen in the histogram plots of field and lab data in Figure 3 and Figure 4. Resampling is used to keep things under check. If we compare Figs. 3 and 4 to Figs. 5, because there was no data for activity 8 and just a tiny quantity of data for activity 11, this occurrence occurred. As a consequence, oversampling in the field data had little to no reference point, resulting in an obvious class imbalance in the combined data. So, Stratified KFold is used in our study since it attempts to preserve the proportion of data that is present in the train-test split. This will prevent any kind of partiality. In this case, we employed cross-validation with 10 folds to improve speed.

MATLAB Statistics and Machine Learning Toolbox were used to assess the classifier's performance. The Random Forest classifier was estimated to have the best performance. Adding insult to injury, the data set is very unbalanced, which makes it extremely susceptible to overfitting. Overfitting may be readily reduced using the Random Forest classifier. Following are the random search hyperparameters for the Random Forest classifier: The number of trees is 1800, the minimum number of splits is 2, the minimum number of leaves is 1, the maximum number of features is the square root of the total number of features, and bootstrap is True.

Table 2: Accuracy Comparison of all the Tested Models

Window size	Classifier	Accuracy (%)
128	Random Forest	65.9
	Cubic SVM	57.8
	Quadratic SVM	52.3
	Fine Tree	41.2
	Medium Tree	33.6
	Linear Discriminant	33.5
	Fine KNN	55.7
	Boosted Trees	36.6
256	Random Forest	63.2
	Cubic SVM	56.8
	Quadratic SVM	52.4
	Fine Tree	46.7
	Medium Tree	47.6
512	Random Forest	63.9
	Cubic SVM	57.7
	Fine Tree	48.9
	Boosted Trees	47.7
	Cosine KNN	48.8

V. RESULT AND ANALYSIS

We tried a variety of window widths, feature sets, and algorithms to find the most effective solution in this project. All of the evaluation's experimental findings will be summarised in this section. Initial tests were conducted using MATLAB Statistics and Machine Learning Toolbox to predict the best potential combination. Table 2 shows the best potential results from all of the data. In every section, we can observe that the Random Forest Classifier has provided the greatest accuracy if we look into the data attentively.

There is a considerable risk of bias and overfitting since our data set is so uneven. With the correct hyperparameters and Random Forest classifier with Stratified KFold cross-validation, we can easily minimise this chance.

If you're dealing with an unbalanced class situation, you can't utilise accuracy as a performance metric.

In order to obtain a better sense of how our suggested strategy performs, we have employed different performance indicators, such as precision, recall, and F1 score. We have prioritised precision, recall, and F1 score above accuracy because to the data set's extreme class imbalance. The resampled data had a maximum accuracy of 65.9%. Table 3 shows the findings for both resampling and non-resampling. Low false-positive rates are associated with high accuracy. With resampling, the average precision is 0.67, whereas without resampling, it is 0.69. With resampling, we've seen an average recall of 0.66, which is over the 0.5 threshold for this model. However, without resampling, the average recall score is only 0.41. For classes with a more unequal distribution of students, the F1 score is typically more valuable than the accuracy score. Resampled and unresampled data accuracy is fairly similar in our situation, but their average F1 scores are considerably different: 0.66 for resampled data and 0.50 for unresampled data. Fig. 9 depicts the proposed classifier's confusion matrix, which demonstrates that Wheelchair and All A are the most puzzling activities.

Right Lying (LL) and Supine position (SP/RL) are the second most perplexing activities (LL).

VI. CONCLUSION AND FUTUREWORK

Class imbalance, missing labels, missing points, and incorrect timestamps were among the many issues we encountered when working with this data.

Labeling errors made by humans are mostly to blame for these issues.

With the Random Forest Classifier, we have performed Stratified KFold cross-validation in an attempt to minimise overfitting due to class bias. The Random Forest classifier provides the greatest result, with an accuracy rate of 65.9%, when accuracy is compared using several methods. This model has a lot of room for growth, as seen by an examination of the data for each performance parameter. Even after resampling, there is still a substantial class imbalance in the field data, which is why the expected result was not achieved. Data augmentation and resampling are two options to consider. During the course of our study, this approach yielded an accuracy of 70.85 percent. Resampling and data augmentation are often employed to solve this sort of issue, however in our instance they didn't work well together. In light of the rarity of this data collection, further experimentation and analysis are necessary before the concepts of resampling and data augmentation can be used here. Due to a lack of time, more testing has not yet been performed and will be included in our next project. Semi-supervised learning may also be used to produce pseudo labels and data points if there are too many missing data and labels. As a result, there will be less of a wealth gap. The lack of computing resources prevented us from implementing this technique, however others who will deal with this data set in the future may use this method. The testing dataset's recognition result will be included in the challenge summary article.

REFERENCES

[1] Rahman, A., Hassan, I., & Ahad, M. A. R. (2021, September). Nurse Care Activity Recognition: A Cost-Sensitive Ensemble Approach to Handle Imbalanced Class Problem in the Wild. In Adjunct Proceedings of the 2021 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2021 ACM International Symposium on Wearable Computers (pp. 440-445).

[2] Alia, S. S., Adachi, K., Hossain, T., Le, N. T., Kaneko, H., Lago, P., ... & Inoue, S. (2021, September). Summary of the Third Nurse Care Activity Recognition Challenge-Can We Do from the Field Data?. In Adjunct Proceedings of the 2021 ACM International

Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2021 ACM International Symposium on Wearable Computers (pp. 428-433).

[3] Matsuyama, H., Yoshida, T., Hayashida, N., Fukushima, Y., Yonezawa, T., & Kawaguchi, N. (2020, September). Nurse care activity recognition challenge: a comparative verification of multiple preprocessing approaches. In Adjunct Proceedings of the 2020 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2020 ACM International Symposium on Wearable Computers (pp. 414-418).

[4] Basak, P., Tasin, S. M., Tapotee, M. I., Sheikh, M. M., Sakib, A. N., Baray, S. B., & Ahad, M. A. R. (2020, September). Complex nurse care activity recognition using statistical features. In Adjunct Proceedings of the 2020 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2020 ACM International Symposium on Wearable Computers (pp. 384-389).

[5] Kowshik, M. A., Pritom, Y. A., Rahman, M. S., Akbar, A., & Ahad, M. A. R. (2021, September). Nurse Care Activity Recognition from Accelerometer Sensor Data Using Fourier-and Wavelet-based Features. In Adjunct Proceedings of the 2021 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2021 ACM International Symposium on Wearable Computers (pp. 434-439).

[6] Kadir, M. E., Akash, P. S., Sharmin, S., Ali, A. A., & Shoyaib, M. (2019, September). Can a simple approach identify complex nurse care activity?. In Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers (pp. 736-740).

[7] Lago, P., Alia, S. S., Takeda, S., Mairittha, T., Mairittha, N., Faiz, F., ... & Inoue, S. (2019, September). Nurse care activity recognition challenge: summary and results. In Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers (pp. 746-751).

[8] Anand, S. J., Magesh, S., & Arockiamary, I. (2021). Contemporary Human Activity Recognition Based Predictions by Sensors Using Random Forest Classifier. Journal of Computational and Theoretical Nanoscience, 18(4), 1243-1250.

[9] Anand, S. J., Magesh, S., & Arockiamary, I. (2021). Contemporary Human Activity Recognition Based Predictions by Sensors Using Random Forest Classifier. Journal of Computational and Theoretical Nanoscience, 18(4), 1243-1250.

[10] Wang, J., Chen, Y., Gu, Y., Xiao, Y., & Pan, H. (2018, July). SensoryGANs: An effective generative adversarial framework for sensor-based human activity recognition. In 2018 International Joint Conference on Neural Networks (IJCNN) (pp. 1-8). IEEE.

A sensor-based Glove interaction for nursing care Robot assistance

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Abstract- Between 2015 and 2050, the World Health Organization predicts that the number of old people would quickly increase. Population ageing is leading to an increase in physical disabilities and mobility issues. There is a significant opportunity to improve healthcare delivery by using assistive robots, which are constantly improving robotic technology. Robotic technologies for the care of the elderly and handicapped are thus becoming more relevant. In an assistive robotic system, a sensor glove for human-robot interaction is conceived, manufactured, and assessed in this article. Flex sensors and an inertial measurement unit (IMU) are used to detect the user's finger motions and additional off-the-shelf electrical components are employed in the sensor glove. It is the primary objective of this study to make human-assistive robot interaction more intuitive and dependable. As a result, this study focuses on three key topics: 1) developing a pattern for these kinds of sensor gloves, 2) testing the performance of sensor gloves with the use of flexible sensors, and 3) examining how to analyse systems with a person in the loop while using a sensor glove. Using this design pattern, the sensor glove can be a reliable interface for operating the assistive robotic system, according to our experiments. Aside from that, our estimate approach may be used to the study of an assistive robotic system with a person in the loop, allowing us to theorise about the system's optimal parameters.

Keywords— nursing-care assistive robotics, sensor glove,human-robot interaction, human-in-the-loop system.

I. INTRODUCTION

Between 2015 and 2050, the World Health Organization predicts that the number of individuals aged 60 and older would climb from 900 million to 2100 million. The ageing population is leading to an increase in the number of people who are physically disabled or have mobility issues. As robot technology continues to advance, assistive robots have the potential to extend healthcare services to solve the following issues.

In order to operate assistive robots remotely, gesture-based human-robot interfaces are a simple and intuitive [2] option. There are three basic ways to implement gesture-based interfaces: image-based, glove-based, and non-wearable techniques. Non-wearable techniques have a lower resolution than others. Some researchers [4] have used image-based approaches to operate an assistant robotic system. This means that image-based approaches rely heavily on lighting conditions and surroundings [5]. With these limitations, glove-based solutions are more accurate and dependable in the application of homecare robot control when dealing with changing lighting conditions and complicated human environments. Flex sensors and inertial sensors [6] were employed in our study because they are often used in glove-based systems for detecting static finger bend and dynamic [4] arm movement.

The development of smart gloves with sensors and electrical devices has been a major focus in recent years. To develop a smart glove (HandiMate) that serves as an input device for self-configurable modular robots, a combination of flex sensors and inertial sensors is used. Ziro and other commercial items of a similar kind exist. There have also been investigations on the manufacturing process and characteristics of piezoresistive strain sensors [8]. Besides modular robotics, we designed a number of subsystems that will be detailed in this study, as well. The sensor glove and the whole robotic system will be tested in Section III. Here, we'll explore the system's dependability and accuracy, which were addressed in the preceding sections. Section V concludes the essay. sensor glove that can record both static finger motions and dynamic arm movements. rable sensor glove A prototype nursing-care robotic system including the glove and an Automated Guided Vehicle (AGV) and a commercially available robot has been developed (YuMi). The following is a list of the issues we considered in our research: There is a new design pattern for this kind of sensor glove, and we first looked at it. As a follow-up, we devised a new way to assess the performance of sensor gloves using flex sensors. Three methods for human-in-the-loop system analysis were developed and assessed, one of which included using the sensor glove.

Here's how the rest of the article's sections are organised:

Section II explains the general design of the wearable sensor glove and the nursing-care robot. Sensor gloves were then used in a variety of disciplines, including health care [9], sign language comprehension [8], virtual reality [10], and more.

However, the entire performance of the complete glove system (sensors, electronics, and robotic systems) is seldom formulated by researchers [6]. Even though commercially available smart gloves can be used to control modular robots and virtual reality, studies on applying smart gloves in controlling nursing care robotic systems are of great value, despite the fact that performance specifications for sensor gloves are entirely different from one application to the next, resulting in important issues when trying to match a glove to a specific application. In addition, nonlinear behaviour and reaction times of around 200 ms are common in resistive sensors [11]. Sensor glove systems may become unstable as a result. A performance assessment index should be implemented as a consequence.

II. SENSOR GLOVE

A *Overall Architecture*

YuMi robot placed on AGV has two subsystems. YuMi is a manipulative device created to assist those who have difficulty using their upper limbs. People with lower limb disabilities need to be able to move, and the AGV helps them do so.

As a human-robot interface device, our sensor glove is developed so that users may naturally manage the assistive robotics system. Eight-finger signals may be translated into AGV movement orders and mode switch commands using the glove, as demonstrated in Figure 1.

When the user moves their arm in 3-D, the YuMi can read that movement and translate it into orders for the robot. Gesture-based human-robot interfaces are governed by standards issued by the British Standards Institution (BSI) and the International Standard Organization (ISO). Gesture signs, for example, have taken some of these suggestions into account throughout the design process.

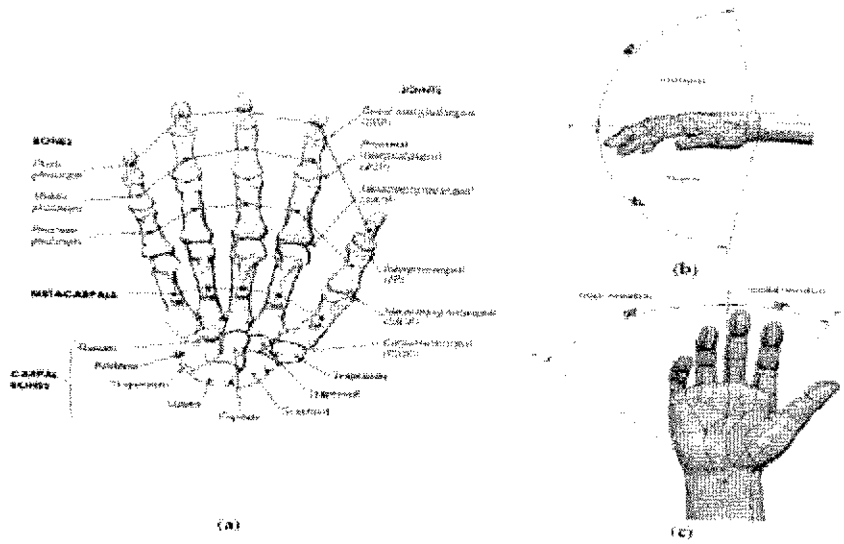

Figure. 1. Fingers and arm gesture representations of the user the robotics system's data and command flow. Schematic of a robot

The following is a breakdown of the steps involved in an interaction: Flex sensors placed in the glove at the user's metacarpophalangeal joints (bent or straight) are also detected by the inertial measurement unit (IMU) linked to the wristband, which measures motion. 2) As shown in Fig. 2, the voltage signals are delivered to a microcontroller. The motions of fingers and arms are identified and categorised into predetermined models using threshold judgement and decision tree classification techniques of classification. Assistive robotic systems' control boards get the appropriate Bluetooth instructions. For the glove system, HC06 was selected because of its small size, high data rate, and low price. AGV or YuMi will then reply in accordance with the current mode of the system (which may be switched back and forth using mode switch instructions).

Figure 2 depicts the sensor glove's circuit design in more detail. It may be broken down into five distinct sections based on its intended use:

- Finger gesture recognition circuit (flex sensor 2.2)
- IMU unit (MPU6050)
- Arduino Mega (microcontroller)
- 9V zinc-manganese dry battery
- Bluetooth unit (HC06)

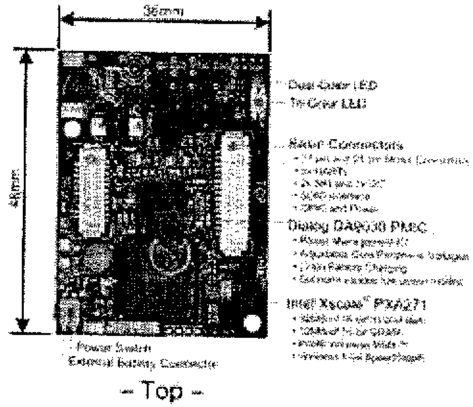

Figure. 2. Sensor glove circuit design

B *Finger Bend Detection Subsystem*

Finger gesture identification relies on the resistance-strain effect, which occurs when a certain motion is performed on the backs of flex sensors inserted in the matching fingers. Measurement of voltage is done using an analog-to-digit converter (ADC) and an adjustable resistor. Next, the resistance of flex sensors is calculated using Kirchhoff principles.

Thus, the "angle-resistance" curve may be determined in advance, and the gesture of fingers (angle of metacarpophalangeal joints) can be derived from this data.

To send a command to an assistive robotic system through Bluetooth, an AGV's omnidirectional movement command may be created using the matching gesture table illustrated in Fig. 1. The mechanical nature of human hands restricts the number of possible finger combinations to a maximum of 32. Only eight of these variables are examined in this study.

C *Arm Movement Detection Subsystem*

A four-stage model [14] may be used to represent the whole arm movement detection process:

Creating and transmitting a signal segmentation and processing of the input signals, and the extraction of feature information The use of pre-trained decision trees for classification Transmission of a YuMi manipulation command

In order to track the movement of the user's arm, we connect an IMU MPU6050 to the wristband. A Digital Motion Processor, a 3-axis gyroscope, and a 3-axis accelerometer make up the MPU6050 (DMP). The serial port may be used to send motion data in the form of 9-axis motion information. MATLAB programme will evaluate the data that is delivered to a computer through Bluetooth from the IMU. Afterwards, a 35 Hz low-pass filter is applied to the original signal to smooth it out. The cut-off frequency was determined by experiments in the 020Hz frequency range, which is the range in which human motion occurs. For the next step, we utilise the Sliding Window Method to segment the signal, which has a duration of 4.5 seconds and an overlap ratio of 20% since the movement is steady and there are little fluctuations. There are six attributes that may be used as features for classification: max/min/average/no. of peaks/variance/standard deviation of yaw/roll signal. We utilised 240 samples to build the decision tree in the course of preparation work (training model). The retrieved characteristics will be utilised to categorise various movements of the user's arm throughout the robotic control procedure. As a result, YuMi will carry out the instructions that were sent to the robotic control board through Bluetooth.

D *Affiliated Electronic Components*

The Arduino Mega is a good choice for this sensor glove project because of its size and capabilities. There are 54 general-purpose digital I/O pins.

Serial communication, which is utilised for Bluetooth in this application, is supported by some of the pins. The quantization error is kept to 4.9mV thanks to the 16 10-bit analogue to digit converters for 05V input. In addition to it, an ATmega2560 CPU with a maximum clock rate of 16 MHz is used. This processor may be used to detect arm and finger motions, categorise them into multiple models, and deliver instructions in this particular application.

Because it's so inexpensive, the Arduino Mega can be easily expanded. We were able to create the glove's functionality more quickly because to the inclusion of open-source tools like the serial communication library.

For a variety of reasons, Bluetooth is the preferred method of communication between the sensor glove and robots. When it comes to indoor assistive robot control, it has a communication range of 10 metres. It has a maximum of 8 devices per network, which is sufficient for the purpose at hand. In addition, Bluetooth's 1 Mbps data throughput, cheap cost, low power profile, and great adaptability make it an excellent option for this application.

There is a 9-volt dry battery linked to the wristband to power the Arduino Mega, Bluetooth, and IMU components. In the meanwhile, a rather steady reference voltage is generated for the finger bend detecting subsystem using a voltage regulator module MC33269 (included into Arduino Mega).

E *Performance Evaluation Index*

Sensor glove stability is influenced by a variety of reasons, including changes in the reference voltage, discrepancies between nominal and real resistor values, quantization errors, and variations in the sensitivity of the flex sensors due to fatigue. Flex sensor error, embedded system error, and measurement error are all examples of these problems. Flex sensor error may be measured and will be detailed later in the experiment. The specifications of electronic components may be used to predict embedded system errors and measurement errors.

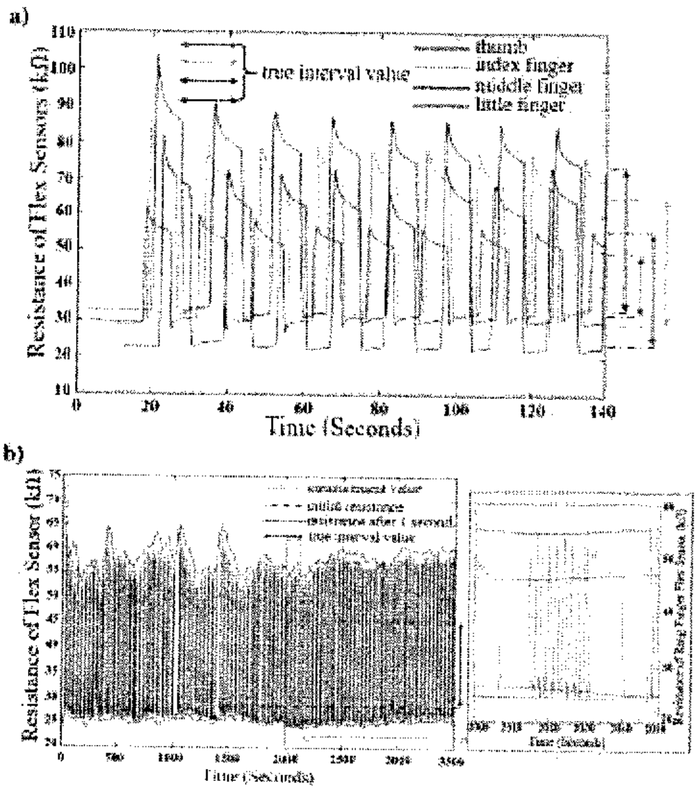

Figure. 3. (a) Resistance of flex sensors corresponding to thumb, index finger, middle finger, and little finger while performing periodic bent/straight motions. To measure static state resistance, bend/straighten the flex sensor ring finger 1000 times and measure the resistance.

Fig. 3 (a) depicts the change in nominal value of flex sensors' resistance produced by varied sensor characteristics and different attachment locations. Sensor interval ranges were 3250 k3067 k3475 k2557 k, correspondingly, for the thumb, index finger, middle finger, and little finger. We are solely interested in the two states of fingers that are totally straight and bent in this study. For this reason, it is only measured and used in these two static states.

$$U_{nominal} = quantization\left[\frac{U_{ref}}{R_{bend} + R_{ref}} R_{ref} \right] \qquad (1)$$

As seen in Equation (1), this voltage may be utilised to determine the position of the fingers. It may be calculated using the voltage law of Kirchhoff. Because of different mistakes and disturbances in the measurement process, such as variances between nominal and real values of reference resistor and reference voltage, this is not a conventional Kirchhoff's laws formulae. However, as shown in Figure 5 since we need to make sure that flex sensors as well as other electrical components do not confuse finger motions, the output voltage will be disturbed and this will decrease the range of the threshold value.

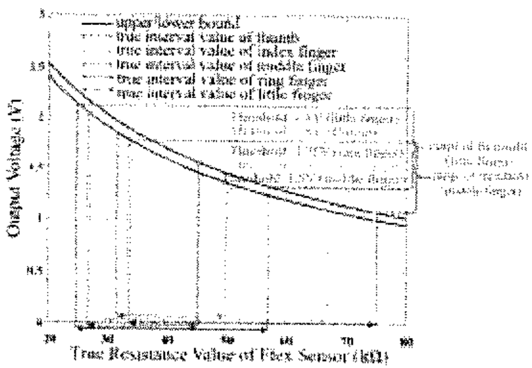

Figure. 4. True resistance of flex sensors and output voltage while considering electronic system uncertainty. The disruption of real resistance value of flex sensors revealed the impacts of sensor individual variation and sensor fatigue.

This section introduces a performance assessment index that may be used to evaluate the sensor's performance when paired with other electrical components.

Additionally, a flex sensor's best threshold value may be discovered by experimentation. To illustrate that the nominal value of an electronic component does not match its real value because of the reference voltage and resistance uncertainty, Fig. 4 demonstrates that the output voltage has upper and lower bounds that correlate to a genuine resistance value. Sensor individuality and sensor fatigue influence the genuine resistance value of flex sensors, resulting in a horizontal axis disturbance.

It is necessary to choose an adequate threshold in order to avoid misjudging the states of finger motions. The length of the range might be used as a performance assessment metric. We are less likely to confuse a bent condition for a straight one if the range is bigger. Confusion is more likely if the range is narrower or even negative in certain cases. Different reasons, such as sensor individual differences, sensor fatigue, electronic system uncertainty, etc. might be responsible for this phenomenon.

It's possible that pre-calibrated techniques like simple linear method, regression and approaches for coupling issues may enhance the performance of motion capture gloves. Instead of looking at the relationship between resistance and bend degree as a whole, this study focused only on the resistance in totally bent and straight states. TABLE I. shows that the success rate is high enough to operate the robot.

III. EXPERIMENTS OF INTEGRATED SYSTEM

A Background, Modelling and Presumptions

The human aspect should be included into the control loop as part of the HMI category.

Uncertain human elements are included into this assistive robotic system, making it difficult to evaluate the whole system. An analysis and forecasting model for the human-in-the-loop system is shown here. A nursing-care robotic system's ideal characteristics, such as angle velocity and acceleration, will be obtained by building a model. Robotic care for the elderly is the primary use case for this assistive robot system, which is often used in tight settings.

To achieve a good balance between accuracy and efficiency, we must consider both at the same time. With the sensor glove present, we intend to acquire the parameters in a theoretical method that can be used to a wide range of robots, and is more general than an experimental approach.

In this portion of the experiment, we examined how the sensor glove helped us steer the robot in the desired direction. We need to first modify the robot's orientation if we are going to use it in a straight tight channel, which is typical in application situations for this technology. The angle v inaccuracy should be kept to a minimum so that the route may be traversed without additional correction. The robot's size and the passage's length and breadth both have a role in determining the precise range.

The temperature limit was established at 6 degrees in this experiment.

As an ideal relay with hysteresis or dead zone, the glove subsystem (human component) is represented mathematically. This relay's threshold is determined by a random variable a, which has a zero-mean Gaussian distribution. Based on the velocity parameter v, this distribution's variance may be calculated This makes perfect sense, since increasing velocity makes it more difficult for a user to point the robot in the desired direction, and as a result, the amount of dispersion rises.

Robotic systems are predictable in compared to human behaviour. Because of this, the system's stopping distance may be described as a fixed function, stop, which is dependent on the velocity parameter.

B *Experiment Setup*

The experiment's primary assessment criteria were whether or not the robotic system could be controlled to stop in the appropriate direction using the user's finger and arm gestures.

Figure. 5. Experiment setup: assistive robot rotates in the passage with length of 1.5meters and width of 0.9meter. The rotating angle is measured by a protractor printed on a paper.

Stages one and two of the experiment were separated into two. Using an illustrated gesture table, a subject wearing the sensor glove performed a series of motions at random and the success and failure rates were recorded.

Second, as seen in Fig. 5, a tunnel measures 1.5 metres in length L and 0.9 metres in width M. Passage and AGV's initial path are about 45 degrees apart. The individual utilised the sensor glove to change the robotic system's direction using varying levels of angular velocity (just the Turn Left/Right command was used). Each experiment had a predetermined angular velocity that was not affected by the joint angle.

Success and failure rates were tabulated and analysed in detail.

The successful examples are those in which the value of the stopping angle v is modest enough that the robots can travel through the passage with no additional modification. A halting angle restriction of 4 degrees to 4 degrees has been specified for this experiment based on the robot's overall dimensions and the route.

For every different parameters of angular velocity (10 rad/s, 20 rad/s, 30 rad/s), we recorded 100 set of data of stopping angle θv, respectively. The human factor (Gaussian distribution) models utilised half of the data for parameter estimation. It was then compared to actual results in order to see whether the model's predictions were accurate.

IV. RESULTS AND DISCUSSION

A *First Stage: Sensor Glove*

This was achieved by using the performance evaluation index approach to determine the ideal threshold value (which was first set to the centre of the range obtained in Fig. 5 and slightly altered via experiment). Figure 5 shows the final threshold values for each of the five fingers. The results \sof success rate for varied motions are presented in TABLE I.

Table I. Efficacy Of Each Gesture

Gesture	*Num of Success*	*Num of Failure*	*Success Rate*
Move Forward	48	2	96%
Move Back	47	3	94%
Move Left	50	0	100%
Move Right	50	0	100%
Turn Left	50	0	100%
Turn Right	49	1	98%
Swich Mode 1	50	0	100%
Swich Mode 2	44	6	88%

Sensor gloves may properly represent the user's intentions using the ideal threshold, as shown in this experiment's results. A technique for determining the appropriate threshold has been proven successful.

B *Second Stage: Integrated System*

We observed a succession of angular errors between the actual stopping direction and the planned stopping direction under varied commands of input velocity values vk. vi is the name of the series.

The maximum likelihood estimator is used to find a suitable value for the unknown parameters of the Gaussian distribution (the human factor). It is a technique for selecting the parameters of a distribution whose likelihood function provides the biggest value.

$$L(\mu,\sigma^2)=\prod_{i=1}^{n} f(\theta_{si};\mu,\sigma^2).$$

Using (2) to estimate the gaussian distribution with unknown mean μ and variance σ2.

$$\begin{cases}\frac{\partial}{\partial\mu}\ln L(\mu,\sigma^2)=0\\ \frac{\partial}{\partial\sigma^2}\ln L(\mu,\sigma^2)=0\end{cases}\Rightarrow\begin{cases}\hat{\mu}=\frac{1}{n}\sum_{i=1}^{n}\theta_{si}=\bar{\theta}\\ \hat{\sigma}^2=\frac{1}{n}\sum_{i=1}^{n}(\theta_{si}-\bar{\theta})^2\end{cases}\quad(2)$$

V. CONCLUSION

Design patterns for sensor gloves that include finger gesture and arm movement sensors are presented in this study.. A robotic nursing system was used in conjunction with the glove. Using the glove developed and tested in this study, the user's intentions for controlling assistive robots were accurately reflected. After conducting an experiment and verifying the model we developed, we found that it properly predicts the success rate of guiding a robot to the intended location.

REFERENCES

[1] World Health Organization, "Multisectoral action for a life course approach to healthy ageing: Draft global strategy and plan of action on ageing and health," 69th World Health Assembly, provisional agenda item 13.4, April 2016

[2] E. Choi, S. Kwon, D. Lee, H. Lee, M. K. Chung, "Can user-derived gesture be considered as the best gesture for a command?: Focusing on the commands for smart home system," Proc. Hum. Factors Ergon. Soc. Annu. Meet., vol 56, pp. 1253–1257, 2012.

[3] L. Corchia, E. D. Benedetto, G. Monti, and A. Cataldo, "Wearable antennas for applications in remote assistance to elderly people," Processings of the IEEE Int. Workshop on Measurement and Networking, Naples, Italy, pp. 1–6, 27–29 September 2017.

[4] G. Yang, H. Lv, F. Chen, Z. Pang, J. Wang, H. Yang, and J. Zhang, "A novel gesture recognition system for intelligent interaction with a nursing-care assistant robot," Appl. Sci., vol.8, 2018

[5] H. Liu, L. Wang, "Gesture recognition for human-robot collaboration: A review," Int. J. Ind. Ergon., 2017.

[6] L. Dipietro, A. M. Sabatini, S Member, and P. Dario, "A survey of Glove-based systems and their applications", IEEE Trans. Syst., Man Cybern.-Part C: Appl. Rev., vol. 38, no. 4, pp. 461–482, July 2008.

[7] J. S. Seehra, A. Verma, K. Peppler, and K. Ramani, "HandiMate: Create and animate using everyday objects as material," in Proc. The 9th Int. Conf. Tangible, E. and E.I., pp. 117–124, January 2015.

[8] T. F. O'Connor, M. E. Fach, R. Miller, S. E. Root, P. P. Mercier, and D. J. Lipomi, "The language of glove: Wireless gesture decoder with low-power and stretchable hybrid electronics," PLOS ONE, vol. 12, no. 7, 2017.

[9] Y. Su, C. R. Allen, D. Geng, D. Burn, U. Brechany, G.D. Bell, and R. Rowland, "3D motion system ("data-gloves"): Application for Parkinson's disease," IEEE Trans. Instrum. Meas., vol. 52, no. 3, pp. 662–674, June 2003.

[10] S. Bryson, C. Levit, "The virtual wind tunnel," IEEE Comput. Graph. Appl., vol. 12, no.4, pp. 25–34, July 1992.

[11] A. Atalay, V. Sanchez, O. Atalay, D. M. Vogt, F. Haufe, R. J. Wood, and C. J. Walsh, "Batch fabrication of customizable silicone-textile composite capacitive strain sensors for human motion tracking," Adv. Mater. Technol., vol. 1700136, 2017.

[12] G. Tang, P. Webb, "The design and evaluation of an ergonomic contactless gesture control system for industrial robots," Journal of Robotics, vol. 2018, Article ID 9791286, 10 pages, 2018.

[13] British Standards Institution, "Information technology—Gesturebased interfaces across devices and methods," BS ISO/IEC CD 30113-1, 2015.

[14] R. Parasuraman, T. B. Sheridan, C. D. Wickens, "A model for types and levels of human interaction with automation," IEEE Trans. Syst., Man Cybern.-Part A: Systems and Humans, vol. 30, no.3, pp. 286– 297, May 2000.

[15] Y. Wang, and M. Neff, "Data-driven glove calibration for hand motion capture," In Proc. the 12th ACM SIGGRAPH/Eurographics Symposium on Computer Animation, SCA'13 pp. 15–24, July 2013.

[16] E. Tzorakoleftherakis, F. A. Mussa-Ivaldi, R. A. Scheidt, and T. D. Murphey, "Effects of optimal tactile feedback in balancing tasks: A pilot study," in Proc. American Control Conference (ACC 2014), pp778–783, July 2014.

International Journal For Advanced Research In Science & Technology

A peer reviewed international journal www.ijarst.in

IJARST ISSN: 2457-0362

Effectiveness of Information, Education, Communication on prevention of Obesity among adolescent children in Chennai, Tamilnadu

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Abstract— The Internet has ushered in a new age of science and technology, with big data in information technology serving as the engine that propels advancements in both fields. Building a nursing management and control platform that integrates nursing quality indicators, nursing event reporting, and nursing risk management, and achieving dynamic and intelligent management and control of nursing quality throughout the process by applying big data and intelligence to the clinical nursing quality management system. The time it takes to input and analyse nursing quality concerns is greatly reduced, the quality of nursing services is enhanced, and patient satisfaction is effectively increased as a result of using big data to the nursing quality management system. An efficient mobile nursing quality management system may save time and money while increasing nurse job efficiency, promoting full involvement in quality management and enhancing patient satisfaction with nursing services.

Keywords- big data; nursing; satisfaction; work efficiency

I. INTRODUCTION

Large-scale data, which has evolved as a result of Internet and information technology's rapid growth over the last several years, is being employed in a variety of medical and health settings. It has become more common for medical records to include more and more information as the usage of electronic health records (EHRs) grows in popularity. Data and knowledge created by humans over the previous 12 000 years has grown at a pace of 90 percent each year during the past five years, according to research. Even while a vast number of unstructured numbers may seem random, they really contain a wealth of useful information that may be tapped into. Since the HITECH Act was passed by the United States Congress in 2009, health-related big data has begun to demonstrate its potential. An event on big data in nursing was organised by the National Institute of Nursing (NIN) at the end of July 2015. The growth of big data in nursing and even medical care in China is trailing behind other nations, but that is not unusual. For medical and health services and social security services, China's State Council published "Outline of Action to Promote the Development of Big Data" in September 2015. Medical and health management and service organisations are encouraged to do research on the creative use of big data in the context of medical and health management.

Big data research has emerged as a major trend in academic progress in the age of big data. The use of large, multi-channel and varied data in nursing may lead to new ways and concepts. Many parts of nursing may benefit from its use, including nursing assessment, improving nursing practise, illness monitoring, nursing scientific research, and clinical decision support [2]. It is the goal of this article to draw the attention of nursing workers to the practical use of big data in different nursing domains, such as nursing practise, nursing research, and so on, in order to better promote the use of big data in nursing.

II. DEFINITION OF BIG DATA

Big data is defined by the McKinsey Global Institute as: Big data is a term used to describe data volumes that are too enormous to be stored, managed, accessed and analysed using traditional database methods. Large amounts of data, measured in terabytes rather than terabytes, are referred to as "big data" in the technical sense. The four features of big data, namely vast data size, quick data flow and dynamic data system, various data kinds, and tremendous data value, are used to create international data firms. For example, all data should not be sampled; efficiency should not be totally exact; and correlation should not cause and effect [3].

III. THE MEANING OF BIG DATA

Prediction is at the heart of big data. Google, for example, mines data on the most popular search keywords used by Americans each day. It is possible to anticipate flu outbreaks using a combination of 45 search phrases, and the correlation between prediction findings and official data is as high as 97%. Big data's worth has been fully realised in a variety of businesses, but it also has its own set of restrictions. For instance: However, big data can only answer "what," not "why." Big data can find megatrends and laws without disruptive innovation; it can give relevant services, but it cannot generate new demands. In order to create and use big data and to better our job, we need this. [4]

IV. THE MEANING OF BIG DATA

A. Electronize nursing documents

The primary goal of a nursing document is to carry out the doctor's orders so that the document may fulfil its intended function in patient care. It is possible to enhance the practicality of nursing papers by converting them to electronic form, allowing nurses to more easily inquire about them, reducing their real burden and increasing the efficiency of their job. Electronic papers are simple to use and meet a high degree of quality, ensuring that nursing reports are of the highest quality. As a result of the many benefits that electronic documents offer over paper papers for nurses, medical professionals and pharmacists, they are increasingly being used as a substitute for paper documents [5].

B. Optimize nursing information analysis

Systematic evaluation of patient care is another example of how big data and nursing may be used together. Nurses and information technology are becoming more intertwined as the medical system becomes more personalised and mobile. In order to meet the needs of patients with a large number of information analysis, it is difficult to meet the needs of patients with a large number of past information means; therefore, the application a large data can reduce nursing staff's workload of patient care information organising, and allow them to care for patients with information collecting, sorting, and categorising the different types of information.

C. Constructing mobile nursing information system

Providing medical treatment on the go would be impossible without the use of a portable nursing system. Mobile information technology allows nurses to constantly have a firm handle on the patient's nursing data, giving them better control over their patients. Using big data, healthcare providers may more efficiently and accurately transmit patient data from their computers to mobile devices. This active collaboration between computers and mobile devices will increase the efficiency and accuracy of healthcare delivery.

D. Help analyze nursing information needs

As technology progresses, so does the clinical medical system, making it more adaptable and individualised than it has ever been. Nurses' job is becoming more and more dependent on information technologies and patient demand for nurses' health care is growing. Clinical information exchange is becoming more necessary since it plays an increasingly significant role in the diagnosis and treatment of patients. New challenges have emerged in the design of nursing informatization as a result of the processing of patient health information. In the original information processing system, there was no analysis of nursing documentation, and the data components were summarised in an inadequate manner. Collection and organisation of nursing health information as well as administration and analysis of nursing health data are critical in the context of clinical big data. Hospital clinical informatization focuses on patient care health information, which encompasses patient health information management, mobile application technology, internet application technology, and clinical care information.

E. Helps make nursing documentation electronic, quick and easy

Traditional paper nursing documentation have the following disadvantages: As a first benefit, the improved electronic file is more succinct, clear and easy to search, which reduces duplication of effort in diagnosis and treatment, frees up labour and increases productivity. First and foremost, the establishment of multi-faceted and comprehensive criteria for nursing documentation, so as to guarantee that clinical nursing reports meet the highest quality requirements. It also aids in the creation of an optimal clinical documenting process. The doctor's order execution document is an essential part of the clinical diagnostic and treatment procedure that is documented in the nursing document. Closed-loop workflows for clinical diagnosis and treatment are the result of the combined efforts of nurses, physicians, pharmacists, and other medical professionals. The alternating use of nursing order and nursing intervention should be maintained throughout the real medical process to guarantee that nursing services are of high quality.

V. CONCLUSION

Use of big data technologies in medical care may assist health care providers in providing better treatment by improving service quality. There are several benefits that come from using large amounts of data to assist nurses make the best clinical medical care decisions. As a result, medical treatment is more productive and better quality care is provided. Even though each hospital department has its own IT system, using big data to integrate hospital internal unique differentiation systems and maintain overall unity while doing so is the most difficult task that big data faces, since each department has its own IT system. Big data's challenges must be handled in order to improve medical care with the growth of time and science and technology.

Acknowledgment

Conflicts of Interest: The authors declare no conflict of interest.

Funding: The authors receive no funding for this work

Ethical approval: This paper has not submitted to anywhere and published anywhere. It does not contain any studies with human participants or animals performed by any one of the authors

References

[1] He, P., Zhang, B., & Shen, S. (2022). Effects of Out-of-Hospital Continuous Nursing on Postoperative Breast Cancer Patients by Medical Big Data. Journal of Healthcare Engineering, 2022.

[2] Li, S., & Tang, Y. (2020). A Simple Framework of Smart Geriatric Nursing considering Health Big Data and User Profile. Computational and Mathematical Methods in Medicine, 2020.

[3] Zhu, R., Han, S., Su, Y., Zhang, C., Yu, Q., & Duan, Z. (2019). The application of big data and the development of nursing science: a discussion paper. International Journal of Nursing Sciences, 6(2), 229-234.

[4] Founds, S. (2018). Systems biology for nursing in the era of big data and precision health. Nursing Outlook, 66(3), 283-292.

[5] Kumar, P., & Chakraborty, S. (2022). Green service production and environmental performance in healthcare emergencies: role of big-data management and green HRM practices. The International Journal of Logistics Management.

[6] Wu, J., Wang, J., Nicholas, S., Maitland, E., & Fan, Q. (2020). Application of big data technology for COVID-19 prevention and control in China: Lessons and recommendations. Journal of medical Internet research, 22(10), e21980.

[7] Rehman, A., Naz, S., & Razzak, I.

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ISSN: 2457-0362

(2021). Leveraging big data analytics in healthcare enhancement: trends, challenges and opportunities. Multimedia Systems, 1-33.

[8] Rehman, A., Naz, S., & Razzak, I. (2021). Leveraging big data analytics in healthcare enhancement: trends, challenges and opportunities. Multimedia Systems, 1-33.

[9] Pashazadeh, A., & Navimipour, N. J. (2018). Big data handling mechanisms in the healthcare applications: a comprehensive and systematic literature review. Journal of biomedical informatics, 82, 47-62.

[10] Ghayvat, H., Pandya, S. N., Bhattacharya, P., Zuhair, M., Rashid, M., Hakak, S., & Dev, K. (2021). CP-BDHCA: Blockchain-based Confidentiality-Privacy preserving Big Data scheme for healthcare clouds and applications. IEEE Journal of Biomedical and Health Informatics.

ISSN:0975-3583,0976-2833 VOL12,ISSUE06,2021

PeayNotes: Content Management System- based Software for Managing Academic Electronic Health Records (AEHRs)

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Abstract - With dual-gain active pixels (APS) and column-parallel readout circuits to decrease the random noise, this article offers a CMOS FPXD. Using the conversion gain control in a sensor array, the proposed dual-gain APS can support both high and low FPXD sensitivity modes. Because of this, the in-pixel conversion gain adjustment increases signal-to-noise qualities. SS-ADCs and charge-summing circuits for pixel binning and analogue double delta sampling are among the column-parallel readout circuits (DDS). Gray-code counters with differing beginning values are used to decrease peak current and power variation in SS-ADCs, which have 12 bits of resolution. In addition, they use a high-resolution continuous-type ramp generator to decrease the space. With an area of 100 micrometres by 100 micrometres, the FPXD was created utilising the 0.18-micrometer process. With 0.43 micro V e- and 3.00 micro V e-, respectively, the conversion gains in high and low sensitivity modes are designed. A random noise of 366 micro V was observed at a resolution of 12 bits and a frame rate of 30 frames per second in high sensitivity mode and a noise of 400 micro V in low sensitivity mode. There is a 92% reduction in the size of the ramp generator, while the peak current of the gray-code counter is a 43% reduction.

Index Terms—CMOS X-ray detector, column-parallel readout, dual-gain pixel,medical X-ray imaging, single-slope analog-to-digital converter (SS-ADC).

I. Introduction

High resolution and high speed imaging applications including computed tomography, fluoroscopy, and mammograms have developed due to the extraordinary growth of image sensor and digital video processing technologies. When low noise, high resolution, and high speed are required, the flat-panel X-ray detector (FPXD) employing CMOS transistors is preferred over the TFTs made of amorphous silicon (a-Si).

Conventional FPXD has relied on a-Si TFT for large-substrate fabrication [3, 4]. Due to the dangling bond in the amorphous crystal phase, the FPXD based on a-Si TFTs exhibits significant noise and sluggish operating speed [1], [2]. As a result, more noise is generated owing to a lengthy signal route between the pixel and the off-chip readout integrated circuit, and the working speed of an A-Si FPXD is restricted by a significant time constant that is defined by the resistance of the TFT and capacitors of the data line and pixel.

In order to improve the SNR and operation speed, the CMOS FPXD was created utilising CMOS transistors made using single-crystalline silicon. There are fewer noise sources and better operating speeds with CMOS transistors because they have a greater electron mobility than a-Si TFT devices [5]–[9], making it possible to integrate active pixel sensors (APS) with readout circuits. However, the active area of CMOS FPXD is restricted by wafer size for

ISSN:0975-3583,0976-2833 VOL12,ISSUE06,2021

medical imaging applications that demand a large image capture area. A three-sided buttable FPXD has been designed to address the aforementioned issue by tiling numerous FPXDs onto a big panel [5]–[7].

Radiography/fluoroscopy equipment and interventional medical devices are becoming more popular as the CMOS FPXD technology advances fast [10].

For medical X-ray applications, varying quantities of X-ray energy and radiation dose must be accommodated in the multi-purpose FPXD [11], making it essential to incorporate multi-gain features. For example, low X-ray dosage applications like fluoroscopy need an FPXD with a high sensitivity, whereas high X-ray dose applications like radiography and mammography necessitate an FPXD with a low sensitivity. The readout circuit of a standard FPXD uses a multi-step gain to regulate the pixel output's sensitivity. Nevertheless, when the readout circuit increases the pixel output voltage, it also increases the pixel noise.

The in-pixel gain control circuit we provide in this study is a CMOS FPXD for several application scenarios. Dual-gain APS and column-parallel readout circuits are used in the CMOS FPXDs that are being developed. In order to offer pixels with dual-step conversion gain, the dual-gain APS modifies their capacitance. The suggested charge-summing circuits use pixel binning and analogue double delta sampling (DDS) algorithms to improve sensitivity and cancel out pixel noise.

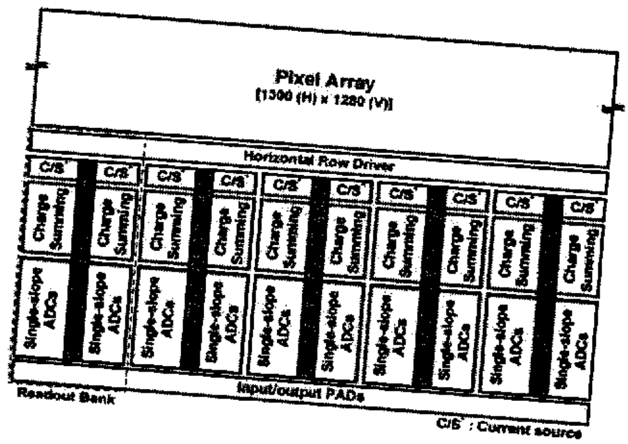


Figure. 1. Block diagram of CMOS FPXD.

This is why the readout circuits use single-slope ADCs (SS ADCs), which have a high degree of linearity and uniformity. For 12-bit SS-ADCs, we suggest a new driving approach including a gray-code counter and a methodology for continuous-type ramp generation to minimise simultaneous switching noise and ramp generator size.

This paper's second portion explains the design of the proposed CMOS FPXD readout circuits. Section III delves into the dual-gain APS pixel circuit in detail. Charge-summation circuit, gray-code counter and continuous ramp generator are all shown in Section IV's implementation of the CMOS FPXD in its full granularity. Comparing the experimental findings of the proposed FPXD to earlier investigations is done in Section V. Finally, in section VI, the conclusions are made.

II. Architecture Of CMOS Flat-Panel Detector

As can be seen in Figure 1, the block design for the CMOS FPXD is downsized to fit on a single wafer. The pixels are 100 micrometres by 100 micrometres. The single-wafer FPXD has a total active pixel area of 130mm (H)*128mm (V). There are five independent readout banks for the CMOS FPXD because the maximum photolithographic area in wafer manufacture and signal integrity of the FPXD are taken into consideration. It is made up of two rows of 260 column-parallel inputs, an external peripheral circuit, and a horizontal readout bank driver. Reference and bias circuits in peripheral circuits run the individual picture capture process.

ISSN:0975-3583,0976-2833 VOL12,ISSUE06,2021

In Fig. 2, a single readout bank is shown. Column-parallel readout includes a tail current source (I TALL), a charge-summing circuit, and an SS-ADC. A pixel is driven by the tail current sources (M SF). In order to improve sensitivity and frame rate, the charge-summing circuits conduct analogue DDS and 2*2 pixel binning. Charge-summing circuit output voltage is quantized by the SS-ADC, which comprises of gray-code counter, memory, and column multiplexer.

It includes a reference buffer, bias circuit, bandgap reference, timing circuit, sensing amplifier and a ramp generator for column-parallel readout circuits. It is the peripheral circuit's ramp generator that creates the SS-ADC operation's ramp signal. Pixel array reset and selection actions are controlled by horizontal row driver.

Figure 1 depicts the column-parallel readout circuits in bilateral symmetry with regard to the readout bank's peripheral circuit, which is placed in the bank's centre. Fig. 2 shows how the column readout arrays have a column pitch of 97.5 micro m, which is less than the pixel pitch of 100 micro m, in order to allow for placement of the peripheral circuit between the arrays. The horizontal row driver and the readout circuit produce a three-sided buttable CMOS FPXD in the horizontal direction.

III. Pixel Design

As seen in FIG. 2, the proposed dual-gain pixel is made up of four transistors, an LED, and an external capacitor. The photodiode contains three control signals, RX, SX, and CG, which regulate the photodiode's reset, select, and conversion gain. Photodiode capacitance at the photodiode node (PD) influences the proposed pixel circuits' sensitivity, which is defined by conversion gain (G). G PD is an abbreviation for the pixel's conversion gain.

$$G_{PD} = \frac{q}{C_{PD}} \times G_{SF}, \qquad (1)$$

C PD is the capacitance at the node of PD with respect to the ground, and G SF is the gain of the source follower in the pixel [5]. It is used to alter C PD and to create the in-pixel dual-gain feature for multipurpose FPXD using M CG's control signal (CG) During the low sensitivity mode, M CG is activated, C PD is enhanced, and the pixel circuit's sensitivity is reduced.

In the high sensitivity mode, M CG is disabled and C PD is reduced, which increases the sensitivity of the device.

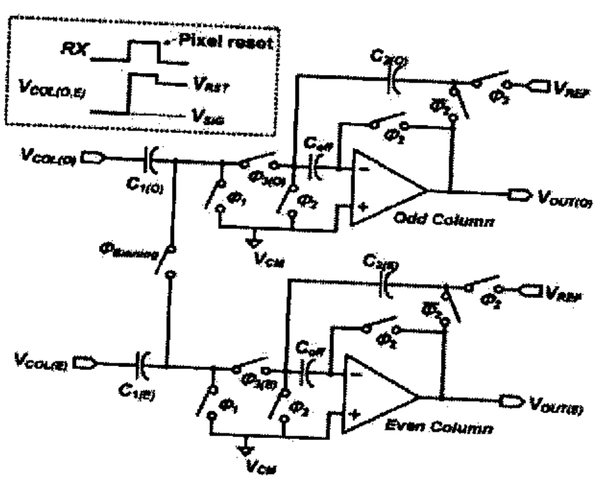


Figure. 3. Schematic diagram of charge-summing circuits for two channels.

The needed full well capacity for medical X-ray imaging applications dictates the photodiode and extra capacitor capacitances. Low-dose fluoroscopy has a sensitivity four to eight times greater than high-dose imaging applications like radiography [11]. The pixel capacitance () of 318 fF and 45 fF are used to construct the in-pixel gains of and. In

ISSN:0975-3583,0976-2833 VOL12,ISSUE06,2021

the low and high sensitivity modes, the conversion gains () are calculated by (1) using the source follower gain () of V/V. A 45-fF photodiode and a 273-fF extra capacitor for conversion gain control were thus used in the design.

IV. Implementations Of Readout Circuit

A Charge-summing Circuit

A charge-summing circuit that conducts pixel binning and analogue DDS operations is shown in Figs. 3 and 4 of this paper. It contains an input terminal (V COL(E) or V COL(O) linked to pixel outputs, four control signals (Φ 1, Φ 2, Φ 3, etc.), and two reference voltages (V CM and V REF) for the charge-summing circuit. As seen in Fig. 4, the analogue DDS is controlled by Φ 1, Φ 2,Φ 3, which selects the number of pixels to be binned. The analogue DDS operation is split into two sequences in full resolution mode.

An offset cancellation is conducted for the amplifier using C1 and C2 when Φ 1 and Φ 2 are both high. The signal voltage (V SIG) of the pixel at (V COL(E,O) is sampled in C1. V COL(E,O) is set to the reset voltage (V RST) after the RX reset operation of the pixel. The charge-summing circuit's output voltage (V OUT) is provided by when Φ 1and Φ_2 are low and Φ_3 is high.

$$V_{OUT} = -\frac{C_1}{C_2} \times (V_{RST} - V_{SIG}) + V_{REF}, \qquad (2)$$

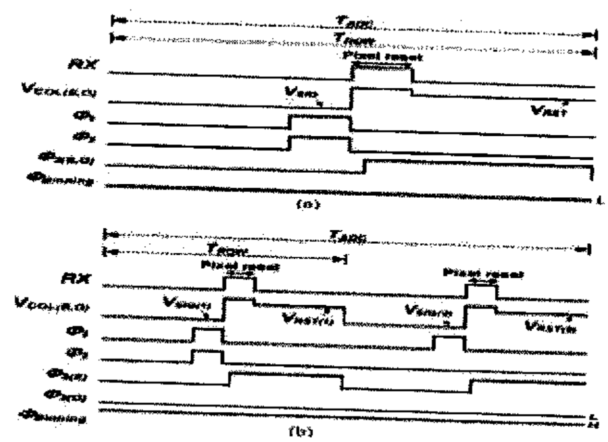
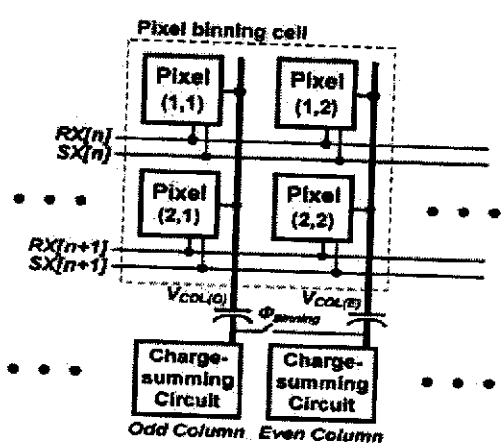


Figure. 4. Timing diagram of charge-summing circuits in (a) full resolution mode and (b) pixel binning mode.



ISSN:0975-3583,0976-2833 VOL12,ISSUE06,2021

Figure. 5. Block diagram of a pixel binning cell.

where Vref is the charge-summing circuit's reference voltage. Data is quantized from analogue to digital in every row line time (Trow), which is exactly identical to the ADC's conversion time (TADC).

FIG. 5 shows an example of pixel binning using the neighbouring 2*2 pixels charged summarily. The binning signal (Binning) improves both the sensitivity and the frame rate. There are only even charge-summation circuits in the 2*2 method of pixel binning C1 (O) and C1 (E).

There are even and odd column voltage charges (V COL (E) and V COL (O), and the odd charge-summing circuits are put to power down mode to decrease power usage.

The 2*2 pixel binning time diagram is shown in Figure 4(b). This initialization and offset cancellation of the amplifier is carried out when 1 and 2, respectively, are high. The even and odd column signal voltages (V SIG (1)) of each pixel are sampled in C1 and C1 accordingly. Reset voltages (V RST (1)) are used to transfer the sampled charges from C1 (E) and C1 (O) to C2 (E) once a pixel has been reset by RX. To prevent charge transfer into odd circuits, the odd circuits remain in an off state. The even and odd column signal voltages (V SIG (2)) of pixels are captured by C1 (E) and C1 (O) in the charge summing operation for the second row line time without the activation of C2 (E) by1. It is only when the pixel output voltage has been adjusted to the reset voltage that 1 goes low and 3 goes high, and the charges from C1 (E) and C1 (O) are also added to the C2 (E) charge. Finally, the charge-summing circuit's output voltage (V OUT) is stated as

$$V_{OUT} = -\frac{C_1}{C_2} \times [(V_{RST(1,1)} + V_{RST(1,2)} + V_{RST(2,1)} + V_{RST(2,2)}) - (V_{SIG(1,1)} + V_{SIG(1,2)} + V_{SIG(2,1)} + V_{SIG(2,2)})] + V_{REF}, \quad (3)$$

B *Gray-code Counter*

Ramp signals are counted by SS-ADC counters until they reach the SS-input ADC's voltage. Every bit transition at every clock triggers the counting process.

Furthermore, changing the most significant bit (MSB) causes the binary counter to update all of its bits, resulting in the highest possible peak current. Due to the high peak current generated by bit transitions in all column counters in a column-parallel readout device, power fluctuations are inevitable when using this kind of readout arrangement. To provide a consistent power supply throughout all readout circuits, a reduction in peak current is critical in the CMOS FPXD readout circuits, which have a width of 2.6 cm.

The CMOS FPXD uses a gray-code counter to reduce peak current [12]. A single clock cycle is all it takes for a bit to change in a gray-code counter. Even and odd counters in columnparallel readout arrays with varying beginning values of "0" or "1" were suggested to minimise power fluctuation difficulties. A 4-bit gray-code counter using the suggested driving technique from two columns is seen in Fig. 6 (shown). It is because the two neighbouring column counters have different beginning values that each half of a bit stream travels in the opposite direction. Peak current and power fluctuation are reduced because the bit transitions in the opposite direction are balanced out.

With and without distinct beginning values, the peak currents of a binary and a gray-code counter, respectively, are shown in Fig. 7 to be 7.18 and 4.49 milliamps, respectively. The peak current of the gray-code counter was lowered by 43% when compared to the binary counter while using various beginning settings. Binary and gray-code counters use an average of W and W, according to the simulation findings. When compared to a binary counter, the gray-code counter uses more power and has more logic gates required for gray-coding. For SS-ADCs, gray-code counters are employed because the peak current is believed to be more significant than the average power consumption in order to avoid power fluctuation in the digital circuit.

ISSN:0975-3583,0976-2833 VOL12,ISSUE06,2021

C *Continuous-type Ramp Generator*

It is common practise in imaging applications to employ the current steering digital-to-analog converter (DAC) type ramp generator to create the ramp signal for SS-ADC input voltage comparisons [13]. However, to create SS-ADCs with a resolution of 12 bits, a DAC-type ramp generator is required. As an example, the 4096 unit cell 12-bit DAC-type ramp generator takes at least 0.75 Sq mm of space [14]. It takes 0.06 square millimetres to build the suggested continuous-type ramp generator (Fig. 8(a)), which includes five transistors, four switches, two capacitors, and one operational transconductance amplifier (OTA). The suggested continuous ramp generator also reduces power usage. While the current steering DAC consumes 15 to 50 mA [15], the suggested ramp generator only consumes 5 and 85 micro A for output load and peripheral control circuit, respectively.

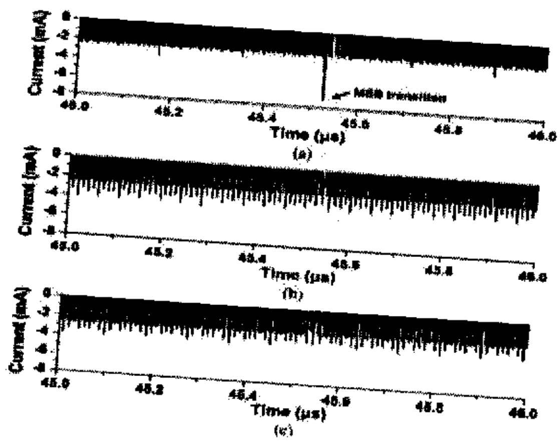


Figure. 7. Simulation results of peak current from two column counters; using (a) binary counter and gray-code counter (b)without and (c) with different initial values.

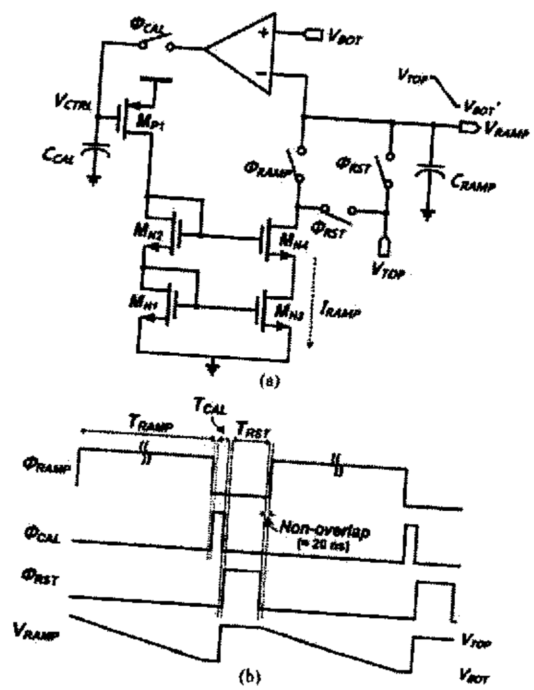


Figure. 8. (a) Schematic and (b) timing diagrams of the proposed continuous-type ramp generator.

ISSN:0975-3583,0976-2833 VOL12,ISSUE06,2021

As may be seen in Fig. 8, a timing diagram for a continuous ramp generator (b). It takes 4096 clock cycles for a 12-bit SS-ADC 12-bit SS-ADC to ramp from a high voltage (V TOP) to a low level (V BOT) during the ramp phase (T RAMP). As an example, V RAMP is written out as

$$V_{RAMP} = V_{TOP} - \frac{I_{RAMP}}{C_{RAMP} + C_{LOAD}} \cdot T_{RAMP}, \qquad (4)$$

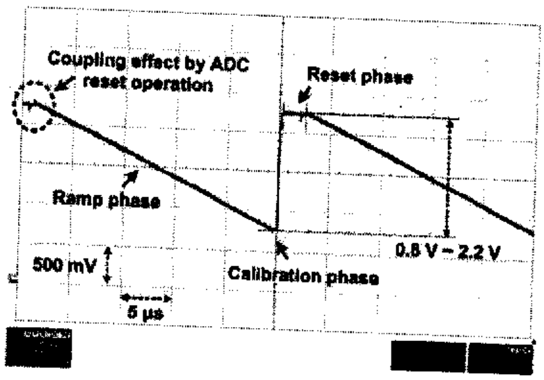


Figure. 9. Measured ramp signal from 2.2 V to 0.8 V at 30 fps.

The output capacitance, the load capacitance, and the load capacitance of the ramp generator are all specified by,, and correspondingly. Fig. 8(a) shows that the, which is generated by process variation, should be able to sustain the broad range of current driving capabilities. The OTA, capacitor, and current source are used in a negative feedback system to calibrate the current bottom voltage () to the target bottom voltage (). It is the difference between and that determines the output voltage of the OTA, and this voltage is then incorporated into the calibration capacitor ( ). It is possible to change the control voltage () from to by a voltage difference of. What determines how stable the feedback system is is decided by how large and how long it takes to complete. Single-stage amplifiers of 20 pF and an external timing system are utilised to ensure the stability of the ramp generator.

After that, the ramp generator's functioning returns to the ramp phase after being reset to in the reset phase. The ADC reset process should continue until the coupling noise is no longer present.

Using a 12-bit resolution, it is possible to measure a time-to-time fluctuation of 0.25 least significant bits (LSB) at the V bottom voltage. There is a gain error in SS-ADC, which is caused by the fluctuation in the calibration procedure. Fig. 9 shows the results of a 30-fps ramp measurement of the ramp signal between 2.2 and 0.8 volts.

Using 12-bit resolution and a frame rate of 30 frames per second, we can measure an inaccuracy of the ramp generator of 0.69 LSB.

V. Experimental Results

FIG. 10 depicts an image of an integrated CMOS FPXD wafer made using a - m 1-poly 4-metal CMOS process with an integrated pixel photodiode that was buried in the substrate. Its active area is 130 mm wide by 128 mm high. It has an image sensor that measures pixels in millimetres rather than millimetres. At 180 MHz and 30 frames per second for the readout circuits, there are five banks including 260 readout channels and peripheral circuits.

ISSN:0975-3583,0976-2833 VOL12,ISSUE06,2021

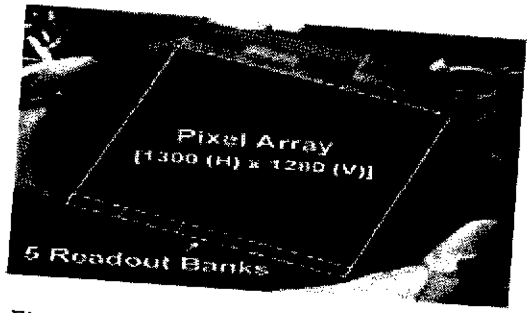


Figure. 10. Photograph of CMOS FPXD wafer

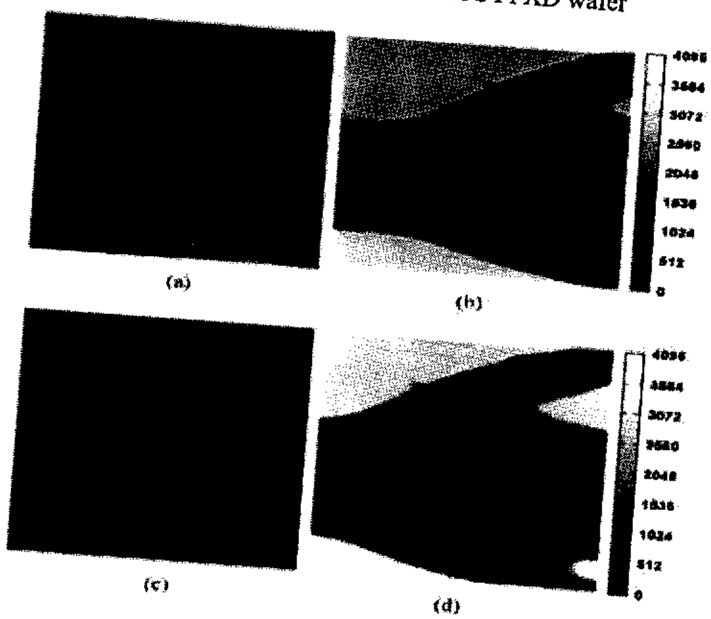


Figure. 11. (a), (c) Captured raw images and (b), (d) processed images of CMOS FPXD with output data from 0 to 4095, frame rate of 30 fps, tube voltage of 50 kV, and tube current of 2.0 mA. (a) and (b) are the images of the high sensitivity mode, while (c) and (d) are the images of the low sensitivity mode.

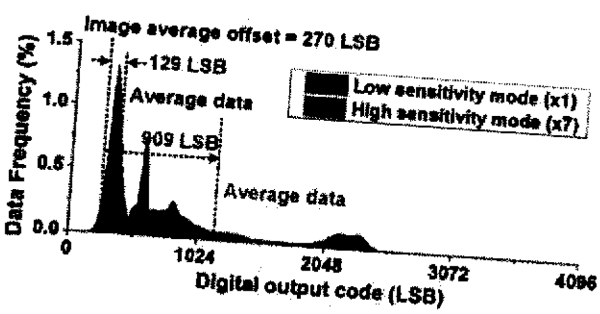


Figure. 12. Histogram of Fig. 11(a) and (c) at low and high sensitivity mode, respectively.

ISSN:0975-3583,0976-2833 VOL12,ISSUE06,2021

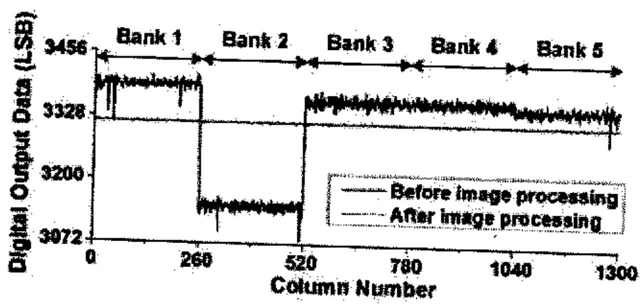


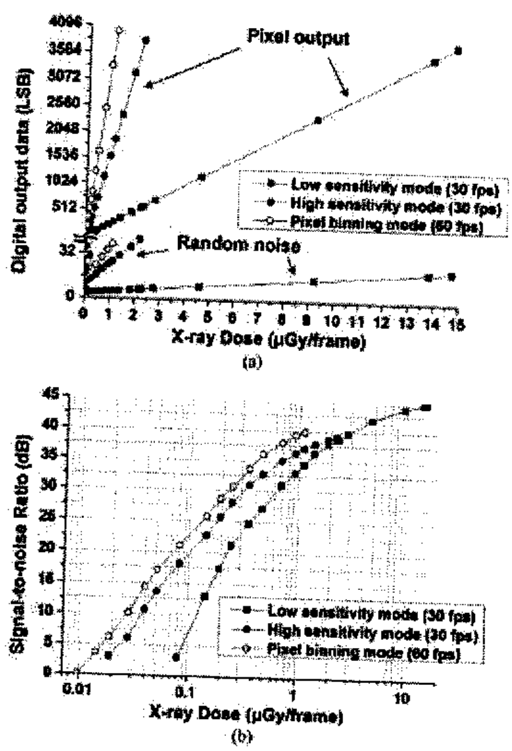
Figure. 13. Output data in the direction of column before and after image Processing

Using 30 successive pictures, random noise, fixed pattern noise (FPN), and signal-to-noise ratio (SNR) are analysed. The CMOS FPXD's signal output and random noise are represented by the pictures' average and standard deviation. The average picture is used to derive the bank-to-bank variance and the column FPN.

The picture outputs of the high and low sensitivity modes are compared to validate the performance of the dual-gain pixel. Figure 12 displays the histograms from Figures 11(a) and (c). For high and low-sensitivity modes, the average data, excluding the average offset data of 270 LSD, is 909 LSD and 129 LSD, respectively.

We can determine the average offset value by adding together 30 consecutive dark state frames' worth of pixel data and averaging them all together. The pixels' conversion gain is 7.0, the ratio between the average data from high and low sensitivity modes. High and low sensitivity mode pixel random noises are 1.17 LSB (V) and 1.07 LSB (V), respectively, derived from output pictures. In order to determine the noise level, the standard deviations of many photographs are averaged together.

According to Fig. 13, we can see how column variation changes before and after image processing. At 12-bit resolution, the greatest picture variance is decreased from 246.3 LSB to 1.9 LSB after image processing. Readout bank columns are 7.96 LSB and 0.59 LSB before and after image processing, respectively.



ISSN:0975-3583,0976-2833 VOL12,ISSUE06,2021

Figure. 14. (a) Pixel output data, random noise, and (b) calculated SNR of CMOS FPXD with respect to X-ray dose per frame.

VI. Conclusions

SS-ADC-integrated readout circuits have been suggested. The proposed CMOS FPXD uses dual-gain APSs with an in-pixel conversion gain control circuit for medical imaging applications that do not increase noise levels. It is possible to use the dual-gain APS with noise levels of 1.78 and 1.07 LSB in high and low sensitivity modes, respectively. For real-time and high-resolution X-ray imaging, the proposed FPXD employs column-parallel readout circuits with the charge-summing circuit, the area-efficient ramp generator, and peak current reduction approaches including a gray-code counter. Analog DDS and pixel binning are provided by the charge-summing circuit.

Conventional structures take up 92 percent more space and 43 percent more power, respectively, compared to the gray-code counter's ramp generator. It is hence appropriate for real-time, high-resolution, and low-noise X-ray imaging applications.

Acknowledgment

Conflicts of Interest: The authors declare no conflict of interest.

Funding: The authors receive no funding for this work

Ethical approval: This paper has not submitted to anywhere and published anywhere. It does not contain any studies with human participants or animals performed by any one of the authors

References

[1] Lee, S., Jeong, J., Kim, T., Park, C., Kim, T., & Chae, Y. (2020). A 5.2-Mpixel 88.4-dB DR 12-in CMOS x-ray detector with 16-bit column-parallel continuous-time incremental ΔΣ ADCs. IEEE Journal of Solid-State Circuits, 55(11), 2878-2888.

[2] Lee, S., Jeong, J., Kim, T., Park, C., Kim, T., & Chae, Y. (2020, February). 28.3 A 5.2 Mpixel 88.4 dB-DR 12in CMOS X-Ray Detector with 16b Column-Parallel Continuous-Time ΔΣ ADCs. In 2020 IEEE International Solid-State Circuits Conference-(ISSCC) (pp. 434-436). IEEE.

[3] Wang, M., Qin, R., Wang, J., Zhang, X., Gu, Z., Li, B., & Yuan, X. (2021). A serial-timing multi-channel CMOS charge readout ASIC for X-ray detectors. IEICE Electronics Express, 18(16), 20210224-20210224.

[4] Hu, D., Bai, X., Wang, C., Zhang, Z., Li, X., Zhang, G., ... & Chen, J. (2022). Pixelated Vacuum Flat Panel Detector Using ZnS Photoconductor and ZnO Nanowires Cold Cathode. Nanomaterials, 12(5), 884.

[5] Bai, X., Zhang, Z., Chen, M., Wang, K., She, J., Deng, S., & Chen, J. (2021). Theoretical analysis and verification of electron-bombardment-induced photoconductivity in vacuum flat-panel detectors. Journal of Lightwave Technology, 39(8), 2618-2624.

[6] Jo, Y. R., Hong, S. K., & Kwon, O. K. (2016). A tileable CMOS X-ray line detector using time-delay-integration with pseudomultisampling for large-sized dental X-ray imaging systems. IEEE Transactions on Electron Devices, 64(1), 211-216.

[7] Ma, C., Liu, Y., Li, Y., Zhou, Q., Wang, X., & Chang, Y. (2017). A 4-M pixel high dynamic range, low-noise CMOS Image sensor with low-power counting ADC. IEEE Transactions on Electron Devices, 64(8), 3199-3205.

[8] Jung, S. J., Hong, S. K., & Kwon, O. K. (2016). A readout IC using two-step fastest signal identification for compact data acquisition of PET systems. Sensors, 16(10), 1748.