INJ INTERNATIONAL NEUROUROLOGY JOURNAL

Exploring the Clinical Effectiveness and Application of "Bedriod" System for Neurologically Impaired Patients with Limited Body Movement by Enhancing Independence and Quality of Life

King-Pong Yu[1] *, Kim-Ming Tsoi[1] , Ka-Leung Chan[1], Man-Hok Shum[1] , Riggs Ng[1] , Yuk-Chu Chan1, Tsz-Yan Yeung[1]

[1]Community Rehabilitation Service Support Center, Hospital Authority, Hong Kong

*Correspondence Author: King-Pong Yu, Assistant Manager/Technology, Community Rehabilitation Service Support Center (CRSSC) , Hospital Authority, Hong Kong .

Orchid ID: 0009-0002-7554-5737

Abstract

Background: Numerous individuals with disabilities, particularly those with neurologically impaired conditions, heavily rely on caregivers for their daily activities. Due to limited functional mobility, these individuals face challenges in controlling their posture while in bed, necessitating frequent assistance from caregivers. Purpose: The purpose of this study is to introduce an innovative remote-control adaptation named "Bedriod," developed by rehabilitation engineers at The Hospital Authority Community Rehabilitation Service Support Center (CRSSC). This adaptation aims to enhance the daily living experiences of individuals with disabilities by restoring their sense of hope and autonomy. Methods: The "Bedriod" device consists of a 3D-printed holder affixed to the electric bed remote. Embedded within the holder is a microcontroller unit responsible for controlling a motor attached to the holder. This configuration enables tele-operation of the electric bed's movement based on the patient's verbal commands using commercially available voice assistant embedded in smart device. Results: A total of six subjects were recruited for this study, and the therapist reported a 100% success rate. Prior to using the "Bedriod," patients had to rely on caregiver assistance. However, with the implementation of the device, patients achieved independent adjustment of their posture. Conclusion: The introduction of the "Bedriod" device has provided patients with the ability to independently adjust their bed posture. The feedback received thus far has been encouraging, demonstrating increased patient confidence in utilizing the device.

Key-words: "Bedriod" System, Controlling method, Diversity of usage.

Introduction

Background

Electric bed is one of most common devices for in-home rehabilitation needs, which allows patients to be tilted and lifted by powered motors. Patients experiencing muscle weakness rely on electric bed to carry out activities of daily living (ADL) such as eating, watching TV and wheelchair transfer, because of the difficulty in controlling core muscles of the trunk. According to social data collected by Census and Statistic Department, HKSAR in 2020, about 189,700 household residential persons with disability (1.82% of total population) in Hong Kong are reported with restriction in body movement [1].

Over the past few years, numerous training aids have emerged with the primary objective of assisting patients afflicted with various disabilities, such as stroke [2], spinal cord injuries [3], poliomyelitis [4], in the restoration of their motor function. However, none of these aids have demonstrated efficacy in aiding individuals diagnosed with disabilities that are irreversible. For patients with severe disability of motor, such as Motor Neurons Disease (MND) and complete spinal cord injury, caregivers are usually required for taking care of the majority of ADL of patients. Therefore, Electric beds provide effective assistance to caregivers to reduce cost of caring and improve the caring quality.

However, the right of controlling Electric beds is in operators (caregivers) instead of users (patients) [5]. Patients often have to ask caregivers to help them sitting upright or lying down each time, while caregivers may not respond to every request. Additionally, patients of severe disability, such as MND and high-level spinal cord injury, lose their ability of finger movement, which makes it difficult to press buttons of electric bed according to their will and trigger emotional distress [6][7]. Meanwhile, there is a possibility of caregivers feeling stressed due to the high frequency of requests and afraid of missing requests from patients [8].

Recent studies show that there are alternatives for patients with restricted body movement to control electric nursing beds, such as eye tracking [9], electroencephalography (EEG) [10] and electromyography [11]. However, the sustainability of those systems are limited since those approaches require computers for signal processing and analysis. The cost of materials and experts for software and hardware maintenance would be high. Additionally, the residential area of patients may be insufficient to place computing devices near the nursing bed. Also, patients are required to receive training to operate those alternative control systems, which could be an additional stress in both physical and mental to people with disability while most of ADL are burdens to them, although those tasks are usual to healthy people.

Therefore, in this study, we propose the implementation of an Electric bed adaptation to assist patients operating electric beds by voice assistance in smart devices. An external device was developed to press buttons of remote control linked with electric bed. The device connects to domestic Wi-Fi network to receive requests from smart devices in form of web requests, and then fires electronic signals to actuator mounted on remote control to press buttons. Patients are required to speak commands, customized by patients and pre-set before use, to voice assistance for sending web requests to the device.

The device aims to support in-home rehabilitation by providing autonomy on operating Electric beds, which can increase independence and self-esteem of patients. On the other hand, it is also beneficial to caregivers since they need not offer too much attention on adjusting electric bed, which can reduce stress and conflicts during caring service [12]. In addition, regaining ability of control can further engage patients' attention on involvement in the rehabilitation process with healthy psychological conditions.

Related Work

Previous studies have proposed smart beds and voice-controlled home automation systems to increase the level of independence of patients with limited mobility. These studies have shown the benefits of such beds in improving patient care and reducing nursing workload, but argued that most existing systems are complex and expensive. Therefore, the researchers focused on designing the whole electric bed in low cost using computer-based speech recognition software or embedded voice recognition modules [13][14][15].

In these studies, voice-controlled smart bed systems for the physically-challenged people were designed. These systems mainly consist of a voice recognition module (Elechouse v3), Arduino microcontroller, relay circuit and an adjustable bed with motor driver or linear actuator [13][14][15]. The voice recognition module has to be trained first with voice commands before it can be used to recognize commands. However, the accuracy of voice recognition is subject to variation due to background noise, weak voices and non-constant pronunciations. These factors can hinder the system's ability to accurately interpret and understand spoken commands. Another limitation of voice recognition technology is the capacity to store and recognize only a limited number of voice commands. The system's capabilities are restricted by the finite amount of data it can effectively process and store. As a result, users may encounter restrictions in the range of commands that can be given and recognized by the voice recognition system.

Design

"Bedriod" System

The "Bedroid" system consists of four major components: (1) a commercially available voice assistant integrated into a smart device, (2) microcontroller units (MCUs), (3) a metal geared servo motor, and (4) customized 3D-printed items shown in figure1. The MCUs are pre-programmed and serve the purpose of receiving and interpreting signals transmitted by the voice assistant following verbal commands. This functionality enables the MCUs to govern the angular positioning of the servo motor, thereby effectuating the pressing of buttons on the electric bed remote controller. The programmability of the MCUs facilitates customization based on individual users' specific requirements, allowing for tailoring of button-pressing duration and the voice command triggering mechanism. Moreover, the 3D-printed items are designed to be customized, ensuring an optimal fit for the particular model of the electric bed, thus ensuring seamless integration and optimal performance.

The Bedroid is customized for users and tailored with the aid of an occupational therapist. Based on the individual's particular conditions, requirements, and functional objectives, the occupational therapist can make use of rehabilitation therapy concepts to help determine the ideal setting combination for appropriate functions. The occupational therapist can also assess the usage of the device and provide comments regarding the performance and functions of the device to make it more user-friendly and intuitive. The design team receives this information and adapts it for the development and implementation of a solution for the user or to improve the design of the system as a whole.

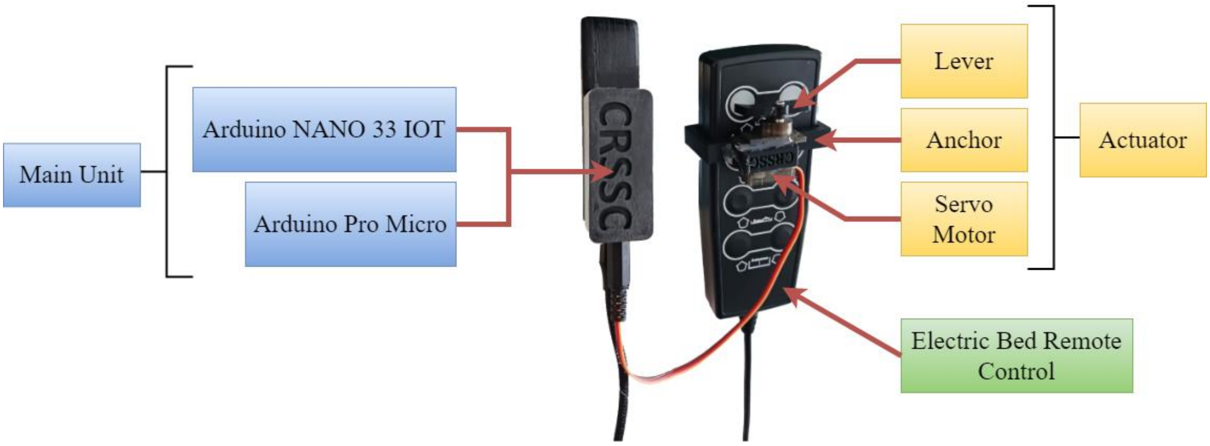

Figure 1. Integrated Bedroid System on electric bed remote control showing major components. Bedroid consists of Main Unit (*left*) and Actuator (*right*). The Main Unit includes electronic devices for sending and receiving signals, while the Actuator includes servo motor for pressing button.

Controlling method

The Bedroid device facilitates control over the electric bed's movements through the utilization of the following components as shown in figure2: (1) Voice recognition component: Activation of the Bedroid occurs through voice commands, employing a commercially available voice assistant integrated into a smart device. The voice assistant can recognize specific verbal commands, such as "tilting up" or "tilting down," spoken by the user. Once the command is recognized, the corresponding automation script created by rehabilitation engineer will be executed and the related web request will be sent. (2) Microcontroller Units (MCUs) component: Supported by the NINA-W102-00B Wifi/BLE module, the Bedroid's MCUs (Arduino Nano 33 IOT and Arduino Micro) establishes a local web server, which is available for receiving web request from the voice assistant. Upon receiving a web command, the MCUs are triggered and interpret the information within the command to execute pre-programmed actions, thereby controlling the angular position of the actuator. (3) Motor component: The Bedroid incorporates a metal geared servo motor (TowerPro MG90S servo) with a stall torque of 1.8kgf·cm as the actuator for manipulating the electric bed remote. The motor receives commands dispatched by the MCUs and performs different actions by adjusting its angular position accordingly. (4) 3D printed components: Customized 3D printed items, including a remote mount, a lever, and a casing, play integral roles in the Bedroid's functionality. Each item is designed using Computer-Aided Design (CAD) software and then fabricated using a Fused Deposition Modeling (FDM) machine (Snapmaker 2.0 A350T) with 1.75mm Polylactic Acid (PLA) filament (eSUN PLA+). The remote mount serves as a secure fixture for attaching the servo motor, while the button-pressing lever acts as a mechanical extension of the servo lever, converting rotary force from the servo motor into linear force exerted onto the button. The lever's geometry is mathematically optimized to ensure effective force application at the center of the button. When the servo motor reaches the target position, the lever triggers the buttons accordingly. Lastly, the casing functions as a protective enclosure, housing and organizing the electronic components of the Bedroid.

INJ INTERNATIONAL NEUROUROLOGY JOURNAL

Figure 2. Working Mechanism of Bedriod System. Patient speaks the preset voice command to smart device, and the smart device recognizes the command and activates the built-in voice assistance function. Smart device sends the corresponding web request to Bedroid system via the local Wi-Fi environment. The Bedroid system then fires electronic signal to servo motor for pressing the corresponding button on eclectic bed remote control.

Method

Subject

This pilot study aimed to evaluate the feasibility and performance of the Bedriod system in altering the position of patients with physical disabilities using voice commands and providing instant feedback on elevation and depression. The study participants were recruited from the The Hospital Authority Community Rehabilitation Service Support Center (CRSSC). These individuals exhibited various degrees of motor impairment in their extremities, resulting in inability to manipulate the bed's remote control, but were capable of speaking simply command in their mother language.

Intervention

To ensure the suitability of the home environment for utilizing the Bedriod system, the intervention included two home visit sessions summarized in table1. During the first session, a rehabilitation engineer and an occupational therapist conducted a comprehensive site inspection of the subject's home. This evaluation encompassed an assessment of the physical layout and arrangement of the home environment. Factors such as accessibility, space availability, and potential obstacles were taken into account to determine the feasibility of integrating the Bedriod system into the existing living space. Additionally, the home visit involved an assessment of the wireless communication signals within the subject's residence. This assessment aimed to verify the adequacy of the signal strength and connectivity required for seamless communication between the Bedriod system and the control interface. Any signal interference or connectivity issues were identified and addressed to ensure the smooth functioning of the system. Furthermore, the measurement of the electric remote control was conducted during this initial home visit shown in figure3. The measurement allowed the rehabilitation engineer to confirm the compatibility of the Bedriod system with the subject's existing bed and remote control mechanism, to ensure the necessary adjustments and installations could be made to facilitate the integration of the Bedriod system. Lastly, a physical examination of the subject was performed to assess their physical abilities and limitations. This examination aimed to ensure that the subject possessed the necessary physical capabilities to effectively interact with the Bedriod system using voice commands or virtual button. It also served to identify any specific considerations or adaptations that needed to be made to accommodate the individual's unique needs and motor impairments.

By conducting a thorough assessment of the subject's home environment, wireless communication signals, electric remote control compatibility, and the subject's physical capabilities, these procedures aimed to establish the feasibility and appropriateness of implementing the Bedriod system for individuals with physical disabilities.

During the second session, the rehabilitation engineer firstly installed the Bedriod system hardware components onto the electric bed, ensuring proper integration and functionality of the system within the existing bed structure. Simultaneously, the rehabilitation engineer collaborated with the subject to create a shortcut of automation script on their smart device, such as a smartphone, tablet, or computer. This automation script served as an interface through which the subject could easily interact with the Bedriod system, enabling efficient

DOI: 10.5123/inj.2023.4.inj7
ISSN:2093-4777 | E-ISSN:2093-6931
Vol. 27 Iss. 4 (2023)

control and adjustment of the bed's position using voice commands. While the rehabilitation engineer focused on the hardware installation and establishing the communication interface, the occupational therapist provided comprehensive instructions to subject on utilizing voice commands effectively to control the bed's position and trigger the desired movements. This guidance involved educating the subject on the proper articulation of voice commands and ensuring that they were comfortable and confident in operating the system independently. To assess the effectiveness of the Bedriod system and evaluate its compatibility with the subject's needs, Goal Attainment Scale(GAS) were applied in this study as a method of evaluating the effectiveness of Bedriod, which involves goal setting procedures and assessment techniques that are practice-based and practitioner-oriented [16], in order to quantify the system's effectiveness in meeting the subject's needs and identify any areas for improvement or further customization. The collaborative workflow between the rehabilitation engineer and the occupational therapist during the second session encompassed the installation of hardware components, establishment of a communication interface, instruction on operating the Bedriod system, and evaluation of goal attainment. This comprehensive approach ensured the successful implementation and optimization of the Bedriod system, aligning it with the subject's unique requirements and enhancing their ability to independently control their bed's position and improve their overall comfort and well-being.

Stage of Intervention	Rehabilitation Engineer	Occupational Therapist
Home Visit Session 1	Conduct site inspection of subject's home Measure compatibility with existing bed and remote control	Provide input on feasibility of integration Evaluate subject's physical abilities and limitations
Home Visit Session 2	Install Bedriod system hardware on electric bed Establish communication interface with smart device Ensure proper integration and functionality Collaborate with occupational therapist on system optimization	Instruct subject on using voice commands effectively Ensure subject's comfort and confidence in operating the system Evaluate system effectiveness using Goal Attainment Scale Collaborate with rehabilitation engineer on system installation
Implementation and Optimization	Focus on hardware installation and communication interface Work with occupational therapist to customize system Enhance subject's ability to control bed independently	Provide comprehensive instructions on system operation Collaborate with rehabilitation engineer on customization Assess subject's goal attainment and identify areas for improvement

Table 1. An overview of the roles and responsibilities undertaken by the rehabilitation engineer and occupational therapist throughout the course of the intervention.

Figure 3. Rehabilitation engineer engaged in the process of measuring the dimensions of an electric bed remote control.

Result

Total six participants were included in this study from 2018 to 2020. The demographic characteristics of these individuals are outlined in Table2. All subjects demonstrated a remarkable ability to independently and safely operate the Bedriod system, without relying on the assistance of caregivers. This achievement reflects a significant milestone towards their goal of attaining independence in managing their bed positions and overall comfort. Table3 presents the results of the Goal Attainment Scale (GAS) scores, which measure the participants' progress in achieving their goals. Encouragingly, all subjects successfully attained their targeted objectives, marking a noteworthy accomplishment. These results underscore the effectiveness of the Bedriod system in empowering individuals with physical disabilities to regain control over their bed positioning, thereby enhancing their independence and overall quality of life.

The significance of the observed improvements cannot be overstated. By successfully achieving their goals through the utilization of the Bedriod system, the participants experienced a tangible enhancement in their ability to manage their physical environment autonomously. This outcome is particularly meaningful and signifies the restoration of a sense of agency and self-reliance for individuals who had previously relied on the assistance of others to perform basic bed adjustments.

Subject	Diagnosis	Age	Gender
A	Stroke cerebellum	46	M
B	Motor-neuron disease	50	M
C	Anterior horn cell disease	56	M
D	Cervical spondylosis with myelopathy	37	M
E	Muscular dystrophy (fasciocapulohumeral)	47	M
F	Motor-neuron disease	47	F

Table2. Demographic characteristic of recruited subjects

Subject	Baseline Score	Achieved Score	Score change
A	30	60	30
B	30	70	40
C	30	70	40
D	30	70	40
E	30	70	40
F	30	40	10

Table3. Goal Attainment Scale of recruited subjects

Conclusion and Discussion

The current study is one of the first trial gives a brief idea on development and implementation of the voice-controlled rehabilitation bed remote control system that investigate the clinical effects of the device for patients with physicals disabilities. This innovative device has demonstrated a profound impact on patients with varying disabilities that involve motor impairment, notably Motor Neuron Disease (MND), spinal cord injuries(SCI), and severe stroke survivors. The system ensures a significant measure of independence, mitigating the constant need for caregiver or family assistance, thereby enhancing the patient's quality of life. The device enhances patients' ability to engage in activities of daily living, such as eating, reading, and watching television, without the need for constant assistance. One of the most salient features of the device is the effectiveness. We have empirically observed that the device responds accurately to voice commands, enabling patients to adjust their bed's elevation angle independently. This is particularly beneficial for those with severe physical disabilities who previously had no means of adjusting their beds without assistance. Our device significantly reduces their dependence on healthcare providers or family members for such activity of daily living (ADL) tasks.

Effectiveness

In terms of Goal Attainment Scale (GAS), patients using the voice-controlled bed system were able to adjust their bed position more promptly and frequently compared to those who did not use the system, indicating the system's efficacy. Patients with motor-neuron disease (MND) often experience progressive muscle weakness and paralysis, making it difficult for them to perform simple tasks independently. By utilizing voice commands, these patients can effortlessly adjust the angle of their rehab beds, enhancing their comfort, support, and body positioning. Similarly, individuals with spinal cord injuries face limitations in mobility and functionality. The voice-controlled remote control provides them with a newfound sense of autonomy, allowing them to control their bed position without relying on others. For patients who have experienced severe strokes, the voice-controlled remote control offers a means to regain control over their environment. Stroke survivors often face challenges in motor coordination and communication, making it difficult for them to operate conventional remote controls. By utilizing voice recognition technology, this innovative device eliminates the physical barriers and cognitive demands associated with traditional controls, enabling stroke patients to effortlessly adjust their bed positions using simple voice commands. This accessibility promotes engagement in rehabilitation activities and encourages patients to take an active role in their recovery process.

Diversity of usage

In addition to its effectiveness, the voice-controlled system displays impressive diversity in its usage. The device can be seamlessly integrated into various healthcare settings, including hospitals, rehabilitation centers, and even home care environments. Utilizing the commercially available voice assistant embedded in smart device, the system can recognize and respond to commands in multiple languages, making it accessible to a wide range of patients. This compatibility feature with language makes it a versatile solution that can be tailored to individual patient needs. Furthermore, the device's user-friendly interface and intuitive voice commands ensure ease of use for patients with varying levels of technological proficiency. Furthermore, the system can also be activated using virtual button on their smartphone, therefore, patients can be able to alter their bed elevation angle with minimal effort by touch their smartphone screen which demonstrating versatility of the system. This inclusivity allows for broad application across diverse patient demographics, thereby increasing its potential impact in the rehabilitation engineering field.

Influence on patient's quality of life

The impact of the voice-controlled rehabilitation bed remote control system on patients' daily activities is profound. By offering patients the independence to control their bed position, it significantly enhances their autonomy and sense of control over their environment. This is vital in a rehabilitation setting, where patient morale and motivation play pivotal roles in recovery. This newfound autonomy enables patients to regain a sense of normalcy and reduces their reliance on caregivers, fostering a greater sense of self-reliance and improving their overall psychological well-being, and the increased independence is empowering and promotes a sense of dignity and self-worth among patients who may have previously felt a loss of control over their own bodies Moreover, by reducing the reliance on caregivers or family members for basic tasks, the system allows them to focus on other essential care aspects.

This not only improves the efficiency of care provision but also alleviates the physical and emotional burden on caregivers, enhancing the overall caregiving experience.

Limitation

While we acknowledge the limitations of this study, mainly that further longitudinal studies are needed to assess the long-term impact of the system on patient recovery, these preliminary results are promising. The voice-controlled bed system represents a significant leap forward in rehab care, empowering patients and transforming the care delivery model. It is our hope that this will encourage further innovation in this field to improve patient care and autonomy.

To summarize, the voice-controlled rehabilitation bed remote control system represents a groundbreaking advancement in the field of rehabilitation engineering. Its efficacy, versatility, and profound impact on the quality of life of patients establish it as a valuable tool within the context of rehabilitation. The outcomes of this study provide empirical evidence supporting the beneficial effects of the Bedriod system in fostering independence among individuals with physical disabilities. By facilitating independent and safe operation, the Bedriod system empowers these individuals to exert greater control over their daily activities and enhances their overall well-being. These findings underscore the potential of assistive technologies, such as the Bedriod system, to promote autonomy and enhance the quality of life for individuals with physical disabilities.

Future research endeavors should focus on further refining and expanding the capabilities of the system to address additional aspects of rehabilitation care. The potential impact of such technology on transforming patient care and significantly improving their quality of life is immense, and we anticipate its broader adoption in the future. Continued exploration and advancements in this field hold the promise of revolutionizing rehabilitation practices and facilitating enhanced outcomes for individuals with physical disabilities.

Acknowledgements

The study was supported by The Hospital Authority Community Rehabilitation Service Support Center (CRSSC)

Ethnical Statement

The author affirms the work's originality and confirms that consent was obtained for the inclusion of the patient's photograph.

Conflict of Interest

No external funding was received for the research and publication of this study.

Reference

1. Social Data Collected via the General Household Survey : Special Topics Report - Report No.63 - Persons with Disabilities and Chronic Diseases. Census and Statistics Department, HKSAR 2021, https://www.censtatd.gov.hk/en/data/stat_report/product/C0000055/att/B11301632021XXXXB0100.pdf
2. Yeung, L. F., Ockenfeld, C., Pang, M. K., Wai, H. W., Soo, O. Y., Li, S. W., & Tong, K. Y. (2018). Randomized controlled trial of robot-assisted gait training with dorsiflexion assistance on chronic stroke patients wearing ankle-foot-orthosis. *Journal of neuroengineering and rehabilitation*, *15*(1), 1-12.
3. Gorgey, A. S. (2018). Robotic exoskeletons: The current pros and cons. *World journal of orthopedics*, *9*(9), 112.
4. Yu, K. P., Yeung, L. F., Ng, S. W., & Tong, K. Y. (2020). Bionic robotics for post polio walking. In *Intelligent Biomechatronics in Neurorehabilitation* (pp. 83-109). Academic Press.
5. Grant JS, Elliott TR, Weaver M, et al. Telephone intervention with family caregivers of stroke survivors after rehabilitation. Stroke 2002;33:2060–2065
6. AARP and National Alliance for Caregiving. Caregiving in the United States 2020. AARP; 2020. https://doi.org/10.26419/ppi.00103.001
7. Pinto, C., Geraghty, A. W. A., Yardley, L., & Dennison, L. (2021). Emotional distress and well-being among people with motor neurone disease (MND) and their family caregivers: a qualitative interview study. BMJ open, 11(8), e044724
8. Liu Z, Heffernan C, Tan J. Caregiver burden: A concept analysis. International journal of nursing sciences. 2020 Oct 10;7(4):438-45.
9. Kopecek, M., Kremlacek, J. (2023). Eye-tracking control of an adjustable electric bed: construction and validation by immobile patients with multiple sclerosis. J NeuroEngineering Rehabil 20, 75.

DOI: 10.5123/inj.2023.4.inj7
ISSN:2093-4777 | E-ISSN:2093-6931
Vol. 27 Iss. 4 (2023)

10. Zhang R et al (2017). A BCI-based environmental control system for patients with severe spinal cord injuries. IEEE Trans Biomed Eng 64(8):1959–1971.
11. Rashid, M., Bari, B.S., Sulaiman, N. et al. (2021). A hybrid environment control system combining EMG and SSVEP signal based on brain-computer interface technology. SN Appl. Sci. 3, 782
12. Supporting Caregivers, Centers for Disease Control and Prevention, USA, www.cdc.gov/aging/publications/features/supporting-caregivers.htm.
13. Fadillah, Nurul, and Ahmad Ihsan. "Smart Bed Using Voice Recognition for Paralyzed Patient." *IOP Conference Series: Materials Science and Engineering*, vol. 854, no. 1, 2020, p. 012045, https://doi.org/10.1088/1757-899x/854/1/012045.
14. H, Kajol, et al. "Design and Development of a Voice Actuated Hospital Bed for Patient Care." *International Journal of Recent Technology and Engineering (IJRTE)*, vol. 8, no. 4, 2019, pp. 1751–1757, https://doi.org/10.35940/ijrte.c5882.118419.
15. Elsokah, Moeid M, and Amer R. Zerek. "Design and Development Intelligent Medical Care Bed Using Voice Recognition." *2022 IEEE 2nd International Maghreb Meeting of the Conference on Sciences and Techniques of Automatic Control and Computer Engineering (MI-STA)*, 2022, https://doi.org/10.1109/mi-sta54861.2022.9837521.
16. [Ottenbacher, K. J., & Cusick, A. (1990). Goal attainment scaling as a method of clinical service evaluation. *The American Journal of Occupational Therapy*, *44*(6), 519-525.

ISSN:2093-4777 | E-ISSN:2093-6931
DOI: 10.5123/inj.2023.4.inj7
Vol. 27 Iss. 4 (2023)