INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 9, Issue 2 - V9I2-1396)
Available online at: https://www.ijariit.com

A study of sudden discomfort of heart patients by advancing the existing wheelchairs

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ABSTRACT

The field of mobility aids and healthcare is constantly evolving, with new technologies and methodologies being developed to improve the quality of life for individuals with disabilities and medical conditions. This study focuses on the needs of wheelchair users and heart/stroke patients, who face unique challenges and discomforts that require specialized solutions. To address these challenges, this study explores innovative research methodologies to better understand the needs of wheelchair users and heart/stroke patients. This paper is divided into two phases, with the first phase providing a comprehensive review of the proposed solution and its features, including a dual-drive system, hybrid chair and bed design, health monitoring using medical electronics, voice assistant feature, and medical alarming. This phase also includes a deployment plan, use cases, target users, and expected outcomes, pains, and gains of the proposed solution. The second phase of the paper focuses on the research work involved in the development of the proposed solution. This phase includes engineering calculations, design, and CAD modelling of the advanced wheelchair, as well as static structural strength analysis and selection and integration of sensors and other components required for proper functioning. The goal of the review is to ideate as well as develop a solution that can help overcome these challenges and provide rehabilitation for a better quality of life. The review article also presents a clear discussion on the pains and gains addressed by the proposed solution. The primary pains include impairments in basic functions, experiences of disability, the need for caretakers, forgetfulness in medication adherence, and cognitive problems and anger. In contrast, the primary

gains offered by the prototype are the ability to alert caretakers of changes in the patient's body condition, dual-mode drive control, reduced need for caretakers, medication adherence alerts, and the prevention of psychological depression. The outcome of the research study is expected to be a fully functional prototype that meets the needs of stroke and heart attack patients, whose success can be quantified through the level of improvement in the quality of life of patients and their caregivers.

Keywords: *Heart Patient, Wheelchair, Lora Technology, and Dual Drive System*

1. INTRODUCTION

In the healthcare domain, timely intervention can play a pivotal role in improving patient outcomes. However, patients with heart and stroke conditions may experience excruciating chest pain, rendering them unable to communicate their distress. The absence of a mechanism to detect and respond to their discomfort can lead to potentially life-threatening consequences. To address this critical issue, we present a groundbreaking solution in the form of an advanced wheelchair that combines cutting-edge technology with compassionate healthcare. This next-generation wheelchair has a range of 750 kilometers and can be operated both manually and wirelessly, offering patients unparalleled freedom and flexibility. Its standout feature is a sophisticated health monitoring system that keeps a constant check on patients' well-being, alerting caregivers, or spouses through a specially designed application in real-time. This system ensures that medical assistance can be provided promptly at the earliest signs of discomfort. Furthermore, the wheelchair incorporates medication reminders that ensure patients take their medication at the prescribed times, enhancing safety and convenience. Besides its impressive technical features, this wheelchair provides significant social and psychological support to patients who may feel isolated and alone. It incorporates voice assistant capabilities, providing comfort and companionship to those who need it the most. This low-cost, semi-autonomous wheelchair is designed to meet the unique needs of heart and stroke patients while embracing a patient-centered approach to healthcare. The integration of a dual-mode drive system, voice assistant features, and LoRa WAN Technology ensures that patients remain connected and supported, irrespective of their location. Our ultimate goal is to empower patients to lead fulfilling lives, unencumbered by the burden of their medical conditions. The advanced wheelchair we present today is a result of tireless research and development, backed by a team of experts committed to improving patient outcomes.

2. LITERATURE ANALYSIS

In the realm of assistive technologies, recent advancements in wheelchair technology offer hope for improved quality of life for wheelchair users. However, to truly realize the potential of these technologies, a user-centered approach to design is crucial. The paper delves into emerging technologies like exoskeletons and brain-computer interfaces that have the potential to transform the field of assistive technologies. It emphasizes the importance of collaboration between researchers, clinicians, and wheelchair users to ensure that these technologies meet the needs of their intended users. Furthermore, the paper highlights the need for policy changes and increased funding for research to make these technologies accessible and affordable. While the paper offers a comprehensive overview of the state of wheelchair technologies, it could benefit from a more critical analysis of the limitations of current technologies and the challenges facing wheelchair users[1]. A meticulous study conducted by the authors to create a novel manual wheelchair that caters to the specific needs of users in India were outlined. The study involved an extensive review of existing wheelchair designs and an analysis of the preferences and requirements of potential users in India. Based on the insights gathered from these activities, the authors developed a prototype of the new manual wheelchair, which was subjected to durability, stability, and ease of use tests. Fig. 1. depicts the process of product development and technology transfer in the manufacturing model. The paper highlights the unique design features of the new wheelchair, such as a foldable frame for easy transportation, adjustable seat height and backrest angle for enhanced user comfort, and improved wheel locks for better stability. Additionally, the study emphasizes the importance of ergonomic design in reducing the risk of injury and increasing user comfort. The research concludes that the new manual wheelchair design is a significant improvement over existing designs, particularly in terms of its durability and stability on uneven terrain[2].

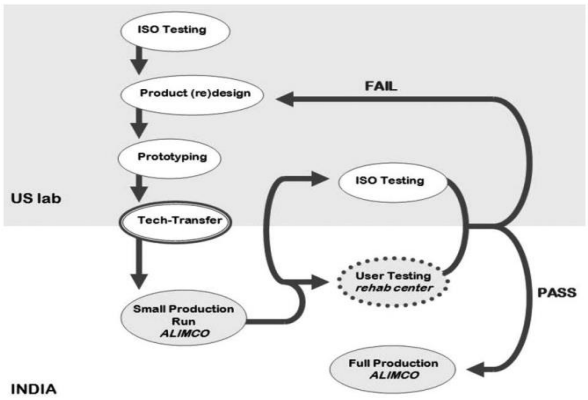

Fig -1. Process of product development [2]

The design and development of a new wheelchair that can easily be used in a hospital setting was detailly discussed. The authors conducted an analysis of the ergonomic requirements of a wheelchair that can fit onto a hospital bed for easy transfer of patients. They then created a scaled prototype of the new wheelchair design to evaluate its feasibility and effectiveness. It also highlights the unique features of the new wheelchair design, including adjustable armrests, a low backrest, and a seatbelt for patient safety. The authors emphasize the importance of user-centered design in creating a wheelchair that meets the needs of both patients and healthcare professionals. According to the study, the new size-bed wheelchair design offers significant improvements over existing designs, particularly in terms of ease of use and patient comfort. However, the authors recognize the need for further research and testing to optimize the design for a diverse range of patients and healthcare settings [3]. A novel design for a wheelchair that can be easily maneuvered in a hospital setting was well presented in this article. The research involved an analysis of the ergonomic requirements of a wheelchair that can fit onto a hospital bed for easy transfer of patients. A scaled prototype of the new wheelchair design was developed to evaluate its feasibility and effectiveness. The paper discusses the unique features of the new wheelchair design, including adjustable armrests, a low backrest, and a seatbelt for patient safety. The study emphasizes the importance of user-centered design in creating a wheelchair that meets the needs of both patients and healthcare professionals. The research concludes that the new size-bed wheelchair design offers significant improvements over existing designs, particularly in terms of ease of use and patient comfort. However, the authors acknowledge the need for further research and testing to optimize the design for a diverse range of patients and healthcare settings[4].

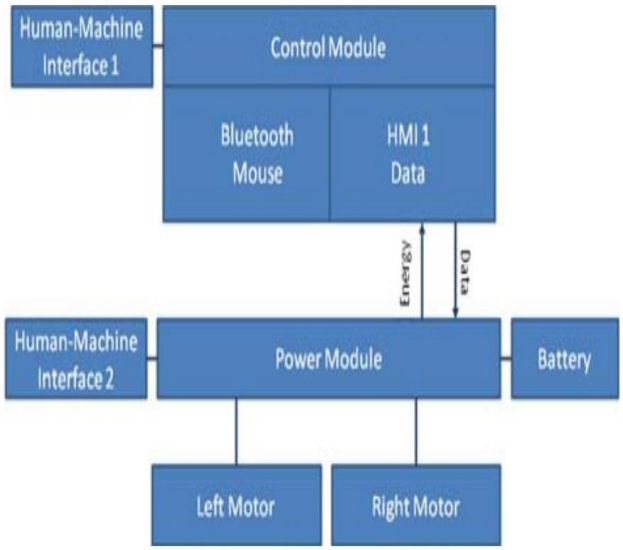

Fig -2. Hardware Architecture of Bluetooth Wheelchair [6]

The research provides an overview of the potential applications of the Internet of Things (IoT) in healthcare. The authors discuss the benefits of IoT technology, such as remote patient monitoring, real-time data collection, and improved communication between healthcare providers and patients. They also explore the challenges associated with implementing IoT in healthcare, including privacy concerns, data security, and regulatory issues. The study concludes that IoT has the potential to revolutionize healthcare by providing more personalized and efficient care, improving patient outcomes, and reducing healthcare costs. However, the authors acknowledge the need for further research and collaboration between healthcare providers, technology companies, and regulatory bodies to ensure the safe and effective implementation of IoT in healthcare. The paper presents a comprehensive and insightful analysis of the potential of IoT in the healthcare sector[5]. The article introduces a groundbreaking Bluetooth-enabled motorized wheelchair. It discusses the wheelchair's architecture, depicted in Fig. 2, and highlights its modular design that allows for easy customization and integration with other control modules. Bluetooth technology enables wireless connection with devices like smartphones or tablets, allowing users to control the wheelchair conveniently and independently. The study evaluates important aspects such as speed, turning radius, battery life, and overall usefulness of the Motion Assistant. The authors emphasize the significant potential of this Bluetooth-enabled electric wheelchair in improving mobility and quality of life for wheelchair users, supported by positive user testing results [6].

The study illustrates creating a recommendation system for proactive health monitoring that makes use of wearable and IoT technology. The authors talk about how these technologies might offer individualized, ongoing health monitoring that could aid in the early identification and prevention of health problems. The recommendation system analyses the data gathered from various wearable devices using machine learning algorithms, then offers the user individualized suggestions depending on their health state. To provide suggestions that are pertinent and attainable, the system also considers the user's interests and lifestyle aspects. The study underlines the necessity of ethical issues, such as data privacy and security, and underscores the significance of user-centered design in the development of health monitoring devices[7]. The integration of the Internet of Things (IoT) in healthcare has led to the development of smart patient assistance and health monitoring systems. These systems comprise smart sensors, IoT infrastructure, and data analytics techniques. Smart sensors, including wearable devices and biosensors, collect real-time data on patients' health status, which is transmitted to an IoT infrastructure for storage, processing, and analysis. Data analytics techniques are used to extract meaningful insights from the collected data and provide personalized recommendations for healthcare management. However, smart patient assistance and health monitoring systems using IoT face several challenges and limitations, such as data security and privacy, interoperability, and user acceptance. Despite these challenges, smart patient assistance and health monitoring systems using IoT have the potential to improve healthcare outcomes and enhance patient experience[8].

The construction of a wheelchair control system that makes use of an Android smartphone as the main input device is described effectively and efficiently. Users using the custom software created by the authors may control the wheelchair's mobility and modify parameters like speed and acceleration. The research describes the system's technical requirements in depth, including the hardware parts and software algorithms that are employed to provide dependable and seamless control. The authors also go through the advantages of utilizing an Android-based control system, including the accessibility of smartphones and the capacity to tailor the app to a user's particular requirements. The study gives a thorough description of the creation of a creative and useful wheelchair control system and has significant ramifications for the development of assistive technology for people with mobility limitations[9]. The creation and use of a microcontroller-based system is examined in this research as a novel approach to non-invasive health monitoring. The system offers precise and real-time monitoring of important vital indicators by integrating a variety of sensors, such as those for heart rate, body temperature, and blood pressure. The authors walk the reader through the design and implementation process, emphasizing the meticulous sensor selection, the challenges of creating a microcontroller-based system, and the communication protocols necessary to assure error-free data transfer. The authors illustrate the system's excellent performance in terms of dependability and accuracy through a variety of demanding tests and experiments. The development of non-invasive health monitoring systems will be significantly impacted by the innovative and useful addition made by this study to the field of health monitoring[10].

This research report argues a method that uses artificial intelligence (AI) to design a wheelchair that is adaptable and user-friendly. The technology is intended to improve older people's and those with disabilities' movement. A smartphone application that is connected to the wheelchair through IoT is used to operate the device. Among other things, the program gives the user control over the wheelchair's movement, seat position, and battery level. In addition, the wheelchair is equipped with sensors that can identify impediments and provide the user guidance on how to avoid them. The authors used machine learning algorithms with IoT technology to create the system. The wheelchair's sensors and actuators were connected to the cloud using a Raspberry Pi computer, and an AI-based algorithm was created to interpret the sensor data and give the user feedback in real time. The system was put to the test in the real world with a group of users, and the findings showed that it was successful in delivering a user-friendly interface and enhancing the users' mobility. Also, the system was able to adjust to the requirements of many users and offer customized settings according to their preferences[11]. The study introduces a new solution for individuals with mobility issues—an advanced smart wheelchair. This wheelchair incorporates state-of-the-art technology to improve accuracy, precision, and safety in its movements. It offers a sleek design and user-friendly interface for a seamless experience. Equipped with sensors, the wheelchair can detect obstacles and avoid collisions, ensuring a safer and more comfortable journey. The integration of a microcontroller enhances control and movement accuracy, resulting in smoother rides. The authors' meticulous attention to detail is evident in the wheelchair's frame design and component integration. This innovative device has the potential to significantly enhance mobility and improve the quality of life for individuals with impairments. Emphasizing the importance of ongoing innovation, the study highlights how the smart wheelchair utilizes cutting-edge technology and user-centered design[12].

With the aid of cutting-edge IoT technology, the study presents an innovative new advancement in healthcare technology that results in a smart healthcare monitoring system. Healthcare practitioners will be able to make better informed judgements about patient care because of the system's real-time monitoring and feedback for patients. The system offers a complete remedy for tracking a patient's health state by integrating a number of sensors and gadgets, including wearable sensors and a blood pressure monitor. Also, the system has a user-friendly smartphone application that patients may use to keep track of their health and get in touch with medical staff. Patients may see their vital signs, set up appointments, and get medicine reminders with this program, which is designed to be simple to use and intuitive. The creation of the smart healthcare monitoring system and its design are clear examples of the authors' dedication to innovation and progress. The system was put through extensive testing on a group of patients, and the outcomes showed how well it provided real-time monitoring and feedback[13].

3. RESEARCH METHODOLOGY

In the field of mobility aids and healthcare, the paper explores innovative research methodologies to better understand the needs of wheelchair users and heart/stroke patients. By recognizing the unique challenges and discomforts faced by these individuals, this embarks on a journey of discovery that leads to meaningful advancements in the development of assistive technologies and medical interventions. The detailed methodology is categorized in the following order, which is depicted in Fig. 3.

Phase 1 of this paper provides a comprehensive review of the proposed solution and its features that aim to address the specific challenges faced by heart/stroke attack patients, particularly sudden chest discomforts. It presents a thorough analysis of the existing solutions and highlights the gaps and constraints that need to be addressed in the development of an advanced wheelchair that can provide better care for the patients. This phase also discusses the usability of the proposed solution, including the manual drive system and the integration of multiple features that make it user-friendly. Moreover, the paper provides a detailed deployment plan for the proposed solution, including installation and integration, resources/materials required, and maintenance/service needs. It also defines the specific use cases and target users of the solution and outlines the expected outcomes, pains, and gains of its implementation.

Phase 2 of this paper will focus on the research work involved in the development of the proposed solution. This phase will delve deeper into the engineering calculations, design, and CAD modelling of the advanced wheelchair, as well as the static structural strength analysis of the system. It will also cover the selection and integration of the sensors and other components required for the proper functioning of the wheelchair. The results of the research

work will be presented and analyzed, providing insights into the efficacy and effectiveness of the proposed solution. Overall, the two phases of this paper will provide a holistic view of the advanced wheelchair solution and its potential for addressing the challenges faced by heart/stroke attack patients.

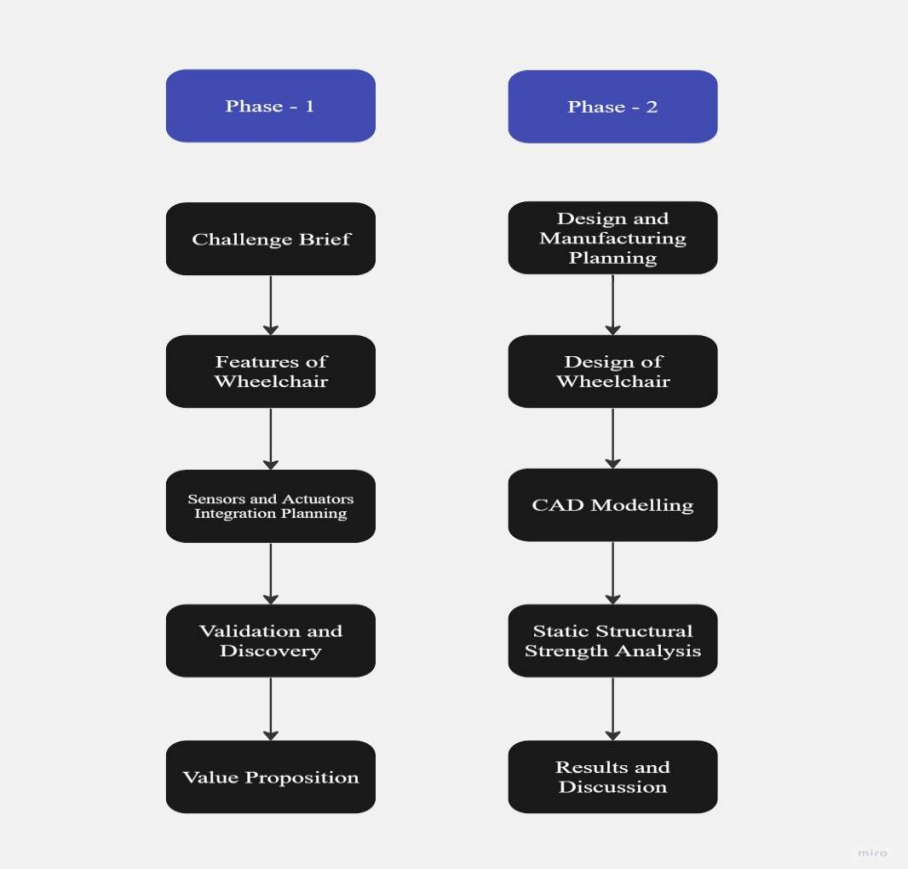

Fig -3. Research methodology

4. CHALLENGE BRIEF

Addressing the needs of stroke and heart attack patients is a significant public health concern, affecting millions of people each year and resulting in numerous deaths. The primary symptoms experienced by these patients are chest pain and discomfort, which, if not communicated effectively, can lead to delayed medical assistance and hinder their chances of recovery. Existing solutions, such as caregivers, regular check-ups, and smart technologies like smartwatches and mobile alarm systems, have limitations in acknowledging patient discomfort, addressing psychological depression, and requiring manual operation of wheelchairs. To overcome these challenges, a proposed solution is an advanced wheelchair that can operate both manually and wirelessly. Equipped with sensors, it monitors the patient's condition 24/7 and alerts caregivers in case of any discomfort or pain. The wheelchair also incorporates an application that provides medication reminders, social support, and psychological assistance to combat feelings of loneliness and depression. The manual drive system is similar to a basic joystick drive wheelchair, making it easy to use, while the distance control method is simple to learn.

The prototype is currently deployed in hospitals and homes, with readily available materials and resources for installation. However, lack of network connectivity in rural areas can pose communication challenges over long distances. Maintenance and repair may also be slightly more difficult and costly. The specific use-case of the prototype is to protect elderly stroke and heart attack patients who can benefit from its advanced features. It alerts caretakers of changes in the patient's condition, offers dual-mode drive control, reduces the need for caretakers, provides medication reminders, and prevents psychological depression. It addresses impairments, disabilities, reliance on caretakers, medication timing, and cognitive issues. The expected outcome is a fully functional

prototype that meets the needs of patients, measured by patient and caregiver satisfaction. By addressing gaps in existing solutions, this prototype has the potential to significantly improve the quality of life for stroke and heart attack patients.

5. FEATURES IN WHEELCHAIR

Complete features integration in wheelchair is clearly depicted in Fig. 4.

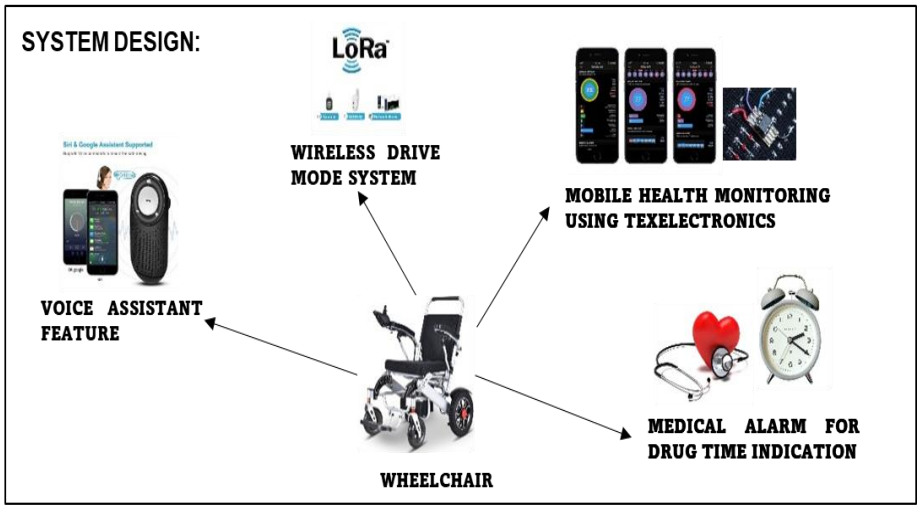

Fig -4. Features integration in Wheelchair

5.1 Dual Drive System – Introducing a revolutionary mobility aid - a state-of-the-art wheelchair that sets a higher standard for accessibility technology. This innovative wheelchair features a dual driving system, offering users unparalleled control and independence. It provides two driving modes to customize the experience according to individual needs. The manual mode offers precise control through a joystick, while the controller coordinates all functions seamlessly. The motor driver with advanced differential control allows effortless adjustment of speed and direction, even in challenging terrain. The efficient power management system ensures extended use between charges. The wireless mode is hands-free, controlled through a remote or mobile phone, ideal for situations where users need to keep their hands free or cannot use the joystick. This wheelchair represents a significant advancement in accessibility technology, empowering individuals with disabilities to lead more fulfilling lives. With its user-centric design, cutting-edge features, and dual driving system, users experience comfort, control, and independence like never before.

5.2 Hybrid Chair and Bed Design – The wheelchair that can be converted into both a chair and a bed as per the user's convenience. The conversion mechanism is controlled by a cerebral controller that is connected to a linear actuator. The linear actuator facilitates the linear expansion and contraction of the device, thereby enabling the smooth transformation of the wheelchair from a chair to a bed and vice versa. The cerebral controller is a sophisticated system that allows the user to operate the device through the buttons that are available in front of the arm rest region. The controller processes the user's intentions and sends commands to the linear actuator, which executes the necessary movements. The linear actuator is a motorized device that converts electrical energy into mechanical energy and produces linear motion. To convert the wheelchair into a bed, the linear actuator expands the device linearly, increasing the length of the seat and backrest, and simultaneously adjusting the height to provide a comfortable sleeping position. Similarly, to convert the bed into a chair, the linear actuator contracts the device linearly, decreasing the length of the seat and backrest and adjusting the height accordingly to create a comfortable seating position.

5.3 Health Monitoring using Medical Electronics – Health monitoring systems integrated into wheelchairs are gaining popularity as essential tools for healthcare professionals and patients. These systems offer precise

measurements of a patient's pulse rate and provide valuable insights into their daily routine, exercise regimen, and overall health. The sophisticated features of these wheelchairs include monitoring breathing patterns, tracking calorie consumption, assessing cardio fitness levels, monitoring sleep patterns, and measuring various vital parameters. This continuous monitoring allows healthcare professionals to gain a comprehensive understanding of a patient's health condition, identify potential issues, and take prompt preventive measures. It is particularly beneficial for patients at risk of developing severe medical conditions such as diabetes, hypertension, or heart disease. The breath monitoring system helps in understanding respiratory health, making it valuable for patients with conditions like asthma or COPD. Calorie monitoring supports weight management and reduces the risk of obesity-related health problems. The cardio fitness tracking feature allows patients to monitor their fitness levels and track progress over time. Sleep tracking offers insights into a patient's overall well-being, which is especially useful for those with sleep-related disorders like insomnia or sleep apnea.

5.4 Voice Assistant Feature – The integration of Voice Assistant features in wheelchairs is a breakthrough in healthcare, providing social and psychological support to isolated patients. The voice assistant acts as a personal companion, offering comfort and companionship during therapy or rehabilitation. It listens to patients' concerns, responds to requests, and engages them with interactive and entertaining communication. Playing music, audiobooks, and games, the voice assistant keeps patients' minds active and provides a sense of security. Importantly, it helps prevent depression, common among physically challenged individuals. Patients confined to wheelchairs due to accidents or illnesses often feel alone and helpless, but the voice assistant acts as a virtual companion, offering reassurance and normalcy. It supports patients' mental wellbeing and aids in rehabilitation. Guiding patients through exercises, the voice assistant ensures correct performance and pace, promoting mobility and independence. This feature encourages patients, contributing to their overall health and wellbeing.

5.5 Medical Alarming – The incorporation of an alarming system into a wheelchair is a significant breakthrough in medical technology, benefiting patients in managing their medication regimen. This system reminds patients to take their medications effectively, announcing the medication name, dosage, and specific timing before or after meals. Connected to the patient's medication schedule, it delivers reminders at specified intervals, eliminating missed doses. Reminders are provided through a voice system that offers additional information like special instructions and potential side effects. This helps patients manage their medications better, avoiding complications. The system is especially valuable for patients with chronic conditions, who may struggle to remember their medication schedule. Its timely reminders ensure patients stay on track and maintain their long-term health.

6. SENSORS AND ACTUATORS INTEGRATION PLANNING

Sensors and Actuators employed in wheelchairs are clearly depicted in Fig. 5.

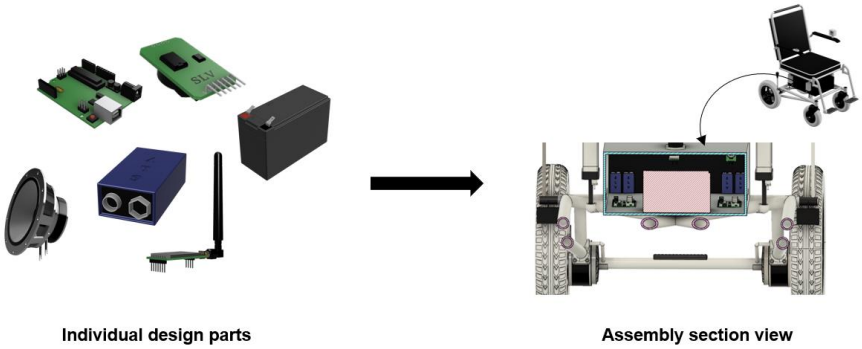

Fig -5. Sensors and Actuators Integration

7. VALIDATION AND DISCOVERY

The challenges faced by elderly patients who have suffered heart or stroke attacks can be significant and can impact their overall quality of life. These challenges can include physical limitations, emotional distress, and the

need for ongoing medical care. Therefore, the goal of this project is to develop a solution that can help overcome these challenges and provide rehabilitation for a better quality of life. To achieve this goal, a prototype will be built, which will incorporate sensors for detecting and alerting in case of emergencies. These sensors will be strategically placed in the wheelchair, to monitor their movements and vital signs. The sensors will be connected to a central monitoring system that will alert healthcare professionals or emergency services in case of any abnormalities. This prototype will be analyzed through various perspectives, considering the needs and challenges faced by elderly patients, their caregivers, and healthcare professionals in future days. The project will involve collaboration with medical professionals, such as cardiologists and rehabilitation specialists, to ensure that the solution meets the needs of the patients. Furthermore, to ensure that the project stays on track and meets its goals, validation and discovery points will be established. These points will include testing the prototype in real-world scenarios with elderly patients and their caregivers, analyzing feedback and data, and continuously improving the prototype based on the results.

8. VALUE PROPOSITION

The proposed solution is an advanced wheelchair designed to support stroke and heart attack patients, particularly the elderly, in their daily activities. It offers a range of features that surpass traditional wheelchairs, making it highly appealing to the target users. The wheelchair includes a health monitoring system that detects patient discomfort and alerts caregivers or doctors remotely via cell phones. It also features a dual-mode drive system, allowing manual joystick control or wireless control via cell phones using LoRa WAN Technology. Additionally, the wheelchair incorporates voice assistant capabilities for psychological support and a drug time indication system for medication reminders. The solution falls under the Medical and Health Tech theme, addressing the need to detect sudden discomfort in heart and stroke patients. Key reasons to purchase this wheelchair include improved quality of life, wireless data transfer with high security, 24/7 caregiver support, and accessible health monitoring. Functionally, it allows patients to drive using a joystick, access a voice assistant in times of distress, and enables caregivers to drive remotely and monitor patient health. Socially, it reduces the risk of emergencies and offers emotional rehabilitation. However, challenges include rural data speed, high pricing due to advanced technology, power management, maintenance, and inequality among users. Nevertheless, this solution differentiates itself by integrating multiple features, advanced technology, independent patient monitoring, and optimization in design. Overall, it provides a comprehensive solution for stroke and heart attack patients and their caregivers.

9. CONCLUSION

The development of specialized solutions to address the unique needs of individuals with disabilities and medical conditions, particularly those who require the use of mobility aids such as wheelchairs, is of utmost importance in improving their quality of life. The review paper presented here explores innovative methodologies to better understand the needs of wheelchair users and heart/stroke patients and proposes a solution that offers a range of advanced features, including a dual-drive system, hybrid chair and bed design, health monitoring using medical electronics, voice assistant feature, and medical alarming. This paper is divided into two phases, with the first phase providing a comprehensive review of the proposed solution and its features, including a deployment plan, use cases, target users, and expected outcomes, pains, and gains of the proposed solution. This phase also presents a clear discussion of the pains experienced by patients and caregivers, which include impairments in basic functions, experiences of disability, the need for caretakers, forgetfulness in medication adherence, and cognitive problems and anger. In contrast, the primary gains offered by the proposed solution are the ability to alert caretakers of changes in the patient's body condition, dual-mode drive control, reduced need for caretakers, medication adherence alerts, and the prevention of psychological depression.

The second phase of the paper will be the future work which focuses only on the research work involved in the development of the proposed solution, including engineering calculations, design, and CAD modeling of the advanced wheelchair, as well as static structural strength analysis and selection and integration of sensors and

other components required for proper functioning. The goal of the review is to ideate as well as develop a solution that can help overcome the challenges faced by wheelchair users and heart/stroke patients and provide rehabilitation for a better quality of life. The proposed solution, if successfully implemented, has the potential to significantly contribute to the field of mobility aids and healthcare, and to the lives of the patients and caregivers it aims to serve. The fully functional prototype expected to be developed through this research is anticipated to demonstrate the effectiveness of the proposed solution in meeting the unique needs of stroke and heart attack patients, and to improve their quality of life. It is hoped that this research will inspire further exploration and development of specialized solutions for individuals with disabilities and medical conditions and contribute to the ongoing evolution of healthcare technologies.

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