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Iot-Based Smart Wheelchair for Elderly Healthcare Monitoring

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Abstract
This paper presents the development and implementation of an Internet of Things (IoT)-enabled smart wheelchair designed to enhance mobility and independence for individuals with disabilities. By integrating advanced assistive technologies and internet connectivity, the system offers a comprehensive solution that addresses key challenges in wheelchair navigation and user autonomy. The smart wheelchair is equipped with a suite of sensors, including ultrasonic and infrared, to perceive its environment, detect obstacles, and provide real-time feedback to the user. These sensors enable the wheelchair to autonomously adjust its path, ensuring safe navigation in dynamic environments. Additionally, integrated GPS and mapping capabilities facilitate efficient route planning and precise location tracking, further enhancing user confidence and safety. A communication module allows for remote monitoring of the wheelchair's status, battery level, and location, providing caregivers with valuable information and ensuring prompt assistance when needed. This feature not only supports user safety but also promotes proactive care management. The IoT-enabled wheelchair aims to empower users with greater control over their mobility, improve their quality of life, and promote independent living. Looking ahead, future developments may include integration with smart home systems, personalized user profiles for optimized assistance, and the incorporation of advanced health monitoring features to further support users' well-being.

Keywords: *Infrared Sensors, Ultrasonic Sensors, Real-Time Feedback, Route Planning, Location-Based Services.*

1. Introduction
In India, over 2.68 crore individuals are living with disabilities, with mobility impairments being among the most prevalent. These individuals face numerous challenges in navigating their environments, often relying on traditional wheelchairs or crutches that are physically demanding and lack the ability to adapt to varied environments. For many, this leads to a loss of independence and a reliance on caregivers or family members for mobility, which can limit their ability to participate in daily activities, access essential services, or engage in social and community interactions. Despite the growing need, access to advanced mobility devices such as powered wheelchairs remains limited, especially in rural areas, where affordability and availability pose significant barriers. Traditional manual wheelchairs, though essential, have limitations in terms of maneuverability, comfort, and the physical strain they place on users. Powered wheelchairs, while offering more convenience, are often expensive, complex to operate, and lack personalized features. Furthermore, the integration of smart technology in mobility aids has remained minimal, leaving a significant gap in providing intuitive and customizable solutions for people with disabilities. In this context, there is a strong demand for innovative, accessible, and affordable mobility solutions that can significantly enhance the quality of life for disabled individuals. The Smart Electric Wheelchair (SEW) was conceived as a response to these challenges. By integrating Bluetooth technology and modern control systems, the SEW

aims to revolutionize mobility for individuals with disabilities, offering them a combination of manual and remote control options, with user-friendly features designed to ensure comfort, ease of use, and adaptability. The SEW is built on the belief that mobility should be a gateway to freedom, not a limitation, and seeks to empower individuals to navigate their surroundings independently and confidently. 2 This wheelchair is designed with the unique needs of disabled individuals in mind, particularly in the context of India, where disability is often associated with limited access to assistive technologies. By incorporating cutting-edge technologies like Bluetooth connectivity and mobile app control, the SEW offers a modern solution that merges functionality, affordability, and ease of use. The introduction of this product represents a significant leap forward in addressing the mobility challenges faced by people with disabilities in India and offers the potential to improve the lives of millions, granting them greater independence and social inclusion.

2. Literature Review

The design and implementation of the Smart Electric Wheelchair (SEW) focus on integrating modern technologies to enhance the mobility, independence, and comfort of individuals with disabilities, while maintaining ease of use and affordability. The design process begins with a deep understanding of the needs and preferences of users, ensuring that the device addresses common challenges faced by individuals with mobility impairments. The SEW is designed to combine both manual joystick control and Bluetooth connectivity, offering flexibility and adaptability to a wide range of users. The wheelchair's frame is made from lightweight yet durable materials, ensuring ease of maneuverability and strength to handle different terrains. The seating system is ergonomically designed to provide comfort and support for prolonged use, with adjustable components to cater to users' varying needs. The joystick 11 control is designed for simple manual operation, enabling users to navigate the wheelchair with precision in both indoor and outdoor settings. The implementation phase involves the integration of hardware and software components, including the Bluetooth system, mobile app development, and the physical assembly of the wheelchair. Testing and refinement are crucial steps in ensuring that the device meets safety standards, performs reliably in different environments, and provides a comfortable user experience. Additionally, the SEW will undergo usability testing with real users to gather feedback and make necessary adjustments.

2.1.EVOX WC104 R Reclining Power Wheelchair with Electromagnetic Brake

The EVOX WC 104 R is a type of reclining power wheelchair that is equipped with an electromagnetic brake system. Evox Recliner Power Wheelchair is designed to provide extra comfort and ease of use. It features a long-lasting motor which is imported from Taiwan and comes with a one-year warranty. This electric wheelchair includes some functions related to their work are Reclining function which allows users to adjust the backrest to a more comfortable position, which can be particularly important and beneficial for those who need to change their posture frequently or continuously to prevent any pressure and discomfort (Figure 1)

Figure 1 **Evox WC-104R Electric Wheelchair**

2.2.ESLEH Travel Electric Wheelchair

The Esleh Travel Electric Wheelchair is a meticulously designed wheelchair with a mobility solution that prioritizes convenience and comfort for users on the go, weighing approximately 50 pounds. It is lightweight with foldable designs, which makes it effortlessly portable and the best, fitting easily into car trunks and airplane storage compartments. Equipped with a high-capacity lithium-ion battery, this wheelchair offers a range of up to 15 miles on a single charge and is powered by dual 250-watt brushless motors that also ensure smooth performance on different terrains. (Figure 2)

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Figure 2 Esleh Travel Electric Wheelchair

2.3.Esleh Stair Chair WD 101

This Esleh Stair Chair WD 01 is specially designed for mobility and safety features transporting individuals up and down the stairs. It also features a sturdy frame and a comfortable seat with securing the harness for the user's safety. The chair is designed with durable tracks and powerful motors for navigating the stairs smoothly and efficiently. It is best for emergencies as it is lightweight foldable and easy to carry and store which makes it ideal for emergency patients, healthcare facilities, and home use. This also controls the design to provide both comfort and reliable stair navigation for mobility challenges. (Figure 3) [1]

Figure 3 Esleh Stair Chair WD 101

2.4.Karma EFlex F20 Power Wheelchair

The eFlexx electric wheelchair combines cutting-edge technology having an ergonomic design that provides users with enhancing mobility and comfort features. Featuring this customizable seating options and intuitive controls that offers it effortless movement in both indoor and outdoor environments, with a lightweight frame and powerful motors, the eFlexx electric wheelchair provides smooth and reliable rides, for providing the needs of individuals with independence and convenience in their daily base activities. eFlexx(EFL) is a type of foldable power wheelchair that can fit into the trunk of a sedan this power chair is ideal for those who live in an area where 15 wheelchair transportation is not available and Electric wheelchair prices are also low. (Figure 4)

Figure 4 Karma EFlex F20 Power Wheelchair

3.

3.1.Arduino UNO

Arduino UNO is a component on the shelf (COTS) circuit board which aims for the helping people on their project. It is based on ATmega328 microcontroller. Rather than making own circuit board from scratch, Arduino UNO provides a sufficient circuit board which able to program and contain most of the necessary pin function as shown in fig 3.4. Arduino UNO board consists of 14 input output pin whereby 6 of them can be used as PWM output. Besides that it contains also 6 analog to digital (ADC) pin. Basically, Arduino UNO operates at 5V and the input power source needs to be a range of 7V to 12V (Figure 5)

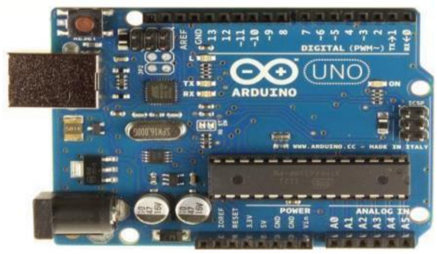

Figure 5 Arduino Uno

3.2.BTS7960 Motor Driver

When control signals are sent from a microcontroller (like an Arduino), the BTS7960 uses these inputs to switch its internal MOSFETs (transistors) on and off. The IN1 and IN2 pins determine the direction of motor rotation—activating one while deactivating the other makes the motor spin in one direction, and reversing them changes the direction. The PWM

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signal is applied to either IN1 or IN2 (depending on the desired direction) to control the motor's speed by rapidly turning the driver on and off (this is known as Pulse Width Modulation). (Figure 5)

Figure 5 BTS 7960 Motor Driver

The EN (Enable) pins need to be HIGH to allow the module to operate, and the IS (current sense) pin can be used to monitor the motor's current draw, which is helpful for diagnostics or implementing current-limiting features. 26 Internally, the BTS7960 handles all the power switching, while also protecting itself and the motor from dangerous conditions like overcurrent, overheating, and short circuits. Thanks to these protections and its high current capability, the BTS7960 can drive large motors smoothly and safely, making it an excellent choice for demanding projects. [2]

3.3.Battery

In a smart electric wheelchair, the battery plays a central and multifunctional role, acting as the core energy source that powers not just the motors for movement, but also all the smart technologies integrated into the system. The battery provides the necessary voltage and current to drive the electric motors through a motor driver (such as BTS7960), enabling the wheelchair to move smoothly and efficiently across various terrains. Since smart electric wheelchairs incorporate additional components like microcontrollers, sensors (for obstacle detection, posture monitoring, etc.), communication modules (Bluetooth, Wi-Fi, GPS), and possibly displays or control interfaces, the battery must also support a stable and reliable power supply for these electronics (Figure 6) [3]

Figure 6 Battery

3.4.Joystick Module

A joystick module in a smart electric wheelchair acts as the primary user interface for controlling the movement of the wheelchair. It translates the physical motion of the user's hand into electrical signals that are interpreted by a microcontroller or motor driver, such as the BTS7960, to control the direction and speed of the motors. These modules are compact, user-friendly, and designed to offer precise, proportional control—meaning the further you push the joystick in a direction, the faster the wheelchair moves in that direction. Typically, a joystick module contains two potentiometers—one for the X-axis (left right) and one for the Y-axis (forward-backward). When the user moves the stick, the resistance in the potentiometers changes, producing variable voltage outputs. These analog signals are then read by a microcontroller like an Arduino or STM32, which processes the input and sends corresponding control signals to the motor driver. (Figure 7)

Figure 7 Joystick Module

3.5.DC Gear Motor

A 250W 12V DC gear motor is an efficient and reliable motor commonly used in applications like electric wheelchairs, scooters, and robotic platforms. It combines a DC motor with a gear reduction system to lower the speed while increasing the torque,

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making it ideal for tasks that require strength over speed, such as driving a wheelchair or electric vehicle. With a rated power of 250W and a voltage of 12V, it can deliver substantial torque (typically over 20–30 Nm), which is essential for moving heavy loads. The motor's reduced speed (typically 200 to 400 RPM) ensures smoother movement at lower velocities, making it suitable for precise control. It usually operates with high current (20–25A), requiring a compatible 12V battery with enough capacity and a motor driver, like the BTS7960, to control speed and direction. The gearbox in the motor ensures that the system is powerful enough for inclines and various terrains while maintaining mechanical reliability. This motor is perfect for mobility applications, providing the necessary power for mobility and making it a solid choice for projects where efficient and controlled movement is required. (Figure 8) [4]

Figure 8 DC Gear Motor

3.6.Bluetooth Module

The HC-05 is a popular module which adds two-way wireless functionality to system and can use this module to communicate between two microcontrollers like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop. (Figure 9) [5]

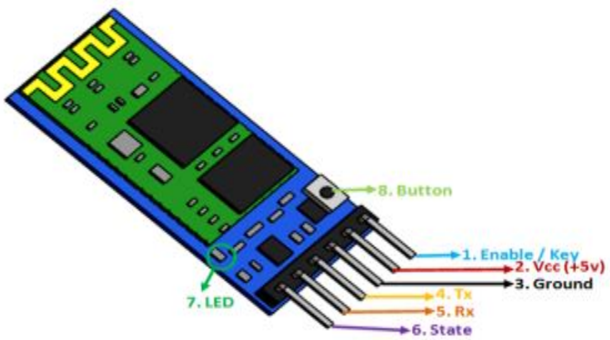

Figure 9 Bluetooth Module

3.7.Wheel Chair Body

The body of an electric wheelchair typically consists of several key elements: the base, which holds the motors and battery; the seat and backrest, which are adjustable for comfort; and the footrests, which ensure the user's feet are properly supported. The wheels are mounted to the base, often consisting of front caster wheels for maneuverability and rear drive wheels for propulsion. These wheels are designed to provide a smooth ride across different surfaces, and depending on the design, they may feature pneumatic tires (for better shock absorption) or solid rubber tires (for lower maintenance). (Figure 10)

Figure 10 Wheel Chair Body

3.8.E18-D80NK Infrared Proximity Sensor

A The E18-D80NK is a popular infrared (IR) proximity sensor used in various electronics and automation projects. It is capable of detecting objects within a range of 3 to 80 centimeters, making it ideal for tasks like obstacle detection, object counting, and motion sensing. The sensor works by emitting infrared light and detecting the reflection from nearby objects, providing a simple yet effective method of non-contact sensing. (Figure 11) [6]

Figure 11 Infrared Proximity Sensor

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4. Approach and Implementation

This chapter discusses the method used to design a SMART ELECTRIC WHEELCHAIR. There several steps taken to complete the task. Before starting to build a Machine, many initial steps have taken such as research on Smart Electric Wheelchair. The development of a smart electric wheelchair aims to enhance the mobility, independence, and safety of individuals with physical disabilities through the integration of modern technology. This project incorporates multiple control methods—Bluetooth, voice, and joystick—to accommodate users with varying levels of physical ability, offering flexibility and ease of use. For safety, an infrared proximity sensor (E18-D80NK) is used to detect nearby obstacles and automatically stop the wheelchair to prevent collisions. The approach focuses on combining hardware components with microcontroller-based logic and responsive software to ensure real-time control, stability, and adaptability. The implementation process involves systematic design, integration of modules, and iterative testing to ensure optimal performance in real-world scenarios. In this project, the core objective is to deliver a user-friendly and intelligent mobility solution by focusing on both functionality and user comfort. The design emphasizes modularity, allowing for future upgrades and easy maintenance. From selecting efficient components to programming the control logic, every stage is aligned with practical user requirements. Through careful planning and prototyping, the system is built to be cost-effective, scalable, and suitable for both indoor and outdoor use. [6-7]

5. Result and Model

In this project, we have presented a system designed to harness the power generated by human movements and wirelessly transfer that energy to a device. We believe this research could provide a solution for uninterrupted smartphone usage. The system is versatile, as it can be built independently of footwear or as a compact version that can be easily strapped onto any shoe. This project addresses a common issue faced by nearly every smartphone user. With approximately 1.8 billion people using smartphones, the desire for longer battery life and the ability to charge their devices on the go is universal. Our research provides a potential solution for continuous smartphone use, removing the need for traditional charging methods (Figure 12,13)

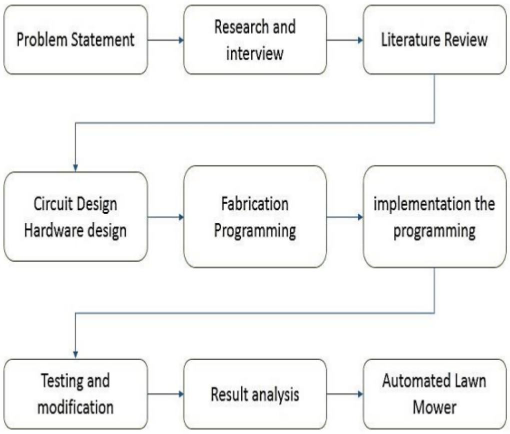

Figure 12 Research Methodology Flow

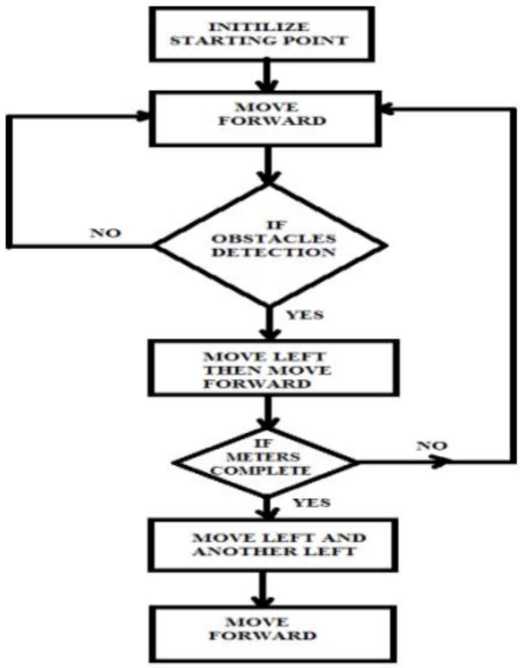

Figure 13 Flow Chart of Software

Energy harvesting from human motion offers a promising approach for obtaining clean and sustainable power. This project has broad applications within consumer electronics, offering an innovative way to power devices. Future work will focus on developing authentication and monitoring systems to further enhance the functionality and security of the system. The wheelchair is driven by two high-torque DC motors, each controlled via the BTS7960 motor driver module, which ensures smooth speed regulation and high current handling suitable for heavy loads. The microcontroller unit (such as Arduino) acts as the central control system, processing input signals from the joystick and voice recognition module, interpreting sensor data, and executing real-time motor control decisions. Key functionality was tested in both indoor and semi-outdoor environments, validating its ability to navigate safely, respond accurately to user commands, and halt immediately when obstacles are detected. The E18 sensor proved effective in providing rapid response to sudden obstructions, thereby enhancing the overall safety of the system. Power is supplied through a rechargeable battery pack, and a battery status indicator informs the user of power levels in real-time. The final prototype meets the design objectives of enhanced accessibility, reliable motion control, safety through multi-sensor input, and ease of use for differently abled individuals. The model is built on a compact and modular structure, which allows future expansion such as integration of AI-based route learning, automation, or advanced feedback systems. [8]

5.1.Circuit Testing

The circuit testing phase of the Smart Electric Wheelchair involved verifying the functionality and reliability of each electronic component before full system integration. Initial testing focused on the power supply, ensuring that the 12V battery provided stable output and that voltage regulators correctly supplied power to the microcontroller, sensors, and motor driver. The microcontroller was tested with basic I/O programs to confirm proper response from the joystick and voice input modules. The BTS7960 motor driver was tested for its ability to handle high current and control motor direction and speed using PWM signals. The DC motors responded correctly to input variations, confirming effective motion control. Obstacle detection sensors, including ultrasonic and E18 infrared sensors, were tested to ensure accurate readings and real-time response during movement. The E18 sensor successfully triggered a sudden stop when a close-range object was detected, validating the emergency stop functionality. Finally, after integrating all modules, complete system testing was conducted to confirm synchronized operation under various conditions, including obstacle avoidance, input control, and emergency handling. (Figure 14)

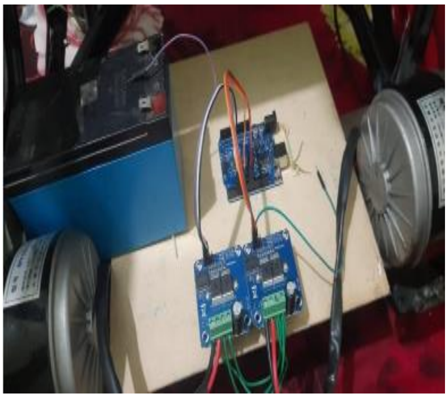

Figure 14 Circuit Testing

5.2.Welding and Chassis Fabrication

The mechanical structure of the Smart Electric Wheelchair was constructed using a mild steel (MS) frame to ensure durability and load-bearing capacity. The frame was fabricated by cutting and joining MS pipes using arc welding techniques. Welding was performed to assemble the base platform, motor mounts, and support brackets with high structural integrity. Proper alignment was ensured during welding to maintain balance and smooth operation of the wheelchair. After welding, joints were ground to remove sharp edges and improve aesthetics, followed by primer coating to prevent rusting. The rigid and stable welded frame provided a strong foundation for mounting all electrical components, wheels, and the seating structure, ensuring safety and stability during motion. (Figure 15) [9]

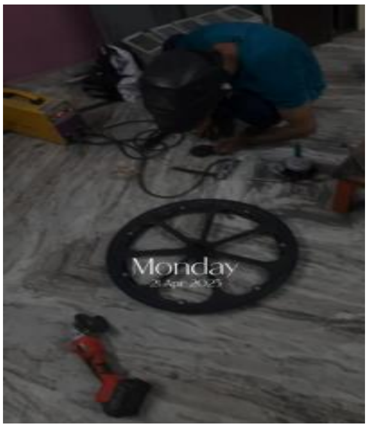

Figure 15 Welding and Chassis Fabrication

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Conclusion

The Smart Electric Wheelchair project integrates cutting-edge technologies to provide a versatile and secure mobility solution for individuals with physical disabilities. The system offers multiple control methods, including Bluetooth control, voice control, and a joystick interface, allowing the user to choose the most comfortable and accessible mode of operation. The Bluetooth control enables the wheelchair to be operated remotely via a smartphone or other Bluetooth-enabled devices, enhancing flexibility for users. Voice control provides hands-free operation, enabling individuals with limited physical mobility to command the wheelchair through simple voice commands, ensuring greater convenience and independence. The joystick control allows for precise, manual navigation, providing users with a more traditional yet reliable method of controlling their movement. For safety, the wheelchair is equipped with an E18 infrared proximity sensor, which automatically detects obstacles and triggers a stop mechanism, preventing potential collisions and ensuring the user's safety while navigating complex environments. Through the integration of these technologies, the Smart Electric Wheelchair provides users with a more personalized, secure, and adaptive experience, addressing the critical needs of mobility, safety, and independence. The modular nature of the design also allows for future upgrades, ensuring that the wheelchair can continue to evolve and meet the changing needs of its users. Ultimately, this project highlights the potential of assistive technologies to improve the quality of life for people with mobility impairments, empowering them with greater freedom and control. [10]

Future Scope

The performance of this machine is slightly away from the desired requirement. Therefore, some recommendation has been listing out for future improvement.

Hardware improvement

The Smart Electric Wheelchair project lays the groundwork for significant advancements in assistive technology, offering numerous possibilities for future development. One key area of future growth involves integrating advanced AI based navigation systems, such as machine learning algorithms, that could enable the wheelchair to learn and adapt to various environments, automatically adjusting its pathfinding to navigate dynamic obstacles and unfamiliar spaces. This would enhance its autonomy, allowing the wheelchair to operate independently in different settings. Additionally, integrating real-time health monitoring systems, such as heart rate, body temperature, and posture sensors, would provide valuable data for users and caregivers. These features could alert medical professionals in case of any health irregularities, improving the overall safety and wellbeing of the user. A GPS tracking system could also be added to enable caregivers or loved ones to track the wheelchair's location, enhancing both security and peace of mind.

Software Improvement

Software improvements for the Smart Electric Wheelchair can enhance its functionality and user experience. One key improvement is the integration of AI based navigation algorithms. These algorithms could enable the wheelchair to learn from its environment and navigate more autonomously by recognizing different obstacles, adjusting its path, and improving decision-making over time. Another area of improvement is the user interface, where gesture-based control or eye tracking software could provide more accessible control options for users with limited mobility. Additionally, a smartphone app could be developed to offer features like real-time diagnostics, health monitoring, and remote control, making the wheelchair more adaptable to the user's needs.

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