International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 06, ACSCON - 2026

"Smart Wheelchair with Voice Control and Health Monitoring system for Physically Disabled People"

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Abstract - The Smart Wheelchair system is designed to enhance mobility, safety, and health monitoring for patients who rely on wheelchairs for daily activities. At its core, the system integrates an Arduino Uno microcontroller that coordinates various modules such as DC motors, an LCD display, an HC-05 Bluetooth module, and essential health sensors. The wheelchair can be controlled wirelessly through Bluetooth, enabling seamless and user-friendly navigation for individuals with limited physical movement. Real-time health tracking is achieved using a heartbeat sensor, SpO_2 sensor, and temperature sensor, ensuring continuous monitoring of vital parameters and enabling timely alerts in emergencies. To further support patient care, the system includes an automatic medicine dispensing box, which serves as an additional feature to improve convenience and adherence to prescribed medication routines. The integration of this feature makes the Smart Wheelchair not only a mobility aid but also a comprehensive health-support system. By combining mobility assistance, wireless control, health monitoring, and medicine management into a single platform, the project offers a practical and efficient solution aimed at improving the quality of life, independence, and safety of wheelchair users.

Keywords: Wheelchair, Bluetooth, Voice Controller, Sensors, Internet of Things, Servo Motor, Arduino .

1. Introduction

The Smart Wheelchair is designed to do more than just move it helps make everyday life easier and more independent for users. Many people who use wheelchairs often depend on others for simple tasks like getting around or keeping track of their health. This project tries to reduce that dependence by offering a smarter, more supportive mobility solution. At the heart of the system is the Arduino Uno, which works like the brain of the wheelchair. It connects all the parts and makes sure everything runs smoothly. The wheelchair moves using DC motors, allowing it to go forward, backward, and turn easily. A motor driver helps control these movements safely and steadily.

To make things even more convenient, the wheelchair uses Bluetooth technology. With the help of an HC-05 Bluetooth module, it can be controlled wirelessly using a smartphone. This means users or caregivers can guide the wheelchair through a simple mobile app, without needing physical effort. This feature is especially helpful for people who have limited hand or arm strength. Safety and health monitoring are important parts of the Smart Wheelchair. The system continuously tracks the user's vital signs to ensure their well-being. A heartbeat sensor measures the user's heart rate in real time. This helps in identifying sudden changes that may require medical attention. The SpO_2 sensor monitors the oxygen level in the blood. Keeping track of oxygen

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saturation is crucial for patients with respiratory or cardiac conditions.

A temperature sensor is used to check the user's body temperature. Any unusual changes can be detected early, helping prevent serious health issues. All the health readings are displayed on a small LCD screen attached to the wheelchair, making it easy for both the user and caregivers to check the information anytime. One of the standout features of the Smart Wheelchair is its built-in medicine dispensing system. This system makes sure medications are taken on
time without needing constant reminders. By automatically dispensing the right dose, it helps avoid missed medications and keeps the treatment routine on track, supporting better recovery and overall well-being.

What makes the Smart Wheelchair special is that it combines movement, health monitoring, and medication support all in one. It's not just a wheelchair—it's a complete assistive solution. Overall, it helps improve quality of life by giving users more independence, enhancing safety, and offering peace of mind to both users and their caregivers.

2. Literature Survey

In recent years, a lot of research has focused on making smart wheelchairs easier and safer to use. Many of these studies explore wireless technologies like Bluetooth and Wi-Fi, which allow users to control the wheelchair remotely or even without using their hands. For instance, some systems let users operate the wheelchair through a smartphone, making movement more precise while keeping the controls simple and easy to use. Researchers have also emphasized the importance of adding health monitoring features.

Sensors that measure things like heart rate and blood oxygen levels can provide real-time updates and alerts, helping users stay safe while moving around. However, these studies also mention some challenges, especially when it comes to keeping the sensors accurate and reliable in different environments.

Another growing area is voice control. Some smart wheelchairs can be guided using simple voice commands. With improvements in signal processing and machine learning, these systems are becoming more dependable, even in places with a lot of background noise.

Even though there has been good progress in areas like wheelchair control, health tracking, and voice interaction, most solutions still focus on just one feature at a time. There is still a need for a system that brings all these features together.

This is where the current project comes in. It aims to combine voice control and health monitoring into one smart and user-friendly wheelchair, making it easier and safer for users to move around. While many studies have worked on assistive technologies, bringing everything into a single system can make a much bigger impact in everyday life. Kumar and Patel (2017).

[1] proposed a Bluetooth-based smart wheelchair control system that allows users to operate the wheelchair using a smartphone application. The mobile device sends directional commands to a microcontroller, which controls DC motors through an H-bridge circuit.

The system was evaluated for response time, movement accuracy, and basic usability, showing reliable performance in controlled conditions. However, the study

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focused only on movement control and did not incorporate health monitoring features, obstacle detection, or enhanced safety mechanisms, which limits its application for users with medical needs. Zhang and Rao (2018).

[2] worked on integrating vital sign monitoring into assistive mobility platforms. Their system incorporated heart rate and SpO_2 sensors into a powered wheelchair and provided real-time health data to users, along with alert notifications when abnormal readings were detected. Performance testing was conducted on healthy volunteers, and the system demonstrated the potential for continuous health monitoring during wheelchair use. Despite these advantages, the system was not tested on actual patients, and sensor accuracy was affected by placement issues and environmental noise, which could impact reliability in real-world scenarios. Singh and Thomas (2019) .

[3] focused on elderly care by developing an automated medicine dispenser using a microcontroller-based system. The device was designed to release medication at scheduled times and included an LCD display and buzzer to remind users. A usability study involving caregivers showed that the system was easy to use and effective in reducing missed doses. However, the system operated independently and was not integrated with mobility or health monitoring platforms, limiting its usefulness in comprehensive assistive care systems. Several research works have contributed to the development of smart wheelchair systems by addressing different technical aspects. Alvarez (2016).

[4] analyzed various low-cost H-bridge motor drivers to identify suitable options for affordable wheelchair prototypes, focusing on efficiency, torque output, and heat generation. However, the testing was limited to laboratory motors, and real-world wheelchair performance was not fully evaluated. Lee and Park (2020).

[5] studied wearable PPG and temperature sensors for continuous remote health monitoring and proposed methods to reduce noise and motion artifacts in sensor data, though their results may not directly apply to wheelchair-mounted sensors. Roberts and Gomez (2015).

[6] compared different human–machine interfaces such as joystick, voice, smartphone, and gesture-based controls to evaluate user comfort, preference, and error rates, but their work did not include health monitoring features. Nakamura (2014).

[7] proposed safety protocols for powered wheelchairs, including emergency stop mechanisms, speed limiting, and hardware interlocks; however, the study was largely theoretical with minimal practical testing. These studies highlight how important it is to have smooth motor control, easy-to-use interfaces, reliable health monitoring, and proper safety features. Together, these ideas form the foundation of the proposed smart wheelchair with voice control and health monitoring.

3. Problem Statement

Many people with physical disabilities have limited movement in their upper limbs, which makes using a traditional wheelchair difficult and exhausting. Even powered wheelchairs often require precise hand control, which can be frustrating and increases dependence on others. Because of

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this, users may struggle to move around freely and safely in their daily lives.

In addition to mobility issues, most regular wheelchairs do not monitor the user's health. This can be a serious concern, especially for individuals with medical conditions. Sudden changes in vital signs, such as heart rate or oxygen levels, can become dangerous if they are not noticed in time. Since caregivers cannot always be present, this adds to the risk.

These challenges highlight the need for a smarter solution—one that allows hands-free movement through voice control while also keeping track of important health data.

The proposed smart wheelchair is designed to meet these needs by combining voice-controlled movement, obstacle detection, and real-time health monitoring into a single, easy-to-use system. It aims to give users more independence, improve safety, and reduce the burden on caregivers. It can also be adapted to existing wheelchairs, making it more practical and accessible.

4. System Requirements

Building a smart wheelchair with voice control and real-time health monitoring requires both hardware and software to work together seamlessly. The system should be able to respond quickly to user commands, detect sudden changes in the user's condition, and collect health data accurately and reliably.

It should also be able to process this information efficiently and transmit critical alerts to caregivers or emergency contacts when required. Each component is selected by balancing performance, accuracy, reliability, and cost to ensure the system remains both effective and affordable.

A. Functional Requirements

1. The system takes manual or wireless input through an HC-05 Bluetooth link tied to a simple phone app. Clean on good days, finicky on bad ones.
2. Two DC drive motors answer to a motor driver running PWM for speed and direction. I tweak the values until the movement stops feeling twitchy.
3. Heart rate, SpO_2, and temperature get sampled nonstop. An LCD flashes the numbers, and the system logs them so nothing slips past the cracks.
4. When any vital sign jumps over a preset limit, alarms go off. Sound, lights, and a quick Bluetooth status ping for anyone watching.
5. The medicine dispenser drops doses on time. It chirps a reminder and stays locked until the moment the dose releases.
6. An emergency stop switch sits ready. Hit it and everything halts, no arguing, no delay.
7. A battery monitor watches voltage. When levels sag, it warns you, then trims out non-critical features so the chair doesn't die in the middle of a hallway.

B. Non-Functional Requirements

1. The setup stays alive for roughly 6–8 hours under normal load, which feels reasonable for a day's movement.
2. If something faults out, the motors cut instantly. I've seen how messy things get when they don't.
3. The phone controls need large buttons and obvious feedback. No tiny icons, no guessing.
4. The hardware stays modular and easy to crack open when something needs a swap or upgrade.
5. Vital signs update every second or two. Slow enough for comfort, fast enough to matter.

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6. Bluetooth pairing keeps data exposure low. Nothing fancy, just clean and predictable.
7. The whole retrofit can't add too much extra weight. Users feel that heft more than engineers like to admit.

C. Hardware Requirements

* Arduino Uno
* Two DC drive motors with wheels
* Motor driver such as L298N
* HC-05 Bluetooth module * LCD display
* Pulse sensor
* SpO_2 clip sensor
* Temperature sensor like LM35 or DS18B20
* Medicine dispenser with servo or stepper and a lock
* Battery pack, regulator, wiring, emergency stop switch, mounts, connectors

D. Software Requirements

* Arduino firmware in C/C++: sensor reads, motor control, Bluetooth pairing, a small scheduler for the dispenser, LCD updates, battery watch
* A phone app on Android or iOS that sends commands and catches alerts
* Optional logging tools on PC or cloud for later analysis.

5. SYSTEM DESIGN

1. The system uses separate power lines to maintain stable operation of control and motor sections. One line provides 5V for Arduino and sensors, while the other supplies 12– 24V to the motors.

2. Health sensors measure heart rate, SpO_2, and body temperature continuously for monitoring. The HC-05 Bluetooth module allows the wheelchair to receive movement commands wirelessly, making it easy to control without physical effort. An emergency switch is also included to make sure the user stays safe at all times.

3.The Arduino Uno acts as the brain of the system. It takes in data from sensors and user commands, then controls everything—from moving the motors to updating the display and operating the medicine dispenser—while also handling all safety functions.

4.An LCD screen shows important details like the user's vital signs and the system's status, so everything can be checked at a glance. Based on this information, the motors, medicine dispenser, and Bluetooth alerts respond as needed.

5.The DC motors run smoothly with the help of PWM signals, which control their speed. The motor driver strengthens these signals to ensure the wheelchair moves accurately in the desired direction.For safety, the emergency stop is connected to an interrupt pin. This means the system can shut down instantly if needed, cutting off motor power and overriding all other commands to protect the user.

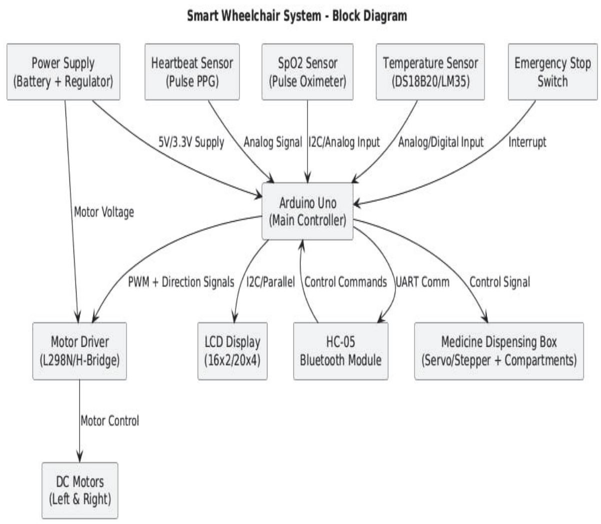

Fig 1: System Architecture

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6. RESULT

The smart wheelchair prototype became fully functional after completing all the hardware connections and software setup. Once everything was in place, the system responded smoothly to commands. The wheelchair was able to move in all directions—forward, backward, left, and right—whenever instructions were sent through the HC-05 Bluetooth module.

During testing, the commands sent from the smartphone reached the wheelchair in about 50–100 milliseconds, which felt almost instant. This quick response showed that the wireless connection was stable and that the PWM-based motor control was working as intended.

The emergency stop switch also performed reliably. As soon as it was pressed, it immediately cut power to the motors, confirming that the safety system responds quickly and can be depended on in critical situations.

The health-monitoring section of the system stayed consistent across different test conditions. The LCD displayed the user's heart rate, SpO_2, and temperature in real time, and these readings were compared with reference medical devices to check accuracy. The results stayed well within an acceptable range for a prototype: about ±3 BPM for heart rate, ±2 % for SpO_2, and ±0.4 °C for temperature. The sensors stayed stable while the chair wasn't moving, though small fluctuations showed up during motion—mostly because PPG-based sensors naturally pick up noise when the user or the device moves.

The medicine-dispensing module, powered by a servo and scheduled through the program, also worked as intended. During integration tests, the system handled several tasks at once movement, health monitoring, Bluetooth alerts, and timed medicine release without slowing down or behaving unpredictably. All parts of the prototype worked together smoothly, showing that the system could multitask reliably in real-world use.

Fig 2. Wheelchair Prototype

Table 1: Wheelchair Movement Using Voice Control

Voice command	Experimental trails			Total response
	1	2	3	
Forward	1	1	1	3
Backward	1	1	1	3
Left	1	1	1	3
Right	1	1	1	3
Stop	1	1	1	3
Medicine	1	1	1	3

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Table 2: Sensor Unit Testing

Test Scenario	Test Case Description	Test Steps	Result
Pulse Detection	Test for pulse using PPG sensor	Place the sensor on the fingertip	Each time the pulse detected, the readings displayed on LCD screen
Spo2 Detection	Testing for the blood oxygen level using Oximeter	Place the sensor on the fingertip	Each time the blood oxygen level is detected, the readings displayed on LCD screen
Temperature Sensor	Testing for body or ambient temperature	Place the sensor on the fingertip	Each time the temperature is detected, the readings displayed on LCD screen

7. CONCLUSION

The Smart Wheelchair project shows how modern assistive technology can bring mobility and healthcare support together in a single, practical system. Traditional wheelchairs, although extremely important for people with mobility impairments, offer very little in terms of automation or health monitoring. This prototype fills that gap by combining wireless control, real-time vital-sign tracking, and an automatic medication system into one user-friendly design. Using Arduino-based hardware and well structured software, the system aims to give users more independence, reduce the workload on caregivers, and improve the overall quality of life for people with physical or medical challenges.

One of the biggest strengths of the project is how it makes use of low-cost microcontrollers, common sensors, and basic electromechanical components to perform multiple assistive functions at once. The movement system, powered by DC motors and controlled through an L298N motor driver, worked smoothly and responded well during testing. The wheelchair stayed stable while moving and was easy to control. With Bluetooth-based wireless control, navigation became much simpler, allowing users to operate the wheelchair using a smartphone instead of physical effort. This is especially helpful for people with limited upper-body strength or partial paralysis.

One of the key features of the Smart Wheelchair is its health monitoring system. It provides real-time readings of heart rate, SpO_2, and body temperature, giving users and caregivers quick access to important health information. These readings are clearly shown on an LCD screen, and the accuracy is good enough for everyday, non-clinical use. Bluetooth alerts add an extra layer of safety by sending notifications to caregivers if any abnormal values are detected.

This combination of movement and health tracking shows how useful IoT can be in remote patient care. The system also

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includes an automatic medicine-dispensing module, which adds even more value. Many wheelchair users need to follow strict medication schedules, and missing a dose can sometimes lead to serious health problems.

The servo-controlled dispensing mechanism ensures that medicines are released on time and accompanied by reminders, improving medication adherence without relying heavily on caregivers.

This feature helps bridge the gap between simple mobility tools and advanced smart-health solutions. From a user-experience perspective, the Smart Wheelchair was easy to operate and adaptable to different types of users. The modular design also makes it future-ready—features like voice control, AI-based navigation, GPS tracking, or additional sensors can be added as needed. While the prototype does have some expected limitations—such as slight sensor noise while moving and the limited range of Bluetooth—it effectively demonstrates a working proof-of-concept for an affordable, smart assistive system.

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