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Design & Development of Voice-Controlled Wheel Chair with Health Monitoring System

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Abstract –This research presents the design and development of a smart, voice-controlled wheelchair system tailored for patients with limited mobility. The system is powered by an Arduino microcontroller integrated with an HC-05 Bluetooth module to receive voice commands transmitted from a mobile application. These commands are decoded and converted into motion signals to drive the wheelchair using high-torque wiper motors. For real-time health monitoring, a pulse sensor continuously measures the user's heartbeat, and an ESP8266 Wi-Fi module communicates abnormal readings via SMS alerts through the Blynk IoT platform. The mechanical structure of the wheelchair is fabricated using a 30×30×2 mm mild steel hollow square tube, offering a balance of strength and lightweight mobility. This integration of assistive control and vital health tracking enhances patient independence while ensuring safety through remote alerts. The proposed system provides a cost-effective, user-friendly solution for both caregivers and patients, with potential applications in home care, rehabilitation centres, and eldercare.

Key Words: Voice controlled, Wheel Chair, ESP, Arduino, HC-05, Pulse Monitoring & safety.

1.INTRODUCTION

Mobility impairments present significant challenges to individuals in maintaining independence and performing daily tasks. Traditional wheelchairs, although effective in providing basic movement support, often require manual effort or external assistance, which may not be feasible for users with severe physical limitations [1]. In response to this issue, the integration of automation and smart control systems into mobility aids has gained momentum. This study introduces an innovative voice-controlled wheelchair that enhances user autonomy by interpreting vocal instructions through a Bluetooth-based communication system.

The system is built around an Arduino microcontroller that interfaces with an HC-05 Bluetooth module, enabling wireless voice command reception. These commands are processed and executed to control the motion of the wheelchair, which is driven by robust wiper motors suited for load-bearing and continuous operation [2]. Simultaneously, a heartbeat sensor monitors the user's pulse in real time, offering an added layer of health awareness. Critical health information is transmitted using an ESP8266 Wi-Fi module connected to the Blynk IoT platform, which sends instant alerts in case of abnormal heart activity.

Mechanically, the wheelchair frame is fabricated using a 30×30×2 mm mild steel hollow section, chosen for its durability, ease of fabrication, and optimal weight-to-strength ratio. This project bridges assistive mobility and health surveillance, providing a dual-function system that not only supports physical movement but also ensures the safety of the user through remote health tracking. The proposed design offers a practical, scalable solution for rehabilitation centers, home-based care, and elderly support environments.

1.1 OBJECTIVE

- To design and develop a wheelchair that can be controlled using voice commands for users with limited hand mobility.
- To integrate an HC-05 Bluetooth module for reliable voice signal transmission from a smartphone to the Arduino microcontroller.
- To employ a heartbeat sensor for real-time monitoring of the patient's health status during wheelchair operation.
- To transmit heartbeat data and emergency alerts via the ESP8266 Wi-Fi module using the Blynk IoT platform.
- To fabricate a lightweight yet strong wheelchair frame using 30×30×2 mm hollow mild steel sections suitable for practical mobility.
- To utilize wiper motors for smooth and controlled motion in forward, backward, left, and right directions.
- To provide a cost-effective, smart mobility solution that ensures both user autonomy and health safety.

1.2 IMPORTANCE OF THE PROJECT

The development of a voice-controlled wheelchair integrated with health monitoring is vital in addressing the mobility and safety challenges faced by individuals with physical disabilities or age-related limitations. This system empowers users to move independently without relying on manual controls, which can be difficult or impossible for many [2]. Incorporating real-time heartbeat tracking adds a crucial health safety feature, enabling caregivers or medical personnel to respond quickly in emergencies [3]. The wireless transmission of alerts via IoT ensures timely communication without physical presence. By combining mobility assistance with smart health surveillance in a cost-effective setup, this innovation significantly enhances the quality of life for patients, reduces dependency, and opens pathways for smarter rehabilitation and eldercare solutions [11].

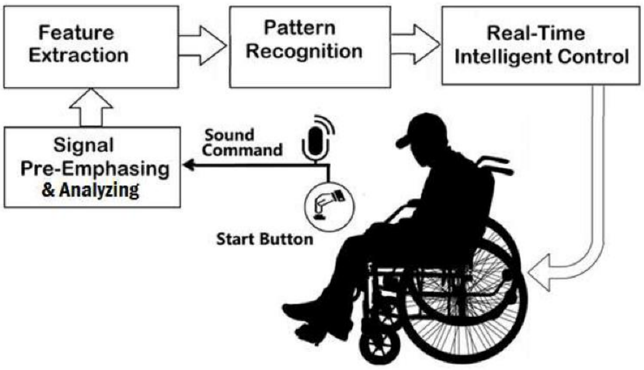

Fig -1 Smart Assisted wheel Chair

2. EMBEDDED SYSTEM

The automatic wheelchair operates based on voice commands given by the user through a mobile phone application or voice assistant. These commands are wirelessly transmitted via the HC-05 Bluetooth module to the Arduino microcontroller, which processes and converts them into control signals. Depending on the command (e.g., forward, backward, left, right, stop), the Arduino activates the wiper motors that drive the wheelchair wheels accordingly.

Simultaneously, a heartbeat sensor attached to the user's finger or wrist continuously monitors the user's pulse rate. This real-time health data is sent to the ESP8266 Wi-Fi module, which is programmed to connect with the Blynk IoT platform [6]. If the heart rate exceeds or drops below the predefined threshold, an alert message is automatically sent to a registered mobile number via SMS or notification on the Blynk app.

The wheelchair's frame is fabricated using 30×30×2 mm mild steel hollow square tubing, providing both strength and lightness. This ensures stability, ease of transport, and durability. Power is supplied by a rechargeable 12V battery that energizes both the control system and the motors.

Arduino Uno: A microcontroller based on the ATmega328P. Controls the entire system by processing inputs and generating motor control signals.

HC-05 Bluetooth Module: A serial communication device for short-range wireless transmission. Receives voice commands from the user's smartphone and sends them to the Arduino.

Wiper Motors: High-torque DC motors, commonly used in vehicle windshield systems. Responsible for moving the wheelchair forward, backward, left, or right based on commands.

ESP8266 Wi-Fi Module: A compact Wi-Fi-enabled microcontroller with built-in TCP/IP stack. Sends real-time heartbeat data and emergency alerts to the Blynk IoT app.

Heartbeat Sensor: An optical sensor that detects the user's pulse rate using fingertip or wrist blood flow. Continuously monitors the user's heart rate and provides vital health data to the system.

Blynk IoT Platform: A cloud-based mobile application platform for controlling and monitoring IoT devices. Displays live heart rate data and sends alert notifications during abnormal heart activity.

12V Lead-Acid Battery: Rechargeable battery used to power motors and electronic components. Acts as the main power source for both mobility and control circuits.

30×30×2 mm Mild Steel (MS) Hollow Tube: Square-section steel tubing with good strength-to-weight ratio. Used for fabricating a durable, lightweight wheelchair frame structure.

Motor Driver Module (L298N): Dual H-Bridge motor driver circuit. Enables direction and speed control of the wiper motors through Arduino.

Wheels and Caster Wheels: Rubberized or plastic wheels with swivel castors for better movement. Ensure smooth and balanced mobility across different surfaces.

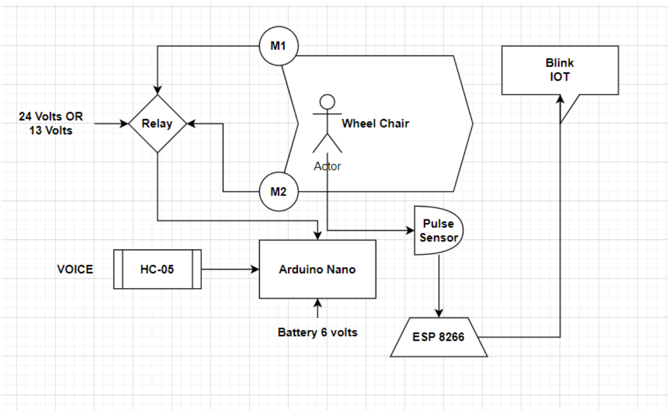

Fig -2 Schematic diagram of Project

3. DESIGN & CALCULATION

The hub motor readily available in market it is permanent magnet, self-generating motors with 350 -watt power and 600 rpm. The motors run on 24 volts and 11 amps power source. These motors reach a peak current during starting equal to 15 amps.

Torque generated by motor

Power of motor = 350 N- m /s

Rpm of motor = 600 rpm

Calculation Fo Final Speed & Torque

$$P = 2\pi NT/60$$

$$350 = 2\pi x600xT/60\ x\ motor\ efficiency$$

$$(Motor\ efficiency\ =\ 60\%)$$

$$T\ =\ 5.57\ x\ 0.6\ N-m$$

$$T\ =\ 3.34\ N-m\ =\ 3342\ N-mm$$

$$Force\ generated\ at\ wheel$$

$$Torque\ =\ Force\ X\ Radius$$

$$F\ =\ 3342/75$$

Force = 44.56 N

Speed of wheel chair

$$V = \pi\ DN/60$$

$$V\ =\ 3.12\ x\ 0.150\ x\ 600/60$$

$$V = \ 4.695\ m/sec =\ 16.9\ Km/hr$$

Designing Of Motor Shaft

$Load\ of\ W\ kg\ on\ motor\ pipe, so\ it\ may\ fail\ under\ bending.$

$$Bending\ Moment\ =\ WL\ =\ W\ \times\ 20$$

$$=\ 20W\ N-mm$$

$$Z\ section\ of\ modulus\ =\ \pi\ (D\ 4 -\ d\ 4)\ /D\ x\ 32$$

$$=\ \pi\ (154 -\ 64)\ /\ (15\ x\ 32)$$

$$Z =\ 102.77\ mm3$$

$$\sigma b\ (allowable\ bending\ stress)\ =\ M/Z$$

$$655\ =\ 20W/102.77$$

$$W\ =\ 3365.71\ N\ =\ 342.9\ kg$$

$As\ induced\ load\ is\ less\ then\ allowable\ load\ i.e., 100\ kg$
$design\ is\ safe.$

Design of handle pipe

$$Length\ of\ handle\ pipe\ =\ 500\ mm$$

$$Bending\ Moment\ =\ WL\ =\ W\ \times\ 250$$

$$=\ 250W\ N-mm$$

$$Z\ section\ of\ modulus\ =\ \pi\ (D\ 4 -\ d\ 4)\ /D\ x\ 32$$

$$=\ \pi\ (204 -\ 174)\ /\ (20\ x\ 32)$$

$$Z =\ 375.41\ mm3$$

$$\sigma b\ (allowable\ bending\ stress)\ =\ M/Z$$

$$270\ =\ 250W/375.41$$

$$W\ =\ 405.44\ N\ =\ 41.3\ kg$$

Allowable load for handle pipe is 41.3 kg max

Design for handle shaft

$$Diameter\ of\ handle\ shaft$$

$$Length\ =\ 215\ mm$$

$$Bending\ Moment\ =\ WL\ =\ W\ \times\ 215$$

$$=\ 215\ W\ N-mm$$

$$Z\ section\ of\ modulus\ =\ Z =\ \pi/32\ x\ d3$$

$$Z =\ \pi/32\ x\ 20\ 3$$

$$Z =\ 785\ mm3$$

$$\sigma b\ (allowable\ bending\ stress)\ =\ M/Z$$

$$270\ =\ 215W/785$$

$$W\ =\ 985.81\ N\ =\ 100.43\ kg$$

Design

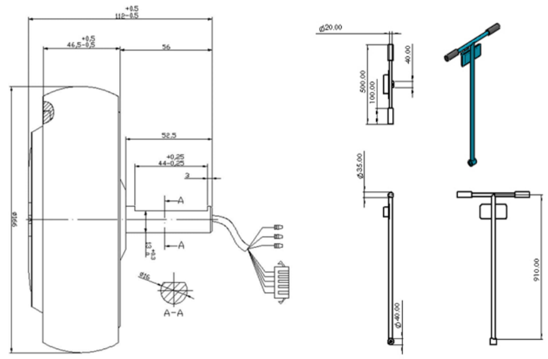

Fig -3 Proposed Wheel Chair wheels & handle

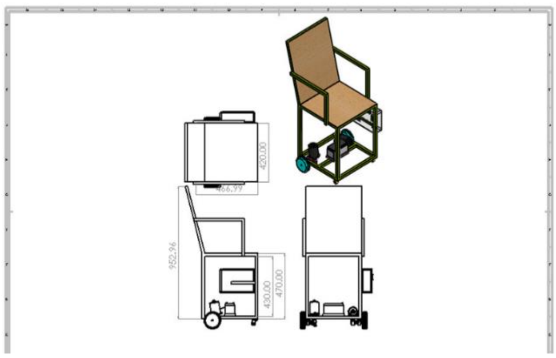

Fig -4 Drafting of Proposed Wheel Chair

Fig -5 Fabricated Modal

4. CONCLUSION

The development of the voice-controlled wheelchair integrated with health monitoring marks a significant step toward smart assistive technologies for individuals with physical disabilities or limited mobility. By combining voice recognition using the HC-05 Bluetooth module and Arduino with vital sign tracking via a heartbeat sensor, the system ensures both independent mobility and continuous health observation. The integration of the ESP8266 Wi-Fi module and the Blynk platform provides a reliable way to transmit real-time health alerts, enhancing patient safety.

Mechanically, the wheelchair's design using a mild steel hollow frame and wiper motors offers a stable and robust structure capable of navigating with ease. The project demonstrates how low-cost components and open-source platforms can be utilized to build an intelligent mobility solution. It holds promise for future upgrades, such as obstacle detection, GPS navigation, and advanced health diagnostics, making it a scalable and impactful innovation in assistive healthcare technologies.

Table -1: Cost estimation

PART NAME	MAT	QTY	COST
WHEEL CHAIR	STD	1 NO	3500
SQUARE PIPE	MS	8 KG	880
BEARING	CI	2 NOS	800
HUB MOTOR	STD	1 NO	9000
BATTERY 12 V	LEAD ACID	2 NOS	1800
HOLLOW PIPE	MS	1 NO	200
SWITCH	STD	1 NO	200
CASTOR WHEEL	STD	2 NOS	300
CHARGER	STD	1 NO	500
SPRAY PAINT	STD	2 NOS	400
WIRES	CU	5 M	120
SWITCH	STD	1 NO	90
NUT BOLT WASHER	MS	2 KG	220
CHARGER	STD	1 NO	450
MISCELLINOUS	-	-	350
TOTAL			18810

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