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EE Gand Head Movement Controlled Wheelchair

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Abstract: *Mobility impairment due to neurological disorders, spinal cord injuries, or muscular dystrophy significantly affects an individual's independence and quality of life. Conventional wheelchairs, which rely on manual operation or joystick controls, may not be suitable for users with severe disabilities who lack the required motor functions. To address this challenge, this project presents an EEG and head movement-controlled wheelchair, which provides a hands-free and intelligent mobility solution. The proposed system integrates brainwave (EEG) signals to detect the user's consciousness and head movements to control the wheelchair's direction. The dual-input approach ensures that users with varying degrees of motor impairment can operate the wheelchair without physical effort. Additionally, an obstacle detection system enhances safety by preventing collisions. The fusion of brainwave analysis, motion sensing, and intelligent navigation makes this system a significant advancement in assistive mobility technology. The system has been tested for accuracy, safety, and real-time response.*

Keywords: EEG, head movement, wheelchair control, brainwave detection, obstacle avoidance, assistive mobility

I. INTRODUCTION

Mobility plays a crucial role in an individual's ability to live independently. For individuals with severe motor disabilities, traditional wheelchairs requiring manual operation may not be feasible. This paper presents an EEG and head movement-controlled wheelchair designed for hands-free navigation, ensuring accessibility for individuals with mobility impairments. The integration of EEG-based consciousness detection with head movement tracking provides an intuitive control system while ensuring safety through obstacle detection mechanisms. Assistive mobility solutions have evolved with advancements in brain-computer interface (BCI) technologies. EEG-based systems can interpret neural activity, allowing users to control external devices without physical movement. Head movement tracking further complements this approach, ensuring smooth and responsive navigation for users with different motor impairments.

II. LITERATURE REVIEW

Recent studies highlight various assistive technologies for wheelchair control, including EEG-based interfaces and motion-sensing techniques. Casali et al. (2013) introduced an EEG-based consciousness detection system, while Sathya and Ramakrishnan (2018) developed an inertial sensor-based smart wheelchair. Li et al. (2019) proposed a sensor fusion approach to enhance wheelchair control precision. These studies demonstrate the potential of combining EEG and motion-sensing for improved mobility solutions. Furthermore, sensor fusion techniques integrating gyroscopes and accelerometers improve control accuracy, reducing unintended movements.

III. SYSTEM DESIGN AND METHODOLOGY

A. System Components

- 1) EEG Subsystem: Detects brainwave patterns to determine user intent.
- 2) Head Movement Detection: MPU6050 gyroscope detects head tilts to control direction.
- 3) Obstacle Detection: Ultrasonic sensors prevent collisions.
- 4) Control System: ESP32 microcontroller processes inputs and commands motor movement via an L293D motor driver.

B. Block Diagram

Figure 1 illustrates the block diagram of the proposed EEG and head movement-controlled wheelchair system.

C. Hardware Implementation

The EEG sensor captures neural signals, which are amplified, filtered, and processed before being transmitted to the ESP32 microcontroller. The MPU6050 gyroscope detects head orientation and movement, allowing precise control.

The ultrasonic sensor ensures obstacle detection, stopping or redirecting the wheelchair when necessary. A 16x2 LCD display provides real-time status updates to the user, improving system feedback. The L293D motor driver regulates motor power, ensuring smooth acceleration and deceleration.

IV. COMPONENTS REQUIRED WITH DIAGRAMS

- 1) ESP32 Microcontroller: A low-power microcontroller with built-in WiFi and Bluetooth for processing sensor data and controlling motors.
- 2) EEG Sensor: Captures brainwave signals and translates them into movement commands.
- 3) MPU6050 Gyroscope and Accelerometer: Detects head movement for directional control.

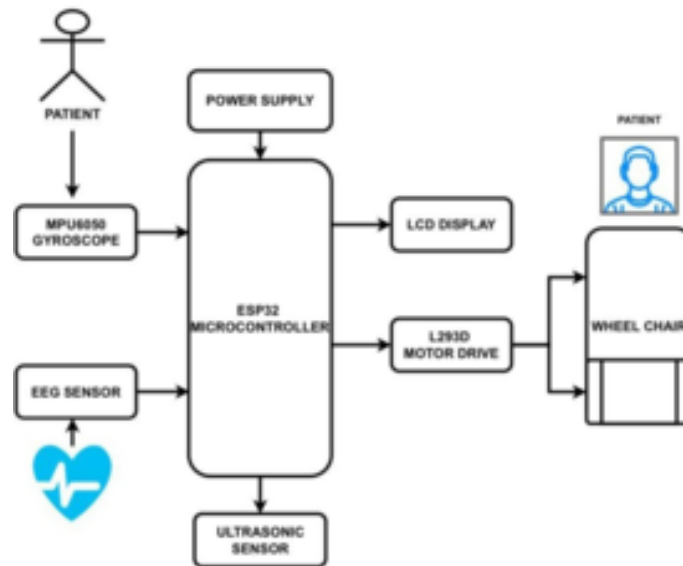


Fig.1. Block Diagram of the EEG and Head Movement Controlled Wheelchair

- 4) Ultrasonic Sensor: Measures distances to detect and avoid obstacles.
- 5) L293D Motor Driver: Controls the wheelchair's motors by regulating power and direction.
- 6) DC Motors: Drive the wheelchair based on the processed inputs.
- 7) LCD Display with I2C Interface: Provides real-time feedback on wheelchair status and detected obstacles.
- 8) Rechargeable Battery and Power Management Circuit: Ensures reliable power supply to all components.
- 9) Bluetooth Module for Wireless Communication: Enables wireless data transmission for remote monitoring.
- 10) Wheelchair Frame and Mechanical Assembly: The structural framework that holds all components and enables smooth movement.

Figures 2, 3, 4, 5, and 6 illustrate the major hardware components used in the system.



Fig.2. ESP32 Microcontroller



Fig.3.EEGSensor

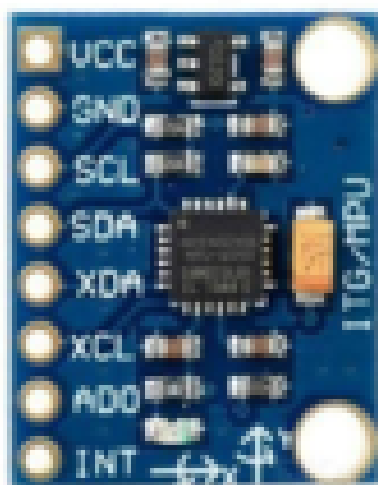


Fig.4.MPU6050GyroscopeandAccelerometer

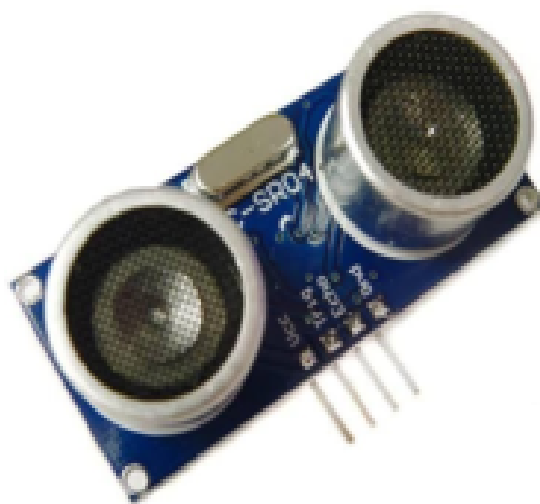


Fig.5.UltrasonicSensor

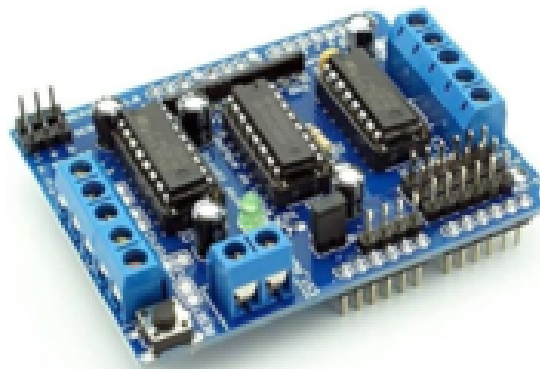


Fig.6.L293DMotorDriver

V. CONCLUSION AND FUTURE SCOPE

This project presents an innovative assistive mobility solution integrating EEG and head movement control. The system offers a hands-free alternative to traditional wheelchair control, enhancing accessibility for individuals with severe disabilities. Future improvements include AI-based signal interpretation, autonomous navigation, and cloud connectivity for remote monitoring. Additionally, machine learning models can be integrated to improve EEG signal processing and prediction accuracy. Enhanced safety features, such as emergency braking and terrain adaptability, could further improve the system's robustness.

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