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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 relyonmanual operationor joystick controls, maynotbesuitableforuserswith severedisabilitieswholackthe required motor functions. To address this challenge, this project presents an EEG and head movement-controlled wheelchair, whichprovidesahands-free and intelligentmobilitysolution.The proposed system integrates brainwave (EEG) signals to detectthe user's consciousness and head movements to control the wheelchair's direction. The dual-input approach ensures that userswith varyingdegreesofmotorimpairmentcanoperate the wheelchair without physical effort. Additionally, an obstacle detection system enhances safety by preventing collisions. The fusionofbrainwave analysis,motionsensing,andintelligentnav- igation 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

Mobilityplaysacrucialroleinanindividual'sabilitytolive independently. For individuals with severe motor disabilities, traditionalwheelchairsrequiringmanualoperationmaynot be feasible. This paper presents an EEG and head movement- controlled wheelchair designed for hands-free navigation, en- suringaccessibilityforindividualswithmobilityimpairments. Theintegrationof EEG-basedconsciousnessdetectionwith head movement tracking provides an intuitive control system while ensuring safety through obstacle detection mechanisms. Assistivemobilitysolutionshaveevolvedwithadvance- mentsinbrain-computerinterface (BCI)technologies.EEG- basedsystemscaninterpretneuralactivity,allowingusers to control external devices without physical movement. Head movement tracking furthercomplementsthis approach,ensur- ingsmoothandresponsivenavigation for userswithdifferent
motorimpairments.

II. LITERATUR EREVIEW

Recentstudieshighlightvariousassistivetechnologiesfor 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)developedaninertialsensor-basedsmart wheelchair.Lietal.(2019)proposedasensorfusionapproach toenhance wheel chaircontrolprecision. Thesestudiesdemon- stratethepotentialofcombiningEEGandmotion-sensing for improved mobility solutions. Furthermore, sensor fusion techniquesintegratinggyroscopesandaccelerometersimprove control accuracy, reducing unintended movements.

III. SYSTEM DESIGN AND METHODOLOGY

A. System Components

1) EEG Subsystem: Detects brainwave patterns to deter- mine user intent.
2) Head Movement Detection: MPU6050 gyroscope de- tects head tilts to control direction.
3) Obstacle Detection: Ultrasonic sensors prevent colli- sions.
4) ControlSystem:ESP32microcontrollerprocessesinputs 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.

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C. Hardware Implementation

The EEG sensor captures neural signals, which are am- plified,filtered,andprocessedbeforebeingtransmittedto the ESP32 microcontroller. The MPU6050 gyroscope detects headorientationandmovement,allowingprecisecontrol.

Theultrasonicsensorensuresobstacledetection,stopping or redirecting the wheelchair when necessary. A 16x2 LCD displayprovidesreal-timestatusupdatestotheuser,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) MPU6050GyroscopeandAccelerometer:Detectshead movement for directional control.

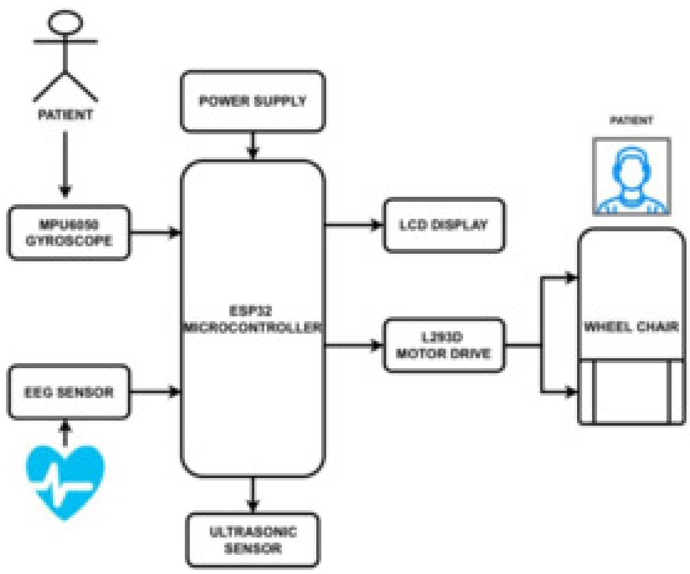

Fig.1. BlockDiagramoftheEEGandHeadMovementControlledWheelchair

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) DCMotors:Drivethewheelchairbasedontheprocessed inputs.
7) LCD Display with I2C Interface: Provides real-time feedback on wheelchair status and detected obstacles.
8) Rechargeable Battery and Power Management Cir- cuit: Ensures reliable power supply to all components.
9) Bluetooth Module for Wireless Communication: En- ables wireless data transmission for remote monitoring.
10) Wheelchair Frame and Mechanical Assembly: The structural framework that holds all components and en- ables smooth movement.

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

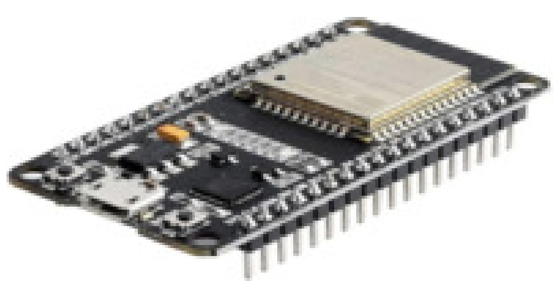

Fig.2.ESP32Microcontroller

Fig.3.EEGSensor

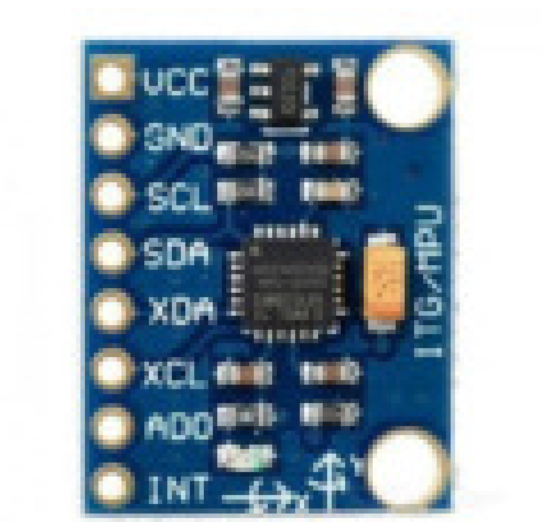

Fig.4.MPU6050GyroscopeandAccelerometer

Fig.5.UltrasonicSensor

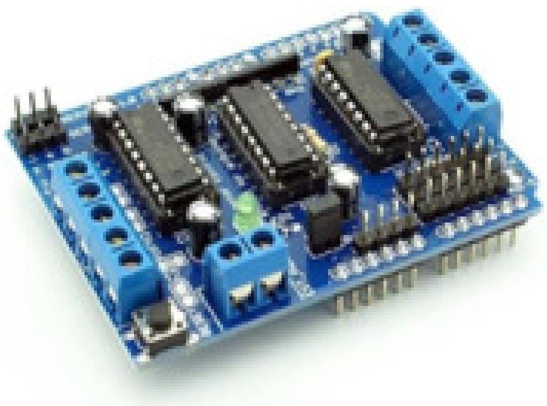

Fig.6.L293DMotorDriver

V. CONCLUSION AND FUTURE SCOPE

This project presents an innovative assistive mobility solu- tion integrating EEG and head movement control. The system offersahands-freealternativetotraditionalwheelchaircontrol, enhancingaccessibilityforindividualswithseveredisabilities. 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.Enhancedsafetyfeatures,suchasemergencybraking and terrain adaptability, could further improve the system's robustness.

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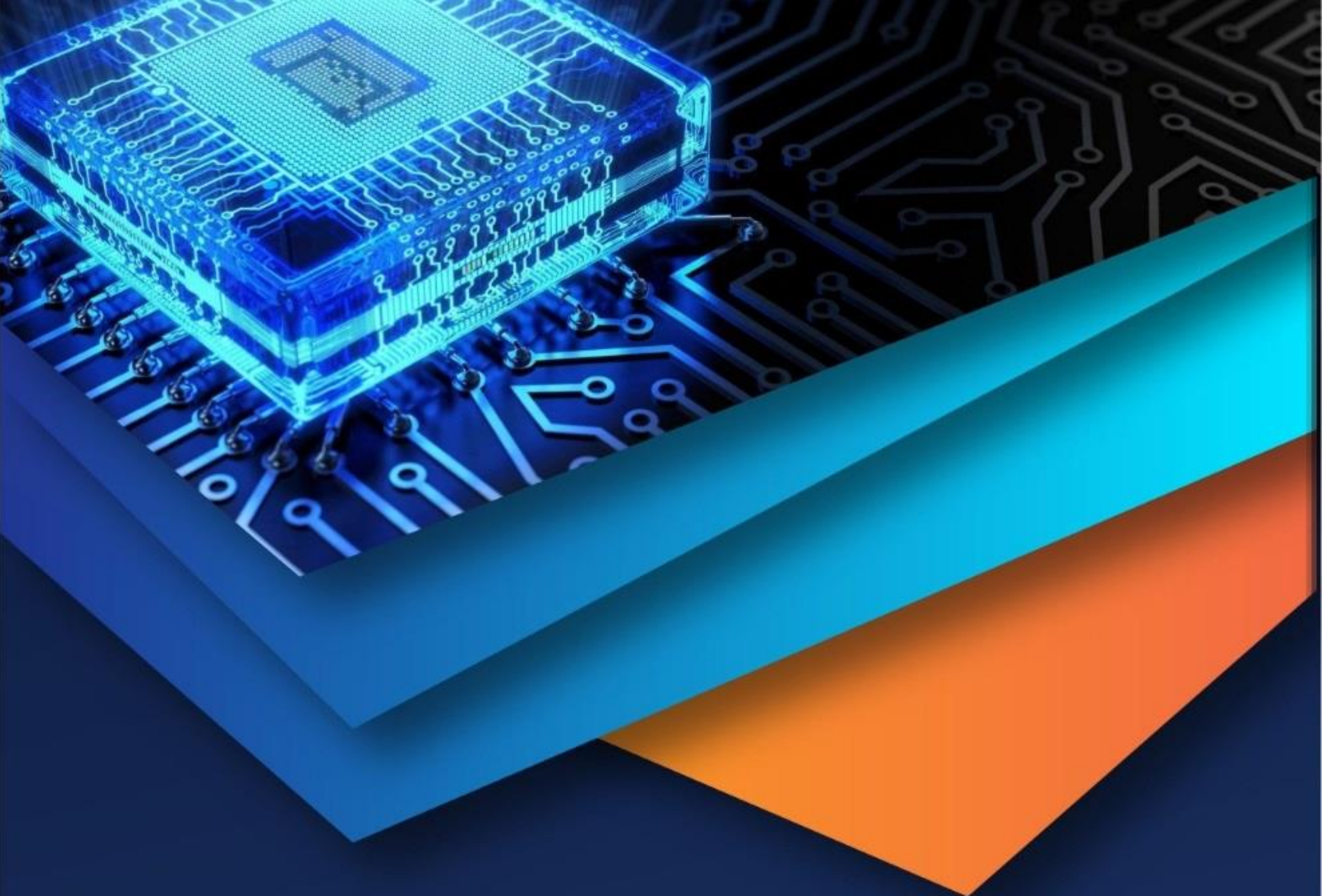

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