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# HEAD MOTIONS CONTROLLED WHEEL-CHAIR ROBOT USING ACCELEROMETER

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## ABSTRACT

Mobility is a fundamental requirement for independent living, yet it remains a major challenge for people with severe physical disabilities. Conventional joystick-based wheelchairs are not suitable for users with limited hand or arm movement. Majorly, the one who has spinal-cord disorders cannot operate with their hands. This paper presents the design and development of a head motion-controlled wheelchair robot using an accelerometer, aimed at providing hands-free mobility assistance.

**Keywords:** Assistive Technology, Accelerometer, Head Motion Control, Wheelchair Robot, Embedded System.

## 1. INTRODUCTION

Assistive technologies play a vital role in improving the quality of life for individuals with physical disabilities. Electric wheelchairs are widely used, but most require manual input through joysticks or switches, which may not be feasible for users with severe motor impairments. To overcome this limitation, alternative control methods such as voice control, eye tracking, and gesture control have been explored. Among these, head motion control using an accelerometer offers a simple, intuitive, and low-cost solution. Head movements are natural and require minimal effort, making them suitable for users with limited limb movement. This project focuses on designing a wheelchair robot that responds to head tilt gestures, ensuring smooth navigation and enhanced safety.

## 2. METHODOLOGY

The methodology adopted for the Head Motion Controlled Wheelchair Robot using Accelerometer focuses on providing safe and hands-free mobility assistance for physically challenged users by integrating head motion control with drowsiness detection and obstacle avoidance features. The system is developed using an embedded system approach that enables continuous monitoring of user activity and surrounding conditions.

The process begins with an accelerometer sensor mounted on the user’s head to detect tilt movements along the X and Y axes. These head movements are continuously monitored and converted into electrical signals, which are fed into the microcontroller acting as the central processing unit. The microcontroller processes the accelerometer data by comparing it with predefined threshold values to determine movement commands such as forward, backward, left, or right.

To enhance user safety, a drowsiness detection module using an IR sensor is incorporated into the system. The IR sensor continuously monitors eye blink patterns of the user. If prolonged eye closure or abnormal blinking is detected, the system identifies a drowsy condition. In such cases, the microcontroller immediately stops the wheelchair and triggers a warning alert, preventing unsafe movement.

Additionally, an ultrasonic sensor is used for obstacle detection. The sensor continuously measures the distance between the wheelchair and nearby objects. If an obstacle is detected within a predefined safe distance, the microcontroller overrides the motion command and stops the wheelchair to avoid collision. This ensures safe navigation in both indoor and outdoor environments.

Based on the processed inputs from the accelerometer, IR sensor, and ultrasonic sensor, the microcontroller generates appropriate control signals and sends them to the motor driver module. The motor driver amplifies these signals and drives the DC motors, enabling smooth and controlled wheelchair movement. The entire system operates in a continuous loop, ensuring real-time response and reliable performance.

## 3. MODELING AND ANALYSIS

**The overall procedure is as follows:**

1. Identify system requirements for head motion control, drowsiness detection, and obstacle avoidance.

2. Select hardware components including accelerometer, IR sensor, ultrasonic sensor, microcontroller, motor driver, and DC motors.

3. Design the system architecture integrating control and safety modules.

4. Mount the accelerometer on the user's head and interface it with the microcontroller.

5. Integrate the IR sensor for eye-blink–based drowsiness detection.

6. Connect the ultrasonic sensor for obstacle detection.

7. Develop and upload embedded C programs using Arduino IDE.

8. Set threshold values for head tilt, eye blink duration, and obstacle distance.

9. Test wheelchair movement, drowsiness response, and obstacle avoidance.

10. Analyze system performance for safety, accuracy, and response time.

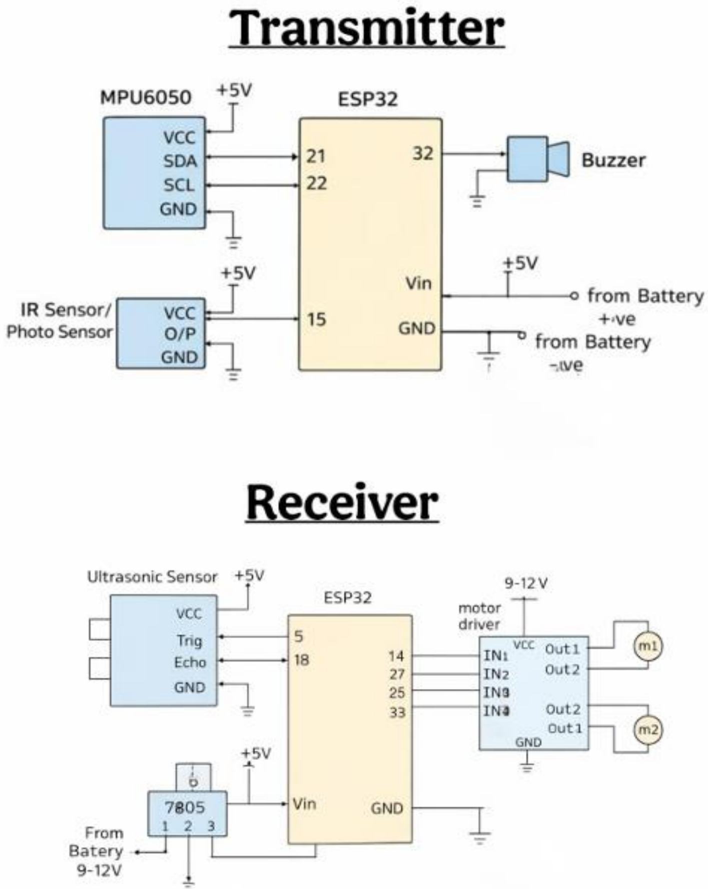


**Figure 1:** Transmitter and Receiver of Wheelchair Robot and head unit

## 4. RESULTS AND DISCUSSION

The proposed Head Motion Controlled Wheelchair Robot using Accelerometer was successfully designed and tested under controlled conditions to evaluate its performance, safety, and reliability. The system demonstrated accurate response to head movements, effective drowsiness detection, and reliable obstacle avoidance.

**1. Accurate Head Motion Control:** The accelerometer accurately detected head tilt movements in forward, backward, left, and right directions. The wheelchair responded smoothly to these gestures with minimal delay, enabling hands-free and intuitive control.

**2. Effective Drowsiness Detection:** The IR sensor successfully monitored eye-blink patterns and detected drowsy conditions based on predefined thresholds. Upon detecting drowsiness, the system immediately stopped the wheelchair, thereby preventing unsafe operation.

**3. Reliable Obstacle Detection:** The ultrasonic sensor consistently detected obstacles within the predefined safe distance. The wheelchair was automatically halted when an obstacle was detected, ensuring collision-free navigation in indoor environments.

**4. Real-Time System Performance:** All sensing, processing, and motor control operations were executed in real time. The system showed low response time and stable operation during continuous testing.

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**5. Safety and User Reliability:** The integration of drowsiness detection and obstacle avoidance significantly enhanced user safety. The system operated reliably without false triggering due to proper sensor calibration.

**6. Cost-Effective and Practical Design:** The use of low-cost sensors and an embedded controller makes the system affordable and suitable for academic projects, rehabilitation centers, and assistive mobility applications.

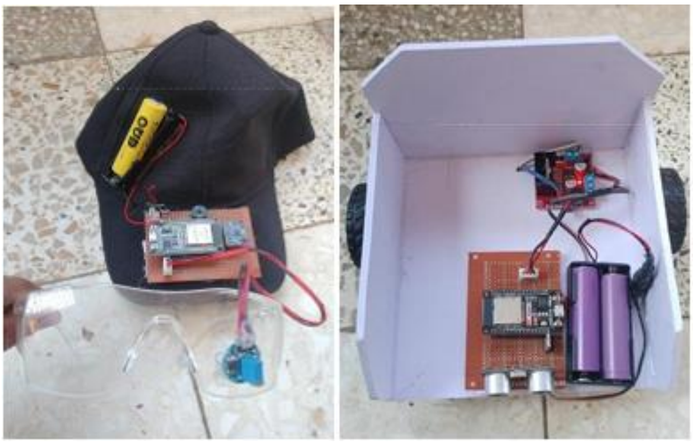

**Figure 2:** hat unit and wheelchair robot

## 5. CONCLUSION

The developed head motion-controlled wheelchair robot using an accelerometer successfully addresses the need for an easy and reliable mobility solution for individuals with physical disabilities. By allowing wheelchair movement through simple head gestures, the system reduces dependency on hand-based controls and provides greater independence to users with limited motor functions. The inclusion of a drowsiness detection feature using an IR sensor plays a crucial role in ensuring user safety by identifying fatigue conditions and preventing unintended movement. Additionally, the ultrasonic-based obstacle detection mechanism helps avoid collisions by stopping the wheelchair when obstacles are detected within a safe distance. The system demonstrated stable real-time performance during testing, with accurate sensor response and smooth motor control. Owing to its low-cost components, simple design, and effective safety features, the proposed system is suitable for academic use as well as practical assistive applications. With further development, the system can be enhanced by incorporating wireless communication, GPS tracking, or health monitoring features to improve overall user safety and comfort.

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