KeAi
CHINESE ROOTS
GLOBAL IMPACT

International Journal of Innovation Studies

# SMART HEAD-CONTROLLED WHEELCHAIR SYSTEM

**Ajay V**
Project Student, Department of Computer Applications, Nehru Arts and Science College, Coimbatore, India

**Praveen.C.R**
Project Student, Department of Computer Applications, Nehru Arts and Science College, Coimbatore, India

**Ukesh.R**
Project Student, Department of Computer Applications, Nehru Arts and Science College, Coimbatore, India

**Mr. Boopathi**
Assistant Professor, Department of Computer Applications, Nehru Arts and Science College, Coimbatore, India

## ABSTRACT

In today's rapidly advancing technological era, assistive mobility solutions play a vital role in enhancing the independence and quality of life of physically disabled individuals. People suffering from paralysis, spinal cord injuries, or severe motor disabilities often face difficulty in operating conventional wheelchairs.This project presents a Smart Head-Controlled Wheelchair System, designed to allow users to control wheelchair movement using head gestures. The system utilizes motion sensors such as an accelerometer and gyroscope (MPU6050), integrated with a microcontroller like Arduino or NodeMCU. Head movements such as forward, backward, left, and right are detected and translated into corresponding wheelchair movements.The system also includes ultrasonic sensors for obstacle detection to ensure user safety. When an obstacle is detected within a predefined distance, the system automatically stops the wheelchair and alerts the user.The proposed solution is low-cost, reliable, safe, and user-friendly. It reduces dependency on caregivers and provides enhanced mobility and independence to differently-abled individuals.

## INTRODUCTION

In recent years, assistive technologies have become essential for improving the quality of life for physically challenged individuals. People suffering from paralysis, spinal cord injuries, or severe motor disabilities often find it difficult to operate conventional wheelchairs that require hand control. To overcome this limitation, this project proposes a Smart Head Controlled Wheelchair using Internet of Things (IoT) technology.

The system enables users to control the wheelchair using simple head movements detected by sensors such as an accelerometer or gyroscope. The head movement signals are processed using a microcontroller (Arduino/ESP32) and transmitted to the wheelchair motor system. Based on the direction of the head movement (forward, backward, left, right), the wheelchair moves accordingly.

The system also integrates IoT connectivity, enabling remote monitoring and emergency alerts through a mobile application or cloud platform. Additional safety features such as obstacle detection using ultrasonic sensors, automatic braking, and emergency notifications improve user safety and reliability.

The proposed solution provides an affordable, efficient, and user-friendly assistive mobility system for individuals with limited hand mobility. By combining embedded systems, sensors, and IoT technologies, the smart wheelchair enhances independence and mobility for people with disabilities.

## LITERATURE REVIEW

Several research studies have been conducted to develop intelligent wheelchairs that assist people with severe physical disabilities. These systems mainly focus on alternative control methods such as head movements, gestures, voice commands, or brain signals. The following literature summarizes the important works related to smart wheelchairs

### Head Motion Controlled Wheelchair

Hamsa Rekha S.D. and Sheetal N. (2023) developed a head motion–controlled wheelchair using IoT technology to assist people with quadriplegia. The system used an MPU6050 sensor to detect the user's head movements and transmit signals to a microcontroller that controls the wheelchair motors. The system allowed movement in four directions: forward, backward, left, and right. It also integrated sensors for obstacle detection to improve safety and navigation. This research demonstrated that head gesture recognition can be an effective alternative control mechanism for individuals who cannot operate traditional joystick-controlled wheelchairs.

### IoT Based Head Motion Wheelchair System

Pakhare et al. (2025) proposed a head motion controlled wheelchair using IoT devices designed specifically for individuals with spinal cord injuries or paralysis. The system used a MEMS sensor (MPU6050) to detect head tilts and a microcontroller to process the signals. The wheelchair navigation was controlled by detecting head movements in four directions. The authors highlighted that the system provides a low-cost and non-intrusive solution for assistive mobility.Their work emphasized that integrating IoT and sensors can significantly improve independence and quality of life for disabled individuals.

### Smart Wheelchair with Head Gesture Control

Anitha Mathew et al. developed E-Wheel, a smart wheelchair that integrates head gesture control along with additional health monitoring features. The system allows users to maneuver the wheelchair using head movements while simultaneously monitoring vital signs such as heart rate and oxygen saturation using sensors.This research demonstrated how smart healthcare technologies can be integrated with assistive mobility devices to enhance both mobility and health monitoring.

### Vision-Based Head Gesture Wheelchair

Somawirata and Utaminingrum (2023) proposed a vision-based head gesture recognition system for wheelchair control. The system used computer vision techniques and the Haar Cascade algorithm to detect the position of the user's face and head gestures. The head gestures were classified into commands such as move forward, brake, turn left, and turn right. Experimental results showed that the system successfully controlled wheelchair movement using visual head gesture detection.This approach eliminates the need for wearable sensors and instead uses cameras to track head movements.

### IoT-Based Automated Wheelchair

Another study presented an IoT-based automated wheelchair for physically challenged individuals. The system used an accelerometer to detect head motion and a microcontroller to convert the signals into motor commands. Bluetooth communication enabled wireless control and improved maneuverability inside homes or indoor environments.The research highlighted the importance of combining embedded systems and wireless communication technologies to create efficient assistive devices. The research highlighted the importance of combining embedded systems and wireless communication technologies to create efficient assistive devices.

### EEG and Head Movement Controlled Wheelchair

Recent studies have also explored advanced control methods combining brain signals (EEG) and head movement detection. This dual-input system allows users with severe disabilities to operate the wheelchair without physical effort. The system also includes obstacle detection mechanisms to improve safety and avoid collisions.Such technologies represent the future direction of smart wheelchair research.

## ADVANTAGES

- Hands-Free Operation:The wheelchair can be controlled using simple head movements, eliminating the need for hand or arm movement. This is highly beneficial for people with paralysis or severe physical disabilities
- Increased Independence:Users can move independently without requiring constant assistance from caregivers. This improves their confidence and quality of life.

- Easy to Use:The system uses simple head gestures (left, right, forward, backward), making it easy for users to learn and operate the wheelchair.
- Improved Safety:The wheelchair can include ultrasonic sensors to detect obstacles and stop automatically, reducing the risk of accidents.
- IoT-Based Monitoring:With IoT integration, caregivers or family members can monitor the wheelchair remotely through mobile applications or cloud platforms.
- Emergency Alert System:The system can send emergency alerts or notifications to caregivers if the user faces a problem or presses an emergency button.
- Cost Effective Solution:Compared to advanced medical mobility devices, this system can be built using low-cost sensors, microcontrollers, and IoT modules, making it affordable.

## EXISTING SYSTEM

Several technologies have been developed to help physically disabled individuals control wheelchairs. These systems use different control mechanisms such as joystick control, voice recognition, sip-and-puff systems, gesture control, and brain–computer interfaces (BCI). Although these systems provide mobility assistance, each has certain limitations that affect usability and accessibility.

### 1. Joystick Controlled Wheelchair

Joystick-controlled wheelchairs are the most common electric wheelchairs used today. The user controls the direction and speed of the wheelchair using a joystick mounted on the armrest.

#### Advantages

- Easy to operate for users with hand mobility
- Accurate direction control
- Widely available in commercial wheelchairs

#### Disadvantages

- Requires hand and arm movement
- Not suitable for people with severe paralysis or quadriplegia

### 2. Sip-and-Puff Controlled Wheelchair

The sip-and-puff system allows wheelchair control using breathing actions. The user inhales (sip) or exhales (puff) through a tube to generate control signals.

#### Advantages

- Suitable for people with very limited body movement
- Hands-free wheelchair control

**Disadvantages**

- Requires strong breath control
- Difficult for users with respiratory problems
- Continuous breathing actions may cause fatigue

**PROPOSED SYSTEM**

The proposed system is an automated cable monitoring solution designed to detect cable tampering or theft immediately and provide instant alerts. This system continually oversees cable conditions using electronic components and communication technology, unlike manual monitoring methods. It guarantees quick detection and rapid response to avert further damage and financial losses. Components Used:

- Manual Wheelchair

Manual wheelchairs are the most commonly used mobility devices. Hands-Free Operation

**Advantages**

- Simple design
- Low cost
- Easy maintenance

**Disadvantages**

- Requires physical strength
- Not suitable for paralyzed or weak patients
- Requires assistance from caregivers

**2. Joystick Controlled Electric Wheelchair**

Electric wheelchairs are controlled using a joystick mounted on the armrest. The joystick sends control signals to motors that move the wheelchair.

**Advantages**

- Easy to control with hand movement
- Comfortable for users with partial mobility

**Disadvantages**

- Requires hand and arm movement
- Not suitable for people with quadriplegia or severe motor disabilities

### 3. Voice Controlled Wheelchair

Some modern wheelchairs use voice recognition systems where the user gives commands like "forward", "left", or "stop".

**Advantages**

- Hands-free operation
- Convenient for some disabled users

**Disadvantages**

- Not reliable in noisy environments
- Speech impairments can affect command recognition
- Requires clear voice input

### 4. Sip-and-Puff Control Wheelchair

This system uses a sip-and-puff mechanism, where users control the wheelchair by inhaling or exhaling into a tube.

**Advantages**

- Useful for users with severe disabilities
- Allows hands-free control

**Disadvantages**

- Requires continuous breathing effort
- Difficult for users with respiratory problems

### 5. Brain–Computer Interface (BCI) Wheelchair

BCI-based wheelchairs use brain signals (EEG) to control movement. The system detects brain activity and translates it into commands for wheelchair navigation.

**Advantages**

- Can be used by people with extremely severe disabilities
- Provides hands-free operation
- Disadvantages
- Expensive and complex
- Requires calibration and training
- Difficult to implement in real-world environments

## METHODOLOGY

### 1. Head Movement Detection

The system uses an accelerometer or gyroscope sensor (such as MPU6050) to detect the movement and tilt of the user's head. The sensor is attached to a headband or helmet worn by the user.

When the user tilts their head in different directions, the sensor measures the change in orientation along the X, Y, and Z axes. These sensor readings are sent to the microcontroller for processing.

The detected head gestures correspond to wheelchair movements such as:

- Head tilted forward → Move Forward
- Head tilted backward → Move Backward
- Head tilted left → Turn Left
- Head tilted right → Turn Right

### 2. Signal Processing

The sensor data is transmitted to a microcontroller (Arduino or ESP32). The microcontroller processes the accelerometer values and determines the direction of head movement.

The program written in Embedded C using Arduino IDE analyzes the sensor readings and converts them into movement commands. Threshold values are defined to identify each gesture accurately.

### 3. Wheelchair Movement Control

Once the direction command is identified, the microcontroller sends control signals to a motor driver (L298N or L293D).

The motor driver acts as an interface between the microcontroller and the DC motors of the wheelchair. It controls the speed and direction of the motors, allowing the wheelchair to move in the required direction.

## MODULE FUNCTION

SYSTEM MODULES:

### Head Movement Detection Module

This module is responsible for detecting the head movements of the user. An accelerometer or gyroscope sensor (MPU6050) is used to sense the tilt and orientation of the user's head.

The sensor continuously monitors the movement of the head along different axes and sends the detected values to the microcontroller. Based on the direction of the head tilt, commands such as forward, backward, left, and right are generated.

Function:

- Detect head gestures
- Convert head movement into sensor data
- Send signals to the control unit

### 5.2 Control Processing Module

This module processes the sensor data received from the head movement detection module. A microcontroller such as Arduino or ESP32 is used to analyze the sensor values.

The microcontroller program interprets the sensor readings and determines the direction in which the wheelchair should move. It then generates appropriate control signals for the motor driver.

Function:

- Receive sensor signals
- Process and analyze head movement data
- Generate movement commands for the wheelchair

### 5.3 Motor Control Module

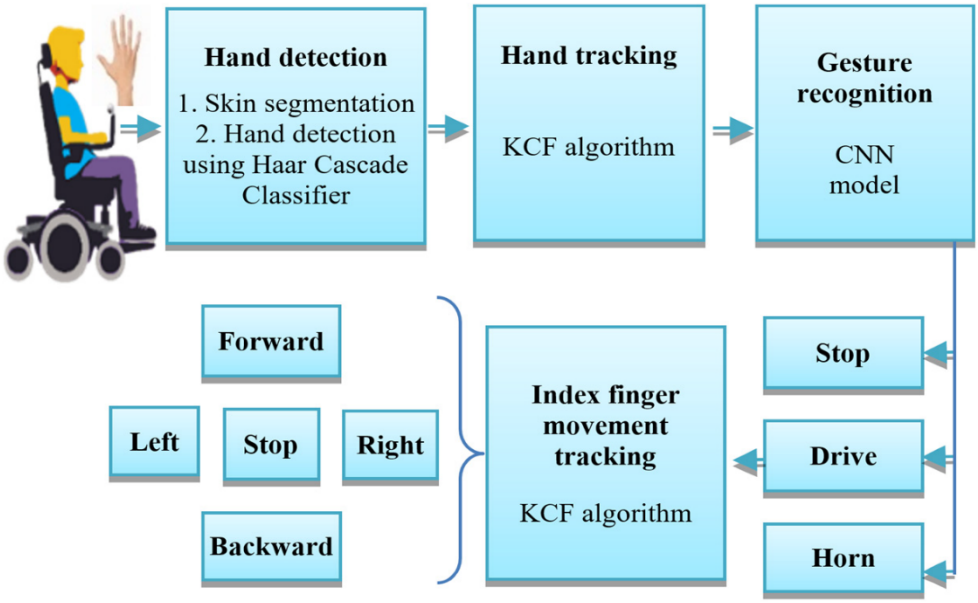
The motor control module is responsible for controlling the wheelchair motors. A motor driver (L298N or L293D) is used to control the speed and direction of the motors.

Based on the commands received from the microcontroller, the motor driver activates the DC motors to move the wheelchair in the desired direction.

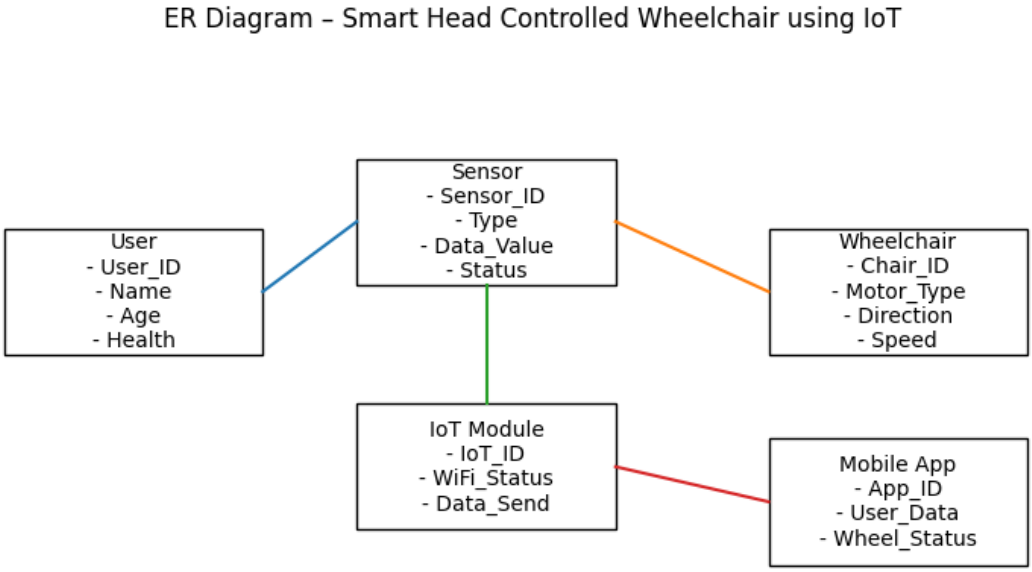
Function:

- Control the movement of the wheelchair
- Manage motor speed and direction
- Execute movement commands

## SYSTEM FLOW DIAGRAM




## ER DIAGRAM



## CONCLUSION

The Smart Head Controlled Wheelchair using IoT is designed to provide an effective mobility solution for individuals with severe physical disabilities. Traditional wheelchairs often require hand or arm movement, which may not be possible for people suffering from paralysis or other motor impairments. The proposed system overcomes these limitations by allowing users to control the wheelchair using simple head movements.

The system uses sensors such as an accelerometer or gyroscope to detect head gestures and a microcontroller to process these signals. Based on the detected movement, the wheelchair motors are controlled through a motor driver to move in the desired direction. The integration of ultrasonic sensors improves safety by detecting obstacles and preventing collisions.

Additionally, the incorporation of IoT technology allows real-time monitoring and communication, enabling caregivers or family members to track the wheelchair status and receive alerts when necessary. This feature enhances the overall safety and usability of the system.

Overall, the proposed system provides a cost-effective, user-friendly, and reliable mobility solution that improves independence and quality of life for physically challenged individuals. The project demonstrates how the integration of embedded systems, sensors, and IoT technology can be used to develop intelligent assistive devices for healthcare and rehabilitation.

## FUTURE ENHANCEMENTS

The Smart Head Controlled Wheelchair using IoT provides an effective solution for assisting people with physical disabilities. However, the system can be further improved by incorporating advanced technologies and additional features to enhance performance, safety, and usability.

### 1. Integration of Artificial Intelligence (AI)

Artificial Intelligence can be integrated into the system to improve gesture recognition accuracy. AI algorithms can analyze user behavior and adapt to different head movement patterns, making the system more intelligent and responsive.

### 2. GPS Tracking System

A GPS module can be added to track the real-time location of the wheelchair. This feature will allow caregivers or family members to monitor the user's location and ensure safety during outdoor movement.

### 3. Mobile Application Control

A dedicated mobile application can be developed to control and monitor the wheelchair. The application can display system status, battery level, movement history, and allow remote control if required.

## REFERENCES

### Books & Research Papers

The Smart Head Controlled Wheelchair using IoT provides an effective solution for assisting people with physical disabilities. However, the system can be further improved by incorporating advanced technologies and additional features to enhance performance, safety, and usability.

**1. Integration of Artificial Intelligence (AI)**

Artificial Intelligence can be integrated into the system to improve gesture recognition accuracy. AI algorithms can analyze user behavior and adapt to different head movement patterns, making the system more intelligent and responsive.

**2. GPS Tracking System**

A GPS module can be added to track the real-time location of the wheelchair. This feature will allow caregivers or family members to monitor the user's location and ensure safety during outdoor movement.

**3. Mobile Application Control**

A dedicated mobile application can be developed to control and monitor the wheelchair. The application can display system status, battery level, movement history, and allow remote control if required.

### Websites & Online Sources

1. **Arduino Blog — Control a Wheelchair Using EEG / Head Signals with Arduino**
Arduino project explaining how head or brain signals can be used to control a wheelchair using sensors and an Arduino microcontroller. https://blog.arduino.cc/2020/11/25/control-a-wheelchair-using-an-eeg-headset-and-arduino/

2. **Hackster.io — Smart Wheelchair Using Arduino**
A complete tutorial with components, circuit design, and implementation of a smart wheelchair controlled using Arduino and sensors. https://www.hackster.io/kast-tech/smart-wheelchair-791580

3. **Hackaday.io — Mind-Controlled Robot / Wheelchair Project**
This project demonstrates how Arduino and sensors can be used to build a head or brain-controlled system that can later be implemented in a wheelchair. https://hackaday.io/project/174674-mind-controlled-robot-using-arduino-and-mindflex

4. **GitHub — Smart Wheelchair IoT Project Repository**
Provides source code and implementation details of a smart wheelchair using Arduino, sensors, Bluetooth, and IoT technologies. https://github.com/ahmedrafat-SW/Smart-Wheel-Chair

5. **Xilir Projects — Advanced Head-Controlled Wheelchair** Describes a smart wheelchair controlled through head movement and connected to a mobile application via wireless technologies. https://xilirprojects.com/product/advanced-head-controlled-wheel-chair/