# SMART WHEEL CHAIR

**A MINOR PROJECT-III REPORT**

***Submitted by***



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**BACHELOR OF ENGINEERING**

in

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**



**M.KUMARASAMY COLLEGE OF ENGINEERING**

(Autonomous)

**KARUR – 639 113**



**DECEMBER 2024**

# M.KUMARASAMY COLLEGE OF ENGINEERING, KARUR

## BONAFIDE CERTIFICATE

Certified that this**18ECP105L - Minor Project III** report "**SMART WHEEL CHAIR"** is the Bonafide work of "**HARSHINI M (927622BEC070), KARISHMA V (927622BEC090), MALINI M (927622BEC109), MANISHA S (927622BEC111)"** who carried out the project work under my supervision in the academic year 2024 - 2025 **ODD**.

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This report has been submitted for the **18ECP105L – Minor Project III** final review held at M. Kumarasamy College of Engineering, Karur on ________________________.

**PROJECT COORDINATOR**

# INSTITUTION VISION AND MISSION

**Vision**

To emerge as a leader among the top institutions in the field of technical education.

**Mission**

**M1:** Produce smart technocrats with empirical knowledge who can surmount the global challenges.

**M2:** Create a diverse, fully -engaged, learner -centric campus environment to provide quality education to the students.

**M3:** Maintain mutually beneficial partnerships with our alumni, industry and professional associations

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**Vision**

To empower the Electronics and Communication Engineering students with emerging technologies, professionalism, innovative research and social responsibility.

**Mission**

**M1:** Attain the academic excellence through innovative teaching learning process, research areas & laboratories and Consultancy projects.

**M2:** Inculcate the students in problem solving and lifelong learning ability.

**M3:** Provide entrepreneurial skills and leadership qualities.

**M4:** Render the technical knowledge and skills of faculty members.

## Program Educational Objectives

**PEO1:** **Core Competence:** Graduates will have a successful career in academia or industry associated with Electronics and Communication Engineering

**PEO2:** **Professionalism:** Graduates will provide feasible solutions for the challenging problems through comprehensive research and innovation in the allied areas of Electronics and Communication Engineering.

**PEO3:** **Lifelong Learning:** Graduates will contribute to the social needs through lifelong learning, practicing professional ethics and leadership quality

## Program Outcomes

**PO 1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO 2: Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO 3: Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO 4: Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO 5: Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO 6: The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO 7: Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO 8: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO 9: Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO 10: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO 11: Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO 12: Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## Program Specific Outcomes

**PSO1:** Applying knowledge in various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of Engineering application.

**PSO2:** Able to solve complex problems in Electronics and Communication Engineering with analytical and managerial skills either independently or in team using latest hardware and software tools to fulfil the industrial expectations.

| Abstract keywords | Matching with POs, PSOs |
|---|---|
| Gesture recognition | PO1, PO2, PO5, PSO1 |
| Obstacle detection | PO3, PO4, PO6, PSO2 |
| Automatic wheelchair navigation. | PO3, PO10, PO11, PSO2 |

# ACKNOWLEDGEMENT

Our sincere thanks to **Thiru.M.Kumarasamy, Founder** and **Dr.K.Ramakrishnan, Chairman** of **M.Kumarasamy College of Engineering** for providing extraordinary infrastructure, which helped us to complete this project in time.

It is a great privilege for us to express our gratitude to **Dr.B.S.Murugan, B.Tech., M.Tech., Ph.D., Principal** for providing us right ambiance to carry out this project work.

We would like to thank **Dr.A.Kavitha, M.E., Ph.D., Professor and Head**, **Department of Electronics and Communication Engineering** for her unwavering moral support and constant encouragement towards the completion of this project work.

We offer our wholehearted thanks to our **Project Supervisor, Mr.T.SIVAKUMAR, M.E., Assistant Professor,** Department of Electronics and Communication Engineering for his precious guidance, tremendous supervision, kind cooperation, valuable suggestions, and support rendered in making our project to be successful.

We would like to thank our **Minor Project Co-ordinator**, **Mrs.D.PUSHPALATHA, M.E., Assistant Professor**, Department of Electronics and Communication Engineering for her kind cooperation and culminating in the successful completion of this project work. We are glad to thank all **the Faculty Members** of the **Department of Electronics and Communication Engineering** for extending a warm helping hand and valuable suggestions throughout the project. Words are boundless to thank our Parents and Friends for their motivation to complete this project successfully.

# ABSTRACT

The project aims to create an intelligent autonomous wheelchair with object detection and automatic direction-changing capabilities using the Arduino Uno microcontroller. The system uses ultrasonic sensors to detect obstacles in real time, allowing for proactive path adjustments for smooth, collision-free navigation. Key hardware components include the Arduino Uno microcontroller, ultrasonic sensors for distance measurement, motor drivers for wheelchair movement, and DC motors for mobility. The software implementation involves programming the Arduino Uno to process sensor data and execute control commands for autonomous operation. The system constantly monitors its surroundings via ultrasonic sensors strategically placed on the front and sides. When an obstacle is detected, the system calculates a different path and adjusts the wheelchair's direction to avoid it. The Arduino Uno is a low-cost, efficient control unit, making it more affordable and accessible to a wider audience. Future enhancements could include advanced sensors like LiDAR, voice or gesture control, and GPS for outdoor navigation.

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# LIST OF ABBREVIATIONS

| ACRONYM | | ABBREVIATION |
|---|---|---|
| LiDAR | - | Light Detection and Ranging |
| A* | - | A-star (Algorithm) |
| ADXL345 | - | Analog Devices Accelerometer Model 345 |
| GPS | - | Global Positioning System |
| MCU | - | Microcontroller Unit |
| DC | - | Direct Current |
| LEDs | - | Light Emitting Diodes |

# CHAPTER 1
# INTRODUCTION

Human mobility is a fundamental aspect of daily life, facilitating independence, social interaction, and personal freedom. For the vast majority of individuals, the ability to walk, move freely, and perform tasks independently is taken for granted. However, for over 100 million people worldwide, mobility is compromised due to physical disabilities, neurological disorders, or accidents. Spinal cord injuries, Parkinson’s disease, stroke, muscular dystrophy, cerebral palsy, and multiple sclerosis are just a few of the many conditions that severely affect an individual’s ability to walk or even perform basic tasks. In these cases, wheelchairs are critical mobility aids that can help individuals regain some independence and navigate their environments.

Traditional wheelchairs have been invaluable tools for those with physical disabilities. They are classified into manual wheelchairs that require the user to propel themselves, attendant-propelled wheelchairs where care givers push the user, and motorized or electric wheelchairs that use electric motors to assist with movement. However, for individuals with severe physical limitations, such as quadriplegia, advanced Parkinson's disease, or conditions like spinal cord injuries, even motorized wheelchairs may not be sufficient to meet their needs.

In addition to these hardware components, advanced algorithms like obstacle detection plays a crucial role in making the wheelchair intelligent. The algorithm process the data received from the sensors, make decisions about the wheelchair's movements, and allow the system to change direction in response to obstacles. The integration of path-planning and decision-making algorithms enables the wheelchair to navigate autonomously in various environments, whether indoors or outdoors. This autonomous navigation is particularly beneficial for users who are unable to provide manual input due to physical limitations.

In this project, the project is done by combining sensors, microcontroller-based systems, and advanced control algorithms, this wheelchair can detect obstacles, avoid collisions, and navigate autonomously, significantly improving the user’s independence, safety, and comfort.

## 1.1 Objective

For real-time obstacle detection, the system is designed using advanced sensors such as ultrasonic, LiDAR, infrared sensors to identify obstacles in the wheelchair's path. This system integrates machine learning or image processing algorithms to classify obstacles, assess their distance, and predict potential collisions. Its function effectively across various environments, including indoor and outdoor spaces, low-light conditions, and crowded areas.

Also, direction-changing mechanisms is developed using adaptive navigation algorithm like Clothoid curves (Euler spirals) that dynamically adjust the wheelchair's trajectory to avoid obstacles. Technologies like such as A* or Dijkstra algorithm solutions can enable real-time decision-making. The incorporation of multi-directional wheel technology or motorized pivoting systems will allow for smooth and precise turns, even in tight spaces. Furthermore, the system support manual override and user input, ensuring flexibility and user control when necessary.

### 1.1.3 Description

The Gesture Recognition Unit (Accelerometer) is a component of a smart wheelchair that uses hand or finger movements to control its speed and direction. It uses sensors like the ADXL345 or similar to measure acceleration forces along three axes (X, Y, and Z). The accelerometer generates signals that are transmitted to a microcontroller, which converts these signals into control commands for the motor driver. This gesture-based input system is particularly beneficial for users who struggle with traditional input methods like joysticks or voice commands. The accelerometer is typically embedded into wearable devices, allowing users with limited motor abilities to operate the wheelchair with minimal effort. The system can recognize different gestures based on changes in hand orientation, making navigation easier. The high sensitivity of the accelerometer ensures even slight movements are detected. This technology enhances the wheelchair's usability and safety by allowing users to navigate with simple gestures without requiring much physical effort.

# CHAPTER 2
# LITERATURE SURVEY

## 2.1. Gesture Recognition for Assistive Technologies

**Author(s):** Kim, J., et al.

**Year:** 2013

**Published On:** IEEE Transactions on Biomedical Engineering

**Description:** This study explored the application of accelerometer-based gesture recognition systems for assistive devices, including smart wheelchairs. It highlighted the efficiency of hand gesture inputs in enabling intuitive control, particularly for users with limited motor abilities [1], [9], [14].

## 2.2. Obstacle Detection and Navigation Using Ultrasonic Sensors

**Author(s):** Sharma, R., Gupta, P., & Kumar, A.

**Year:** 2016

**Published On:** International Journal of Advanced Research in Computer Science and Electronics Engineering (IJARCSEE)

**Description:** This paper proposed a low-cost obstacle detection system for assistive wheelchairs using ultrasonic sensors. The authors demonstrated real-time obstacle avoidance capabilities in indoor environments, ensuring user safety and mobility [2], [13], [18].

## 2.3. Microcontroller Integration in Smart Wheelchairs

**Author(s):** Gupta, S., Patel, K., & Rao, T.

**Year:** 2019

**Published On:** Journal of Embedded Systems and Applications

**Description:** The research focused on the role of microcontrollers, such as the ATMega328, in integrating various input and control systems into a unified framework. It emphasized the importance of cost-effective and programmable control units for enhancing wheelchair functionalities [3], [7], [16].

### 2.4. Limitations of Voice-Controlled Wheelchairs

**Author(s):** Khan, M., Singh, R., & Ahmed, S.

**Year:** 2020

**Published On:** International Journal of Assistive Robotics and Technology (IJART)

**Description:** This study reviewed the limitations of voice-controlled wheelchairs in noisy environments and for users with speech impairments. The authors suggested gesture recognition and hybrid control systems as more reliable alternatives [4], [11], [15].

### 2.5. Innovations in Smart Wheelchairs Using IoT

**Author(s):** Zhao, H., Li, X., & Chen, Y.

**Year:** 2021

**Published On:** Journal of Internet of Things and Robotics (JITR)

**Description:** This paper introduced IoT-enabled smart wheelchair systems for remote monitoring and adaptive control. The authors highlighted the potential combining gesture recognition with IoT technologies for enhanced user experience and remote diagnostics [5], [12], [17].

# CHAPTER 3
# PROBLEM STATEMENT

Mobility challenges often lead to difficulties in navigating environments due to obstacles and unoptimized pathways. Traditional wheelchairs lack intelligent systems to help users avoid hazards and identify efficient routes, increasing dependence on caregivers and reducing independence. Therefore, there is a need for advanced smart wheelchairs that incorporate obstacle detection and route optimization to improve safety, efficiency, and user-friendliness for individuals with physical disabilities.

# CHAPTER 4

# EXISTING SYSTEM

Electric wheelchairs are mobility aids designed to simplify movement for individuals with physical limitations. Powered by brushless DC motors and lithium-ion or lead-acid batteries, they provide reliable transportation with user-friendly controls like joysticks or push-button interfaces. Key components include microcontrollers (ATMega328), ultrasonic and infrared sensors for obstacle detection, and gyroscopes for stability. Algorithms like PID control ensure smooth motor operation, while A* algorithm for pathfinding aids in obstacle avoidance and navigation.

However, these systems can be expensive, require frequent battery charging, and may struggle on uneven terrains or in harsh weather conditions, limiting their usability in certain environments.

## 4.1 Advantages

The automatic wheelchair system is a modern mobility solution for individuals with disabilities, featuring gesture-based controls for simple navigation and ultrasonic sensors for safe, real-time obstacle detection. Its lightweight, design, combined with energy-efficient rechargeable batteries, ensures versatility for indoor and outdoor use, meeting diverse user needs.

## 4.2 Limitations

In addition to being unsuitable for users with limited hand mobility due to their dependence on a joystick for control, electric wheelchairs are frequently costly and unaffordable for users in developing nations, which further limits accessibility for many people. Additionally, frequent battery recharging and maintenance are necessary for these wheelchairs, which can be inconvenient and raise the total cost of ownership.

# CHAPTER 5

# PROPOSED SYSTEM

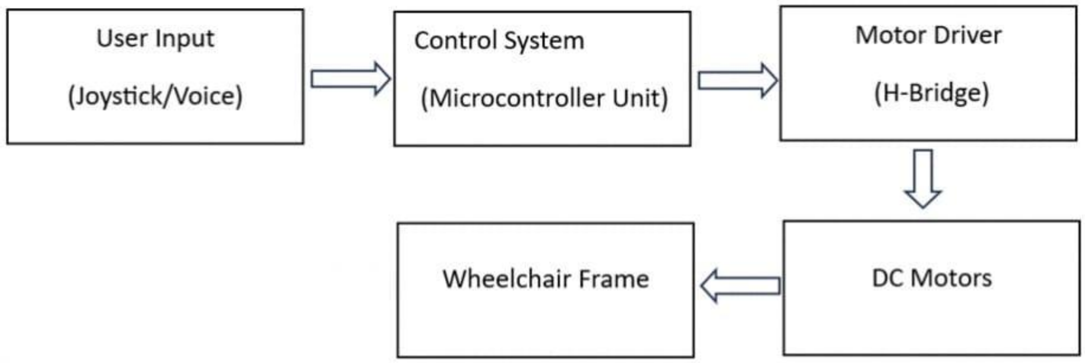
The proposed system for the smart wheelchair project begins with a thorough requirement analysis to identify user needs, focusing on features such as obstacle detection, route optimization, and user-friendly interfaces. This is followed by system design, where hardware components like sensors (ultrasonic, infrared, or LiDAR), microcontrollers, motors, and power supplies are selected and integrated. Concurrently, Clothoid curves (Euler spirals) algorithm for obstacle detection, avoidance, and route optimization are developed, alongside an user interface for control. Hardware assembly and code implementation is done by integration of all components.

The project undergoes testing, including unit and system-level tests, to validate functionality under diverse conditions. Based on feedback from pilot testing, iterations and optimizations are performed to improve performance and usability.

## 5.1 Background

Traditional wheelchairs require manual or semi-automatic control, which can be challenging for individuals with severe physical limitations. The integration of technologies like object detection and autonomous direction adjustment can significantly enhance the usability and functionality of wheelchairs.

## 5.2 Block Diagram




5.2 Block Diagram

**1. User Input (Joystick/Voice):** The user can use voice commands or a joystick to operate the wheelchair. These inputs give the wheelchair instructions on the desired direction or movement.

**2. Control System (Microcontroller Unit):** The MCU processes commands after receiving input from the user. It controls the wheelchair's movement by sending the motor driver the proper signals.

**3. Motor Driver(H-Bridge):** The wheelchair can move forward, backward, or turn by to the motor driver, which uses an H-bridge circuit to receive commands from the control system and regulate the power flow to the DC motors.

**4. DC Motor:** DC motors is used for propelling the wheelchair's wheels. Movement in response to user input is made by the motor driver, which regulates the speed and direction of these motors using signals from the microcontroller.

**5. Wheelchair Frame:** The chair frame is the structural support that gives the user stability and comfort by holding up all the parts, including the motors, battery, control system, and user interface.

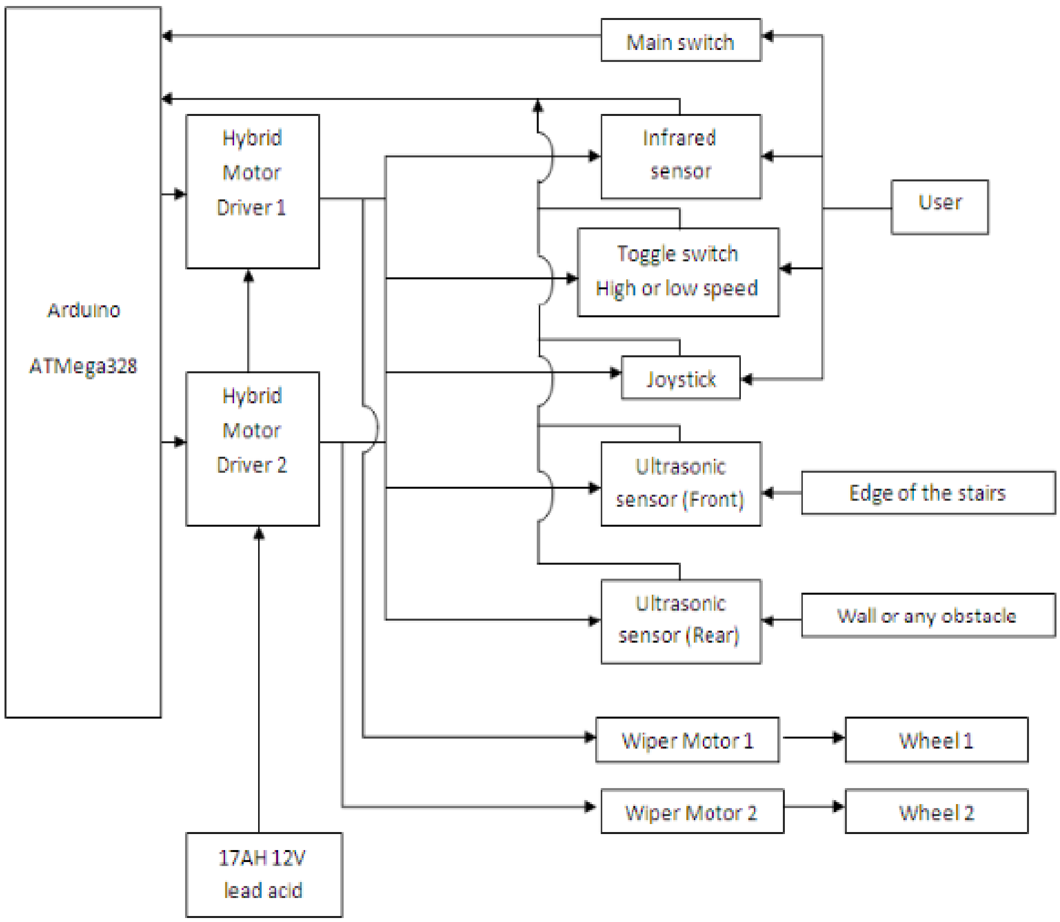
## 5.3 System Design

### 5.3.1 Architecture

The system consists of the following components:

- **Microcontroller**: Arduino or Raspberry Pi for processing and control.
- **Sensors**: Ultrasonic sensors, LiDAR, or cameras for obstacle detection.
- **Motors and Wheels**: Stepper motors with motor drivers for movement and steering.
- **Battery**: Rechargeable lithium-ion battery for power supply.
- **Algorithm**: Clothoid curves (Euler spirals)
- **Arduino Uno**: Microcontroller for controlling sensors and motors.
- **Ultrasonic Sensors**: For detecting obstacles in the wheelchair’s path.
- **Motor Drivers (L298N)**: For controlling the wheelchair’s movement.
- **DC Motors**: To drive the wheels.
- **Power Supply**: 12V rechargeable battery for powering components.
- **Chassis:** Wheelchair frame for mounting all components.
- **Switch/Button**: To activate or deactivate the autonomous mode.

## 5.4. Flow Diagram




5.4. Flow Diagram

### 5.4.1 Arduino ATMega328:

The system's central processing unit (CPU), the Arduino ATMega328, handles all sensor and user input signals. Data from parts like the joystick, infrared sensor, and ultrasonic sensors is continuously processed by it. The wheelchair can move around obstacles and change directions by control commands that the Arduino sends to the motor drivers based on this data. The features of the wheelchair are controlled by the microcontroller, which makes decisions in real time to guarantee safe, efficient operation.

### 5.4.2 Hybrid Motor Drivers (Drivers 1 and 2):

The wheelchair's wheel-drive motors are managed by the Hybrid Motor Drivers (Drivers 1 and 2). The Arduino gives these drivers instructions on how to change the motors' speed and direction. The motor drivers use these instructions to decide whether the wheelchair should move forward, backward, or turn, as well as how fast it should do so. Whether in an indoor or outdoor setting, these motor drivers provide precise control over the wheelchair's movement, helping in responsiveness to user inputs and navigation requirements.

### 5.4.3 Main Switch:

The Main Switch regulates the power supply to the whole setup. It serves as the main channel for turning the wheelchair on and off, enabling the user to control the device. By ensuring that the system only operates when necessary, this switch helps to preserve battery life and avoid wasting power when the wheelchair is not in use.

### 5.4.4 Infrared Sensor:

The Infrared Sensor detects objects in the wheelchair's immediate surroundings, which aids in obstacle detection. It notifies the Arduino of any obstacle in the way that must be avoided by sending data back to it. An extra layer of protection against collisions and safe navigation in confined or cluttered areas are provided by the infrared sensor, which is especially helpful in identifying nearby objects that the ultrasonic sensors might miss.

### 5.4.5 Toggle Switch (High/Low Speed):

The user can alternate between high and low speed settings with the Toggle Switch (High/Low Speed). The user can choose to move the wheelchair more slowly for negotiating confined spaces or more quickly for moving through crowded areas, depending on the situation or particular requirements. The Arduino receives a signal from the switch, processes it, and modifies the motor speed to provide a user experience that can be customized.

### 5.4.6 Joystick:

The wheelchair can be moved manually in a number of directions, including forward, backward, left, and right, also by the Joystick. The wheelchair's navigation can be precisely controlled by the joystick, which acts as the primary interface for user input. The Arduino continuously processes the joystick's signals and translates them into the appropriate motor actions, providing responsive and fluid movement according to the user's preferences.

### 5.4.7 Ultrasonic Sensors (Front and Rear):

The wheelchair's ability to detect obstacles in its path depends on its Ultrasonic Sensors (Front and Rear). By detecting objects or the edge of stairs, the front ultrasonic sensor keeps the wheelchair from going into dangerous areas. For safety, this sensor is especially important, especially when moving into confined spaces. Similar to this, the rear ultrasonic sensor avoids collisions when moving backward by identifying obstacles behind the wheelchair. These sensors give the Arduino system vital feedback that keeps the user safe.

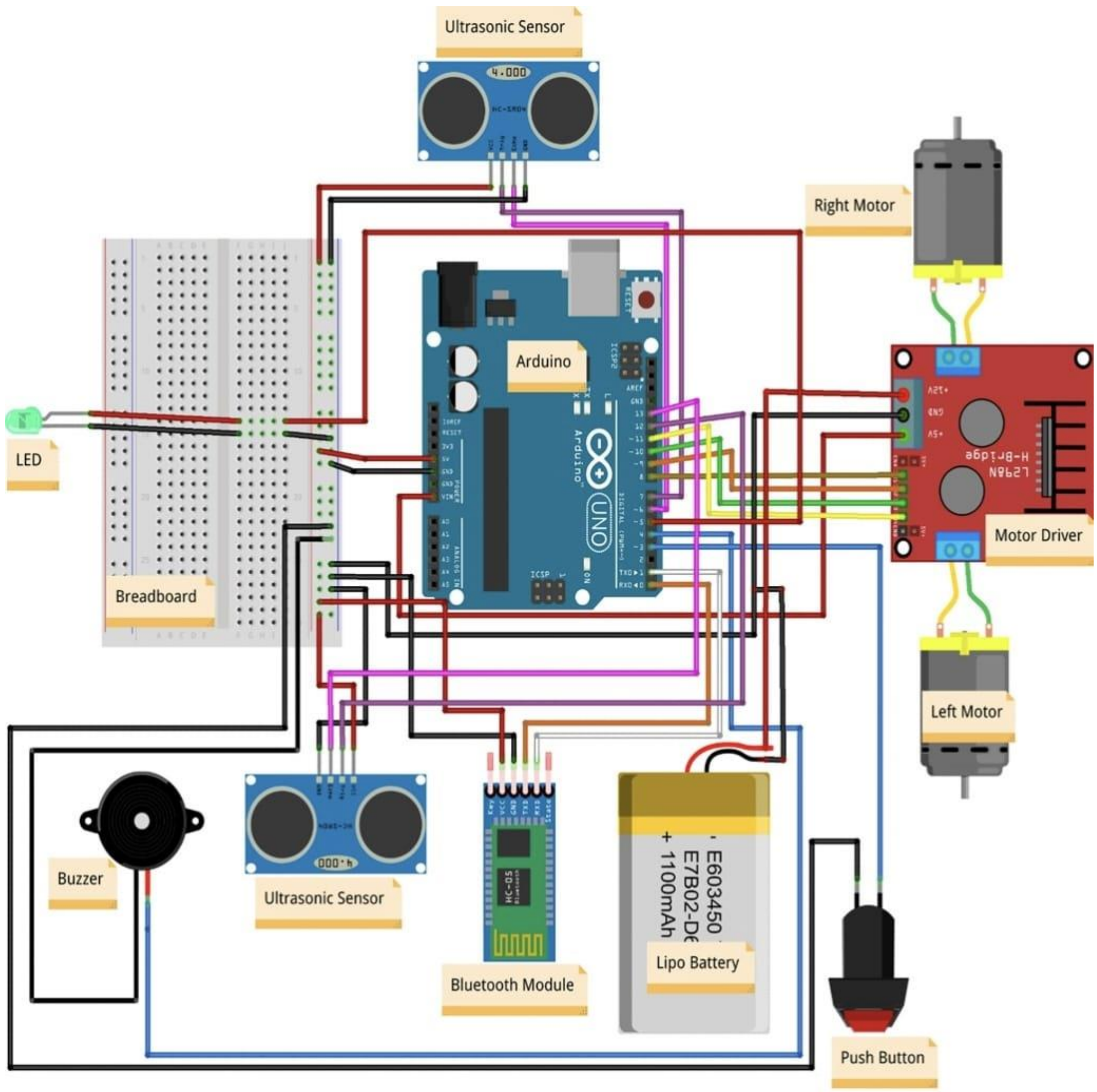
### 5.4.8 Wiper Motors (Motor 1 and Motor 2):

The wheelchair's wheels are propelled by the Wiper Motors (Motor 1 and Motor 2). These motors, which are managed by the hybrid motor drivers, are instructed by the Arduino to allow the wheelchair to move. The motors enable smooth and controlled movement, whether forward or backward, by converting electrical signals into mechanical motion that drives the wheels in the desired direction. These motors are essential to the wheelchair's overall functionality and responsiveness, as well as ensuring its mobility.

### 5.4.9 Wheels (Wheel 1 and Wheel 2):

The physical parts that allow the wheelchair to move are the Wheels (Wheel 1 and Wheel 2). The wiper motors, which supply the required torque to move the wheelchair forward or backward, power them directly. Mobility is made possible by the wheels, which enable the user to move through a variety of places, including flat indoor surfaces and rougher outdoor terrain. These wheels and the motor's control over them are the only things that allow the wheelchair to move, giving the user a seamless and effective mobility solution.

## 5.5. Circuit Diagram:




5.5. Circuit Diagram

The Arduino serves as the system's primary controller, taking in inputs and delivering signals to regulate different parts. The VCC and GND pins of the ultrasonic sensor are connected to the Arduino's 5V and GND pins, respectively. On the Arduino, the Echo pin is connected to a digital pin (like D8) and the Trig pin is connected to a digital pin (like D9). The input pins of the motor driver (L298N) are IN1, IN2, IN3, and IN4. The right motor is controlled by IN1 and IN2 connected to digital pins (like D5 and D6), while the left motor is controlled by IN3 and IN4 connected to other digital pins (like D10 and D11).

The motor outputs (OUT1-OUT4) are connected to the left and right motors, and the enable pins (ENA and ENB) are connected to PWM pins on the Arduino (such as D3 and D9) to regulate motor speed. The positive and negative terminals of the battery are linked to the power pins VCC and GND, respectively. If the jumper is installed, the Arduino can be powered by the 5V pin. The motor driver's outputs are linked to the DC motors. The Arduino's 3.3V or 5V pin, GND to GND, TX to RX (like D0 or D1), and RX to TX (like D1 or D0) are all connected to the Bluetooth module's VCC.

The buzzer's negative terminal is connected to GND, and its positive terminal is connected to a digital pin (such as D12) via a current-limiting resistor. One terminal of the push button is connected to a pull-down resistor and a digital input pin (such as D7), while the other terminal is connected to 5V. The cathode (short leg) of the LED is connected to GND, while the anode (long leg) is connected to a digital pin (such as D13) via a current-limiting resistor. The positive terminal of the LiPo 1100mAh battery is connected to the motor driver's and other components' VCC, and the negative terminal is connected to the Arduino and motor driver's GND.

## 5.6 Implementation

In order to detect hand movements and convert them into gestures, the Gesture-Controlled Smart Wheelchair requires the assembly of hardware components such as the ADXL345 accelerometer, which is interfaced with the help of Arduino. These gestures are used by the motor driver (L298N) to control the wheelchair's motors. Obstacles are detected by ultrasonic sensors (HC-SR04), and alerts are provided by an LED or buzzer. When obstacles are detected, the ultrasonic sensors initiate safety measures like stopping or reversing the wheelchair. The system uses accelerometer data to control movement (forward, backward, left, or right). The system is tested for obstacle detection and precise gesture control. After testing, every part is firmly fixed to the wheelchair for secure and user-friendly operation, improving user independence.

## 5.7 Working Principle

### 5.7.1 Object Detection and Obstacle Avoidance:

Ultrasonic sensors are used by the Gesture-Controlled Smart Wheelchair to identify obstructions in its path. These sensors measure the time it takes for the echo to return after releasing ultrasonic waves. The system calculates the distance to nearby objects by calculating the time delay. In order to prevent collisions, the system either stops or modifies the wheelchair's movement if an obstacle is detected within a predetermined range . In order to ensure safe navigation, this allows the wheelchair to continuously monitor its environment and respond in real time.

### 5.7.2 Direction Change Mechanism:

An Arduino Uno processes data from the ultrasonic sensors to control the smart wheelchair's direction change. The system can identify obstacles by the sensors, which produce sound waves and measure how much of them are reflected off of objects. After analysing this data, the Arduino determines the action. When the wheelchair detects an obstruction on its left side, the system instructs it to turn right in order to avoid it. Likewise, the wheelchair will turn to the left if it detects an obstruction on the right side. The wheelchair is stopped by the system while it waits for the path to clear in situations where obstacles are detected on both sides. This decision-making procedure guarantees safe, effective, and real-time navigation.

### 5.7.3 Code Implementation for Smart Navigation:

The wheelchair's movement is controlled by the Arduino, which is configured to process data from the ultrasonic sensors. The logic uses conditional statements to regulate motor movements and ultrasonic sensors to calculate distances. TensorFlow Lite is used for real-time object detection, detecting obstacles within a specified range and classifying them if required. With the help of this software, the system can precisely detect obstacles and modify the wheelchair's trajectory as needed.

### 5.7.4 Path Planning and Dynamic Control:

The smart wheelchair finds the best way to get around obstacles by using path planning algorithms like Dijkstra's or A* and Clothoid curves (Euler spirals) algorithm. By taking into account the distances to different obstacles, these algorithms assist the system in planning the route, enabling more fluid, collision-free movement. Based on sensor data, the system dynamically responds to environmental changes by modifying the steering and motor speed in real-time. The wheelchair stays on a clear path by the ultrasonic sensors' constant feedback, and the system adjusts when an obstruction is detected.

### 5.7.5 System Workflow:

The user's gestures, which are picked up by the accelerometer, are what drive the wheelchair. The microcontroller receives this information, interprets the gesture, and instructs the motor driver to move the wheelchair in the proper direction. Ultrasonic sensors detect for obstacles in the environment. The system automatically turns off the motors and notifies the user with an LED alert or buzzer if it detects an obstruction. A rechargeable battery powers the entire system, guaranteeing the wheelchair's portability and functionality over time.

### 5.7.6 Control Logic for Motor Movement:

| Position | Arduino Pin No. | | | | Direction |
|---|---|---|---|---|---|
| | #8 | #9 | #10 | #11 | |
| Normal | 0 | 0 | 0 | 0 | STOP |
| Forward | 1 | 0 | 1 | 0 | FORWARD |
| Backward | 0 | 1 | 0 | 1 | BACK |
| Left | 0 | 1 | 1 | 0 | LEFT |
| Right | 1 | 0 | 0 | 1 | RIGHT |

5.7.6 Control Logic for Motor Movement

For different movements, the wheelchair employs a particular control logic. The wheelchair stays motionless when in the Normal (Stop) state because all of the pins are set to LOW (0, 0, 0, 0). Pins #8 and #10 are set to HIGH (1) for forward movement, which turns on the motors to propel the wheelchair forward. To move the wheelchair backward in backward movement, pin #10 is set to HIGH, pin #8 to LOW, and pins #9 and #11 inverted. A right turn happens when pins #8 and #10 are set to HIGH and pins #9 and #11 stay LOW, whereas a left turn is accomplished by setting pins #9 and #11 to HIGH while maintaining #8 and #10 LOW. These setups helps for accurate control over the wheelchair's movement based on real-time sensor data. This system ensures smooth and autonomous navigation, allowing the wheelchair to adjust its path and avoid obstacles efficiently while providing users with a safe and reliable experience.

# CHAPTER 6
# RESULTS AND DISCUSSION

The development of a smart wheelchair system has been very effectiven in obstacle detection and smooth navigation improved user feedback, making it easier to navigate complex environments. By improving sensor accuracy and reliability, path planning algorithms, battery life, user input and gesture recognition, system integration, accessibility and cost, and accommodating users the project is done dynamically.

Ultrasonic sensors, cameras, and LiDAR technologies delivers accurate data in various environmental conditions, and crowded areas or reflective surfaces. Smooth navigation and path planning were implemented , with path planning algorithms like A* and Dijkstra's algorithm and Clothoid curves (Euler spirals) efficiently avoids obstacles and ensure smooth transitions.

User input and gesture recognition systems receives sensitive and accurate to detect subtle movements without error, ensuring user safety and comfort. System integration with interference-free communication between components and safety features like obstacle avoidance is implemented.

## 6.1 Prototype of the proposed system


6.1 Prototype of the proposed system

# CHAPTER 7
# CONCLUSION

The proposed automatic wheelchair system enhances mobility for individuals with disabilities by integrating gesture recognition, ultrasonic obstacle detection, and microcontroller-based control. Using components like the ATMega328, accelerometer, and L298N motor driver, it provides intuitive control, precise movement, and efficient power management. Its affordable and modular design ensures accessibility for resource-limited settings while enhancing user safety with real-time obstacle avoidance.

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## Sivakumar T

### Design and Implementation of an Obstacle-Detecting Smart Wheelchair

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**Paper ID**
1870

**Paper Title**
Smart Wheelchair

**Abstract**
The Smart Wheelchair with Obstacle Detection and Route Optimization is an innovative solution designed to assist individuals with mobility challenges. This project aims to enhance the independence and safety of wheelchair users by integrating intelligent technologies into a traditional wheelchair. Equipped with ultrasonic sensors for real-time obstacle detection, motor drivers for precise movement control, and an Arduino Uno for processing, the system ensures smooth and secure navigation.

The project also incorporates route optimization algorithms to suggest efficient paths and reduce manual effort. Additional features include real-time responsiveness to environmental changes, user-friendly controls, and the potential for health monitoring integrations. By leveraging electronics and IoT technologies, this smart wheelchair addresses the needs of differently-abled individuals, promoting mobility and improving their quality of life.

The project also explores advanced functionalities, such as assistive robotics, telemedicine integration, and active sitting solutions, to further enhance the wheelchair's utility. Overall, this solution represents a significant step forward in creating cost-effective, intelligent mobility aids for people with physical disabilities.

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