A

MINI PROJECT

REPORT

ON

GESTURE CONTROLLED CAR USING ESP32

BY

MIND MATES

UNDER THE GUIDANCE OF

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ACADEMIC YEAR: 2025-2026

CERTIFICATE

This is certified that the Project report entitled **"*GESTURE CONTROLLED CAR USING ESP32*"** submitted by **MIND MATES.** Is a Bonafede work carried out by us under guidance of **DR. ASHISH KR RAO,** and it is approved for the for the partial fulfillment of the requirement of the University of Mumbai for theaward of the Master of Information Technology.

This Project report has not been earlier submitted to any other Institute of University for the award of any degree or diploma.

Place: MEERUT,

Date:

_____

GUIDE

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HEAD OF DEPARTMENT

DECLARATION

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that We have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. We understand that any violation of the above will cause disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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ABSTRACT

The Gesture Controlled Car using ESP32 is an innovative wireless control system that enables vehicle movement through intuitive hand gestures instead of conventional remote controllers. The system utilizes an MPU6050 accelerometer-gyroscope sensor to capture the orientation and tilt of the user's hand. These gesture signals are processed by an ESP32 microcontroller, which then transmits corresponding control commands wirelessly using ESP-NOW to another ESP32 mounted on the robotic car. The receiver ESP32 interprets these commands and drives the motors through an L298N motor driver to achieve movements such as forward, backward, left, right, and stop.

This project eliminates the need for physical buttons and introduces a more natural human–machine interaction. It demonstrates the integration of wireless communication, sensor data processing, and embedded systems. The system is low-power, cost-effective, and offers fast response time, making it suitable for robotics applications, assistive technology, and smart control systems. The design can be extended with additional features such as Bluetooth control, obstacle avoidance, or autonomous navigation.

KEYWORDS: Gesture Control, Arduino, MPU6050, Wireless Communication.

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Overview

Gesture-controlled technology allows users to interact with devices through intuitive hand movements, eliminating the need for physical controllers. In this project, a **Gesture Controlled Car using ESP32** is designed to demonstrate the integration of wireless communication, sensors, and embedded systems. Using an **MPU6050 accelerometer**, the system reads hand gestures and transmits commands wirelessly via **ESP-NOW** to another ESP32 mounted on the robotic car. The car responds to motions such as tilt forward, backward, left, and right, enabling an interactive and modern control system.

This project showcases innovation in human–machine interaction, making it suitable for engineering exhibitions, college projects, and robotics learning.

Existing System

The existing system of a gesture-controlled car typically consists of a microcontroller, gesture-detecting sensors, a motor driver, and a power supply. In most designs, an accelerometer and gyroscope sensor, such as the MPU6050, is worn on a glove or wristband to detect hand movements like tilting, shaking, or rotating. The sensor sends this motion data to the microcontroller, which processes the input and maps it to corresponding commands for the car. These commands are then sent to a motor driver, like the L298N, which controls the DC motors to move the car forward, backward, left, or right. Some advanced systems use wireless communication modules, such as Bluetooth or ESP-NOW, to transmit gestures to the car without wires. While effective, existing systems often face limitations like limited gesture recognition, response delay, sensor inaccuracies, and higher costs when using advanced camera-based detection methods

CHAPTER 2

LITERATURE SURVEY

Survey of Existing System

Several studies and projects have explored gesture-controlled cars, primarily focusing on using sensors and microcontrollers to translate human hand movements into vehicle commands. Most existing systems employ accelerometer and gyroscope sensors, like the MPU6050, mounted on a glove or wristband to detect tilts, rotations, and shakes. These sensors communicate with microcontrollers such as Arduino or ESP32, which process the data and send appropriate signals to motor drivers (e.g., L298N) to control the car's motion. Wireless modules like Bluetooth or ESP-NOW are commonly used to allow remote operation. Research indicates that while these systems are effective for simple directional control, they are often limited by sensor noise, latency in wireless communication, and the ability to recognize only basic gestures. Some advanced implementations have explored camera-based gesture recognition, but they are more complex and expensive. Overall, existing systems provide a foundation for intuitive robotic control but leave room for improvements in accuracy, gesture variety, and real-time responsiveness

Problem Statement

Traditional remote-controlled cars rely on physical controllers, which can be cumbersome and limit user interaction. While gesture-controlled cars aim to provide a more intuitive and natural method of control using hand movements, existing systems face several challenges. These include limited gesture recognition capabilities, sensor inaccuracies, latency in wireless communication, and high costs when using advanced camera-based detection. Additionally, most systems can only interpret simple gestures, restricting the range of control and responsiveness of the car. Therefore, there is a need to develop a more accurate, real-time, and cost-effective gesture-controlled car system that can recognize a wider variety of gestures and provide smooth, reliable control.

Objective

 To design and develop a robotic car that can be controlled using hand gestures, providing an intuitive and natural user interface.

 To implement sensors, such as accelerometers and gyroscopes, for accurate detection of hand movements and gestures.

 To process gesture data using a microcontroller (e.g., ESP32 or Arduino) and convert it into motor commands for controlling the car.

 To enable wireless communication between the gesture-detecting device and the car, ensuring mobility and ease of operation.

 To improve the accuracy, response time, and reliability of gesture recognition for smooth and precise car control.

 To create a cost-effective and efficient system that can be used for educational, experimental, or entertainment purposes.

CHAPTER 3

PROPOSED SYSTEM

Enhanced Accuracy and Responsiveness:

The proposed system will implement advanced gesture recognition algorithms using sensors like the MPU6050 to detect tilts, rotations, and hand movements with high precision. Real-time processing by the microcontroller (ESP32 or Arduino) ensures immediate response to gestures, reducing lag and improving the overall control experience.

Wireless Control and Mobility:

The system will employ wireless communication technologies such as ESP-NOW or Bluetooth to transmit gesture commands from the glove or wristband to the car. This eliminates physical constraints, providing smooth and uninterrupted mobility while maintaining reliable signal transmission.

Efficient Motor Control and Power Management:

The proposed system will use the L298N motor driver to efficiently control DC motors, enabling precise movements in all directions. Power management strategies, including optimized battery usage and low-power sensor operation, will ensure longer operational time without compromising performance.

Multi-Gesture Capability:

The system will support multiple hand gestures, allowing for intuitive control of forward, backward, left, right, and stop commands. Advanced mapping of gestures to motor actions increases flexibility and expands the range of possible movements.

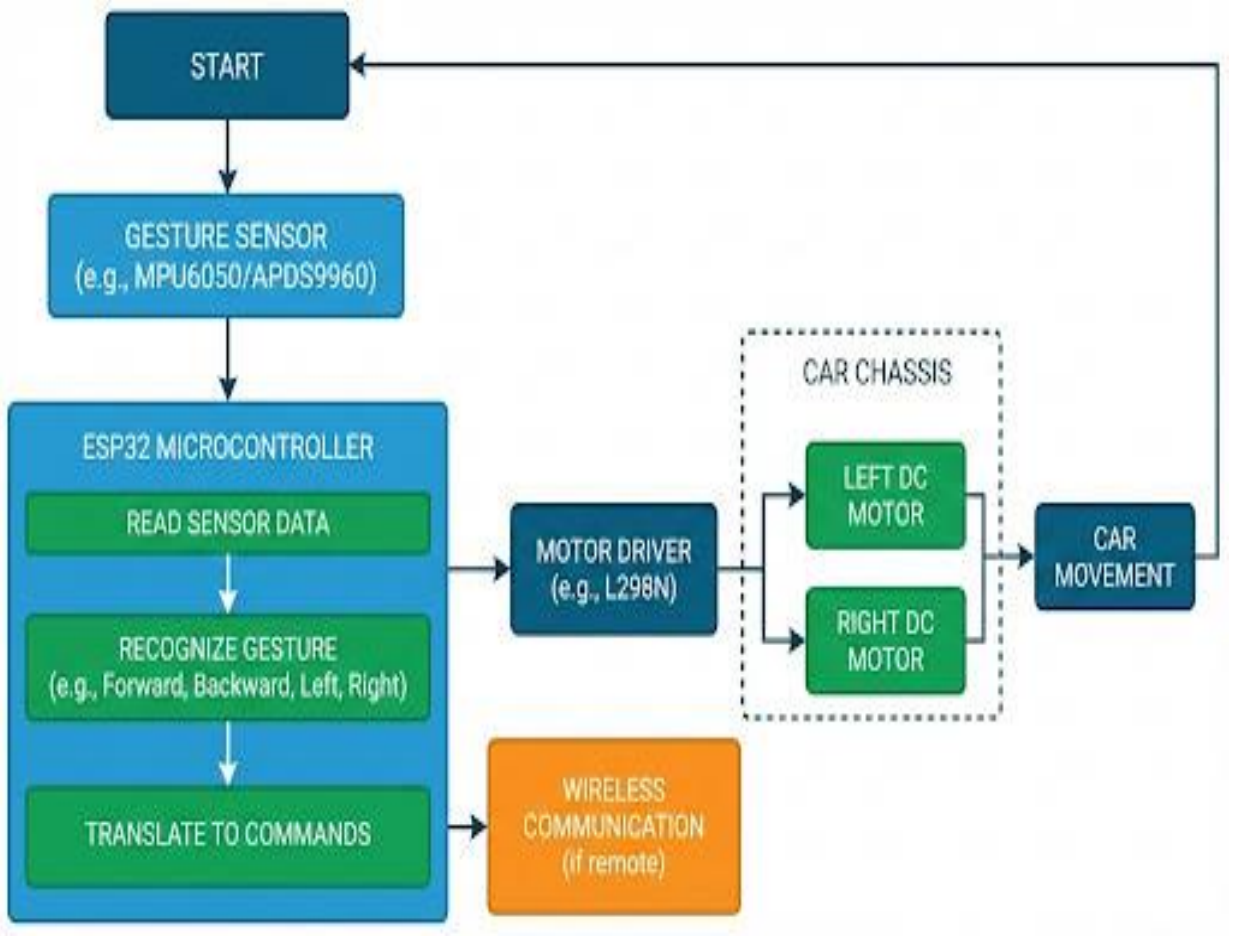
User-Friendly and Cost-Effective Design:

The system will be designed for ease of use, with a simple wearable sensor interface and intuitive gesture controls. By relying on widely available components, the system will be affordable while remaining robust and reliable for educational, experimental, or hobbyist applications.

Scalability and Future Integration:

The proposed system will allow for easy integration with additional sensors, IoT devices, or automation modules. This makes it scalable for more complex robotic applications, enabling future enhancements such as obstacle avoidance or camera-based gesture recognition.

Flowchart:


START
GESTURE SENSOR
(e.g., MPU6050/APDS9960)
ESP32 MICROCONTROLLER
READ SENSOR DATA
RECOGNIZE GESTURE
(e.g., Forward, Backward, Left, Right)
TRANSLATE TO COMMANDS
MOTOR DRIVER
(e.g., L298N)
CAR CHASSIS
LEFT DC
MOTOR
RIGHT DC
MOTOR
CAR
MOVEMENT
WIRELESS
COMMUNICATION
(if remote)

CHAPTER 4

METHODOLOGY

1. System Design and Component Selection:

- Identify the hardware components required: ESP32 or Arduino microcontroller, MPU6050 accelerometer and gyroscope sensor, L298N motor driver, DC motors, and rechargeable battery.
- Select the communication method: Bluetooth or ESP-NOW for wireless control.
- Design the mechanical structure of the car to accommodate motors, wheels, and electronic components.

2. Sensor Calibration and Data Acquisition:

- Mount the MPU6050 sensor on a glove or wristband for gesture detection.
- Calibrate the sensor to ensure accurate measurement of tilt, rotation, and acceleration.
- Acquire real-time sensor data from hand movements and transmit it to the microcontroller for processing.

3. Gesture Recognition and Mapping:

- Process the sensor data using the microcontroller to recognize specific gestures such as forward tilt, backward tilt, left tilt, right tilt, or stop.
- Map each gesture to a corresponding motor command for controlling the movement of the car.
- Implement threshold values to reduce errors and avoid false gestures.

4. Motor Control and Car Movement:

- Send the processed gesture commands to the L298N motor driver.
- Control the speed and direction of DC motors based on the recognized gesture.
- Ensure smooth and responsive movements of the car corresponding to user gestures.

5. Wireless Communication:

- Establish a reliable wireless link between the sensor module and the car using Bluetooth or ESP-NOW.
- Ensure low-latency transmission of gestures for real-time car control.

6. Testing and Optimization:

- Conduct multiple tests runs to verify the accuracy of gesture recognition and car movement.
- Optimize sensor calibration, threshold values, and motor speed to improve responsiveness.
- Troubleshoot issues related to wireless connectivity, power consumption, and motor control.

7. Final Implementation:

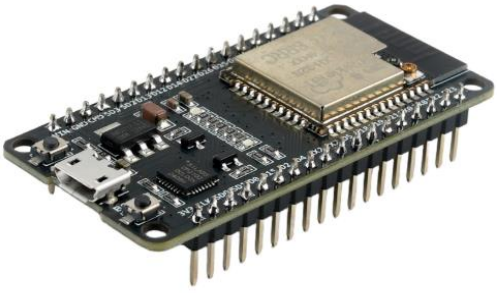
- Integrate all components into the car and wearable device.
- Demonstrate smooth and accurate gesture-controlled operation.
- Document results, including accuracy, response time, and overall performance of the system.

Components Required

1.Hardware

- 2 × ESP32 Development Boards
- MPU6050 Gyroscope + Accelerometer Sensor
- L298N Motor Driver Module
- Gear Motors (2 or 4 depending on design)
- Wheels and Chassis
- Battery Pack (7.4V/12V)
- Connecting Wires
- Switch
- Breadboard

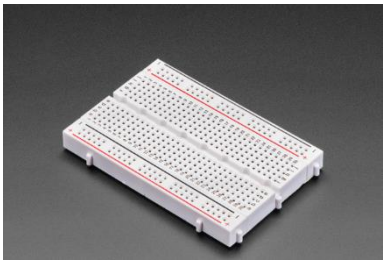
ESP-32:



L298N:

MPU6050:

Breadboard:



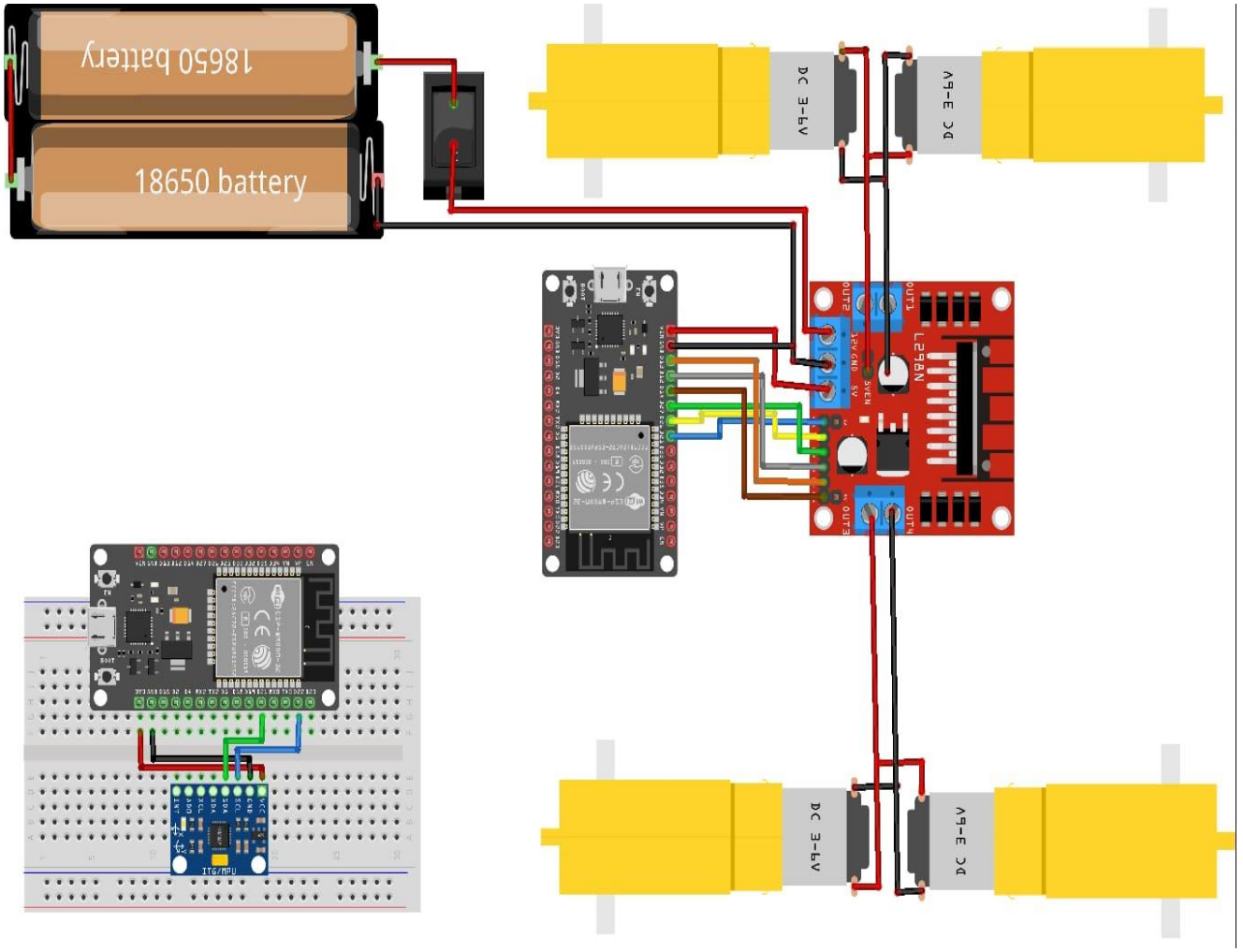
2.Software

- Arduino IDE
- ESP32 Board Package
- ESP-NOW Library
- MPU6050 & Adafruit Sensor Libraries

CHAPTER-5

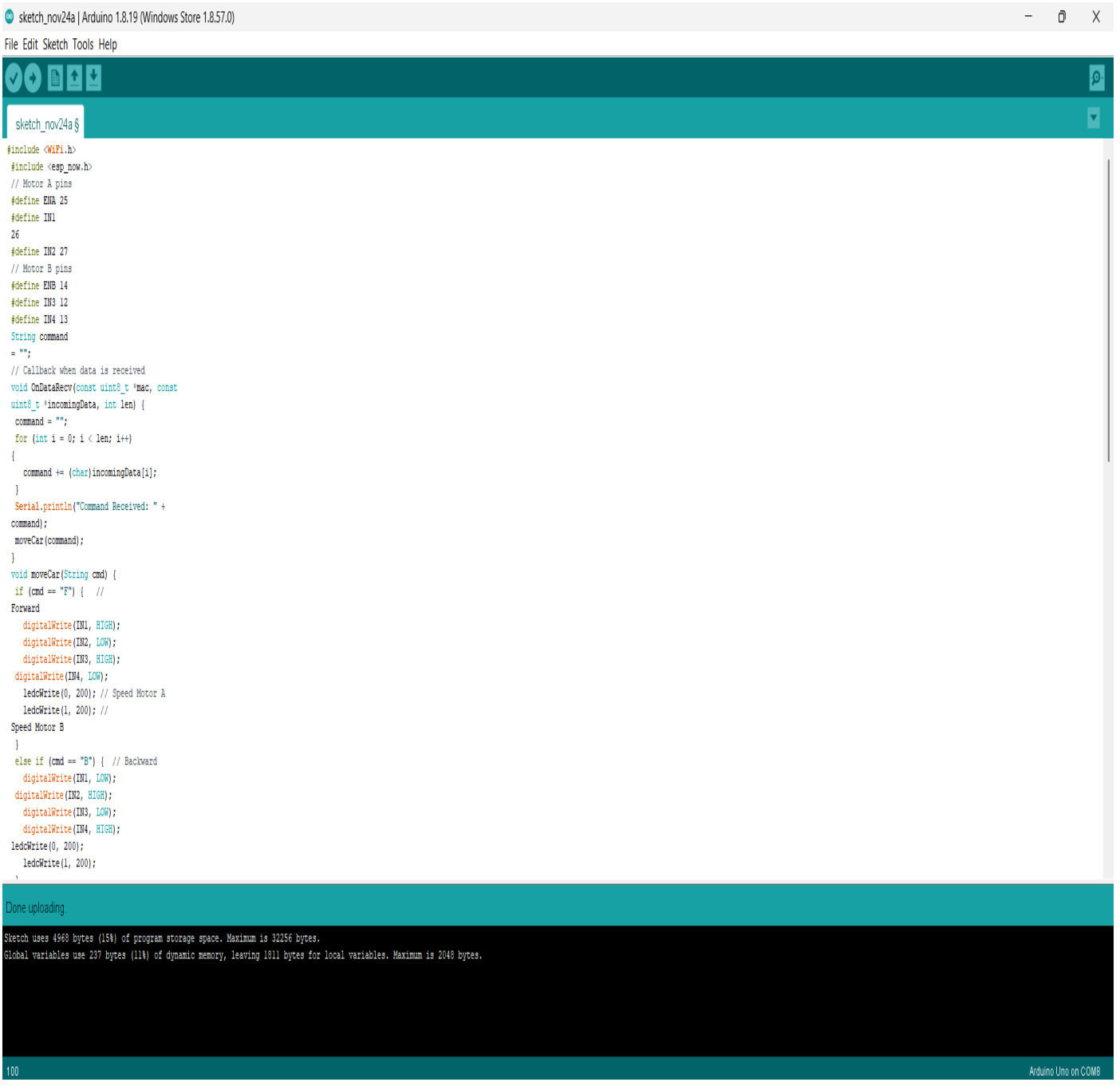
SNAPSHOT

Block Diagram:

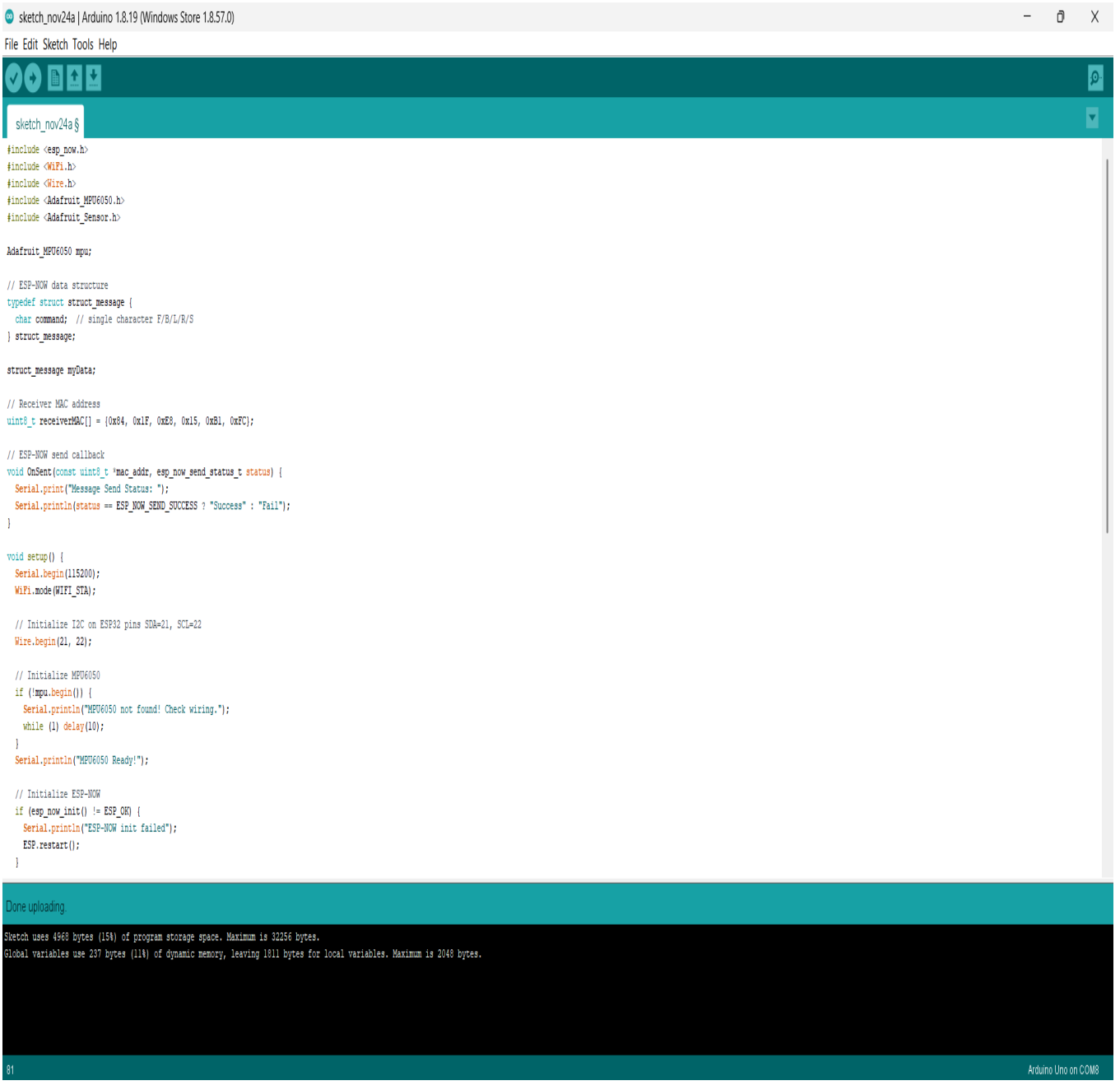


Code Execution:

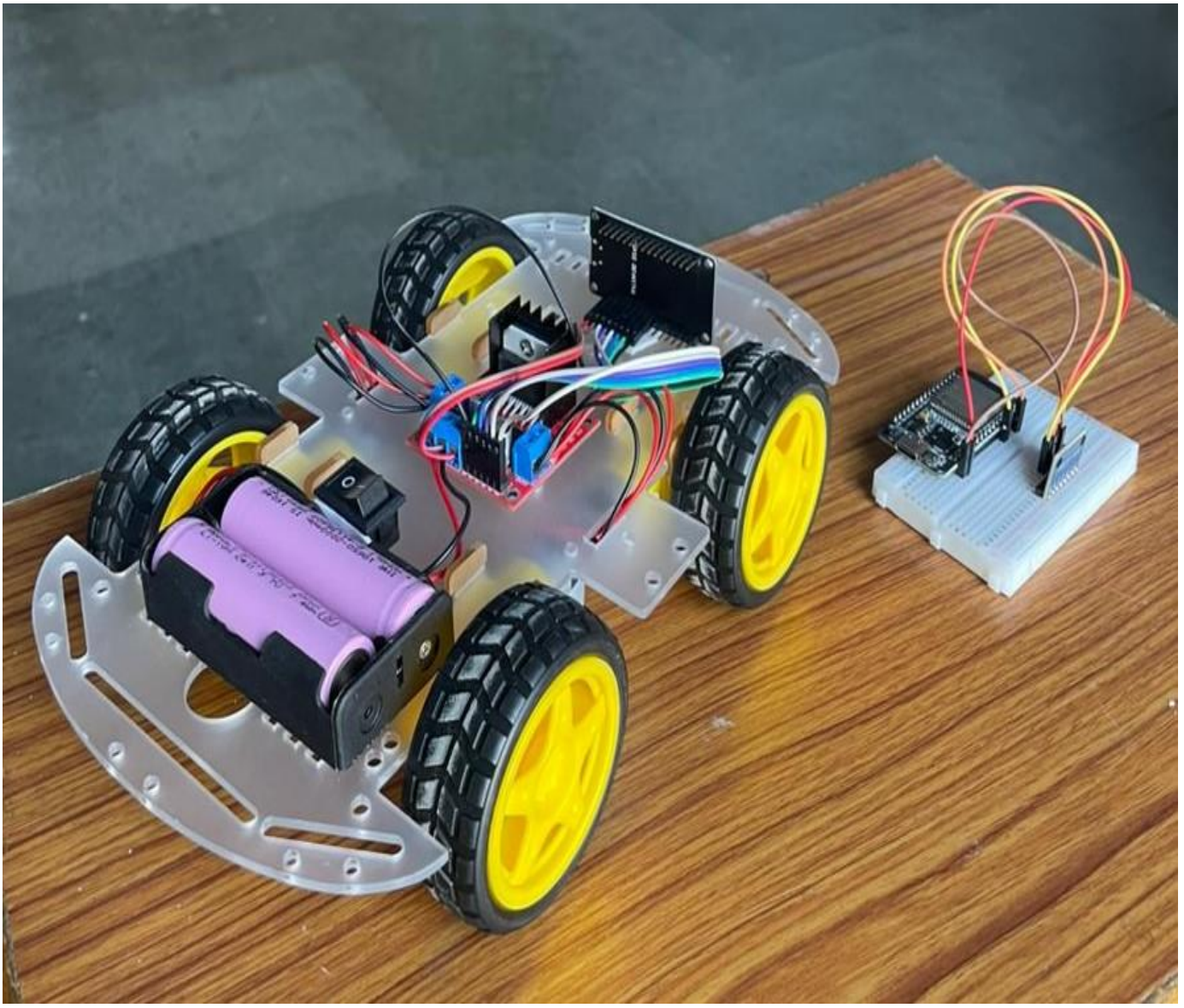
Receiver Code:



Transmitter Code:



OUTPUT :



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CONCLUSION&FUTURE SCOPE

Conclusion:

1. Successful Implementation:

- The project effectively demonstrates real-time control of a car using hand gestures.
- Gestures are accurately detected and translated into motor movements.

2. Technology Integration:

- Combines ESP32 microcontroller, motion sensors (e.g., MPU6050), and motor drivers.
- Illustrates the use of embedded systems and wireless communication.

3. Applications and Benefits:

- Provides touchless, intuitive control of robotic systems.
- Useful in automation, assistive devices, and smart vehicles.

4. Learning Outcomes:

- Enhances skills in sensor interfacing, motor control, and IoT-based systems.
- Demonstrates practical implementation of gesture recognition in robotics.

Future Scope

The Gesture Controlled Car project successfully demonstrates the integration of modern embedded systems, sensors, and wireless communication to create a responsive and interactive robotic vehicle. By utilizing the ESP32 microcontroller along with motion sensors such as the MPU6050, the system effectively detects and interprets human hand gestures and converts them into precise motor commands. This allows the vehicle to perform movements such as moving forward, reversing, and turning in different directions based solely on hand gestures. The project highlights the potential of touchless control mechanisms, which are not only intuitive but also enhance user interaction with robotic systems. Through this project, students gain practical experience in sensor interfacing, motor control, and programming, while also exploring the applications of the Internet of Things (IoT) in robotics. The integration of gesture recognition with robotics opens up numerous possibilities for creating innovative, human-centric technologies.

Beyond the immediate achievement of a gesture-controlled vehicle, the project has significant potential for future enhancements. Advanced gesture recognition algorithms, possibly based on artificial intelligence and machine learning, can be implemented to detect more complex and nuanced gestures, improving both the accuracy and range of control. This would allow for more sophisticated commands and a more natural user experience. Additionally, incorporating obstacle detection sensors such as ultrasonic sensors, infrared sensors, or even LiDAR could enable the car to navigate autonomously while avoiding collisions, thus combining gesture control with safe and intelligent navigation. Such features could make the system suitable for real-world applications, including automated delivery systems or indoor transportation robots.

Integration with mobile applications represents another avenue for expansion. By connecting the vehicle to a smartphone app over Wi-Fi or Bluetooth, users could remotely monitor the car's status, control it from a distance, or even combine app-based and gesture-based commands for a more versatile interface. Multi-modal control, such as combining voice commands with gestures, could further enhance the usability of the system, providing a seamless and highly interactive human-robot interface. In the long term, these advancements could evolve the project into a semi-autonomous or fully autonomous robotic vehicle, capable

of performing tasks with minimal human intervention.

The potential applications of this technology are vast. In industrial settings, gesture-controlled or semi-autonomous vehicles could assist in material handling and warehouse automation. In daily life, such systems could serve as assistive devices for individuals with mobility challenges, providing greater independence and convenience. Educationally, this project provides a solid foundation for learning about robotics, embedded systems, and sensor technology while inspiring further exploration into the development of intelligent robotic systems. Overall, the Gesture Controlled Car project not only demonstrates a successful proof of concept but also lays the groundwork for future innovations in robotics, IoT, and human-machine interaction, combining technology, practicality, and creativity in one integrated platform.

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