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Arduino Mobile Robot with Gesture Control

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Abstract: *This project presents a gesture controlled mobile robot using Arduino technology and wireless communication technology controlled entirely through hand gestures , eliminating the need for mobile phones or physical remotes. The user just needs to wear a gesture device in which a sensor is included. The sensor will record the movement of hand in a specific direction which will result in the motion of the robot in the respective directions. The robot and the Gesture instrument are connected wirelessly through Bluetooth. User can interact with the robot in a more friendly way due to the wireless communication. We can control the robot using accelerometer sensors connected to a hand.*

The sensors are intended to replace the remote control that is generally used to run the robot. It will allow user to control the forward, backward, leftward and rightward movements, while using the same accelerometer sensor to control the throttle of the robot. Movement of robot is controlled by the differential mechanism. The mechanism involves the rotation of both forth & rear wheels of left or right side to move in the anticlockwise direction and the other pair to rotate in the clockwise direction which makes the robot to rotate about its own axis without any kind of forward or backward motion. The main advantage of this mechanism is the robot with this mechanism can take sharp turn without any difficulty. The design and implementation of a gesture control robotic arm using flex sensor is proposed. The robotic arm is made to imitate the human hand movements using a hands.

Keywords: *Arduino technology*

I. INTRODUCTION

An Arduino-based mobile robot with gesture control is a fascinating and practical example of embedded system applications, combining sensor technology, wireless communication, and robotic control. This system allows a user to control a robot's movement through simple hand gestures, eliminating the need for traditional input methods like remote controls or joysticks. It uses an Arduino microcontroller as the central processing unit, which interprets real-time data from motion sensors such as an accelerometer or gyroscope, typically mounted on a glove or handheld device worn by the user. These sensors detect the orientation and movement of the hand, and the data is wirelessly transmitted—commonly via Bluetooth or RF modules—to the robot. Upon receiving this data, the Arduino on the robot decodes the signal and activates the motors to move in the direction corresponding to the gesture, such as forward, backward, left, or right.This entire setup is a compelling example of how embedded systems work, as it integrates both hardware and software to perform a dedicated function in real time. Embedded systems are designed to be reliable, efficient, and compact, performing specific tasks within larger systems or as standalone applications. In this robot, the embedded system includes components such as the Arduino board, motion sensors, wireless modules, and motor drivers, all programmed to work together seamlessly. The Arduino microcontroller is programmed using C/C++ in the Arduino IDE, and it continuously processes incoming data, applies logic to interpret gestures, and controls the actuators accordingly. The role of the embedded system is central, enabling precise and timely responses to user commands, which is crucial for any real-time robotic application. From a technical perspective, the system consists of key components like the Arduino board (such as UNO or Nano), the MPU6050 sensor for gesture detection, HC-05 Bluetooth or RF modules for wireless communication, an L298N motor driver to control the motors, and a battery-

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powered motorized chassis to form the body of the robot. Each component has a specific role, and the embedded system is responsible for integrating them through software logic and electrical connections. When the user performs a gesture, the sensor captures motion data, the microcontroller processes this input, and the motors respond almost instantaneously. This allows for a highly interactive experience that feels intuitive and modern.

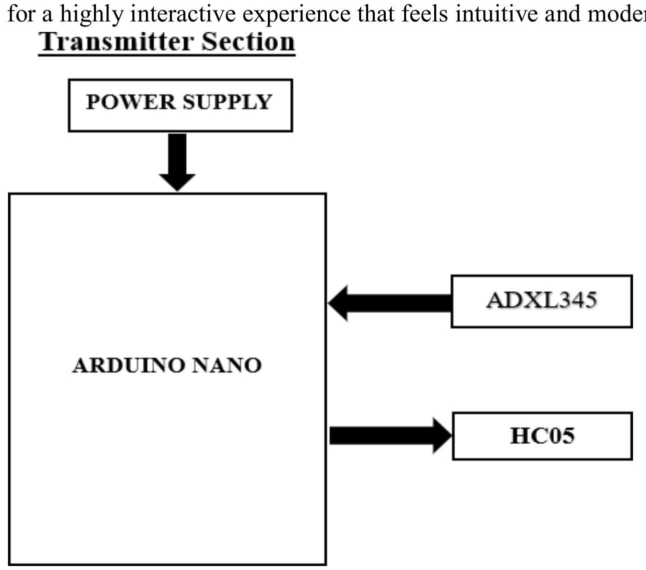

Fig 1: Block Diagram of Transmitter side

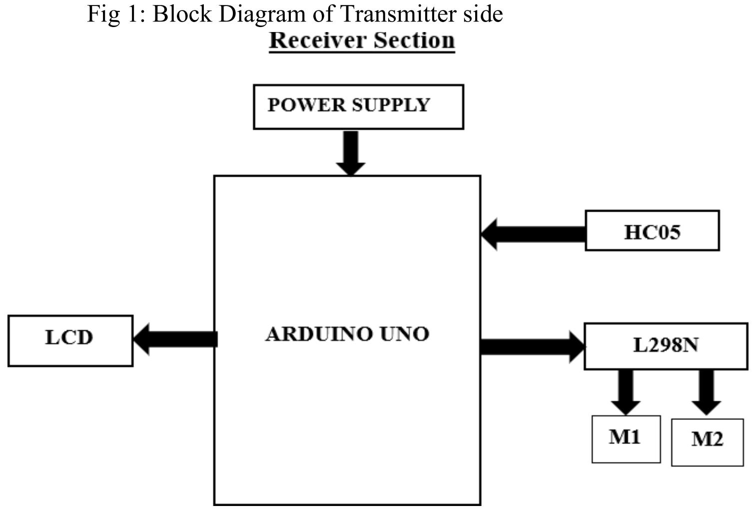

Fig 2: Block Diagram of Receiver side

II. EMBEDDED SYSTEM

An Embedded System is a specialized computer system that is designed to perform a specific task or function within a larger mechanical or electrical system. Unlike general- purpose computers, embedded systems are optimized for particular applications, often operating under real-time constraints. They combine hardware and software components to carry out dedicated functions efficiently and reliably.

Embedded systems are everywhere—in household appliances, automobiles, medical devices, industrial machines, consumer electronics, and more. For example, a washing machine uses an embedded system to control its operations based on user inputs, while a car may contain dozens of embedded systems to manage everything from engine control to safety features like airbags.

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Typically built around microcontrollers or microprocessors, these systems interact with their environment through sensors and actuators. The embedded software (firmware) embedded in ROM or Flash memory provides the logic that drives the system.

With the advancement of technologies like the Internet of Things (IoT), embedded systems are becoming smarter and more connected, playing a vital role in building intelligent environments such as smart homes, smart cities, and autonomous vehicles.

III. GESTURE CONTROL

Gesture control is a technology that interprets human body movements—typically hand or finger motions—as commands to control electronic devices. It eliminates the need for physical interfaces like buttons or joysticks, making the interaction more natural and intuitive. In gesture-controlled systems, sensors such as accelerometers (e.g., ADXL123) detect changes in orientation or movement, which are then processed by a microcontroller like the Arduino. These gestures are translated into specific commands that can be used to operate devices such as robots, drones, or smart home appliances. In the case of a gesture-controlled Arduino mobile robot, the system reads the user's hand gestures through an accelerometer, processes the motion data, and sends corresponding commands wirelessly to control the robot's movement. Gesture control enhances user experience, offering a touch-free and efficient method of interaction, especially in robotics and assistive technologies.

IV. EXISTING SYSTEM

In the existing system, the mobile robot is controlled using hand gestures, which are detected by an accelerometer and processed by an Arduino Nano mounted on a wearable or handheld gesture controller. This controller forms the transmitter unit. The accelerometer senses the direction and movement of the user's hand and sends the raw data to the Arduino Nano, which interprets it and sends corresponding directional commands wirelessly via the HC-05 Bluetooth module.

The receiver unit, mounted on the mobile robot, consists of an Arduino Uno, another HC-05 Bluetooth module, an L298N motor driver, and two DC motors (M1 and M2).

Arduino Uno receives the commands via Bluetooth, processes them, and controls the motors through the L298N driver module to move the robot forward, backward, left, or right. A separate battery-powered power supply is used to power both the control unit and the robot unit.

This setup allows basic gesture-based wireless control of the robot without the need for physical switches or joysticks. The system demonstrates how embedded hardware and wireless communication can be used together to achieve intuitive robot control. However, while functional, this existing system still presents several limitations that affect performance, efficiency, and flexibility in practical applications.

V. PROPOSED SYSTEM

The proposed gesture-controlled mobile robot system aims to enhance the reliability, range, and usability of the existing setup. It consists of two main units: the gesture control unit and the mobile robot unit. The gesture control unit is built around an Arduino Nano, which reads movement data from an accelerometer sensor mounted on the user's hand. This data is analyzed and converted into directional commands such as forward, backward, left, right, and stop. These commands are transmitted wirelessly using the HC-05 Bluetooth module. On the receiving end, the mobile robot unit is powered by an Arduino Uno, which receives these commands via another HC-05 module. The Uno processes the received data and sends corresponding signals to an L298N motor driver, which controls two DC motors (M1 and M2) that drive the robot. A dedicated power supply provides energy to both the Arduino and the motors, ensuring smooth operation. This improved design allows for more responsive control, reduced wiring complexity, and a more efficient gesture recognition process.

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VI. SOFTWARE EMPLOYED

The software employed for an Arduino mobile robot with gesture control primarily involves the Arduino Integrated Development Environment (IDE), which is used to write, compile, and upload the control code to the Arduino Nano microcontroller. The program is written in C/C++ and utilizes libraries such as Wire.h and SoftwareSerial.h for communication and data handling. The ADXL123 accelerometer is interfaced with the Arduino to capture real-time X, Y, and Z axis values corresponding to the user's hand gestures. These values are processed by the Arduino code to recognize specific gestures. The processed gesture data is then converted into control signals and transmitted wirelessly using the HC-05 Bluetooth module. On the receiver side (usually on the robot), another Arduino interprets the Bluetooth commands and drives the motors accordingly. The software thus ensures seamless integration between gesture recognition, signal processing, and robot actuation, allowing for intuitive and real-time mobile robot control.

VII. RESULTS AND DISCUSSIONS

The gesture-controlled mobile robot was successfully developed and operated as intended. The system accurately detected various hand gestures and responded in real-time by moving the robot in the corresponding directions such as forward, backward, left, right, and stop. Wireless communication between the control unit and the robot was stable and responsive, ensuring smooth operation without delays or errors. The robot consistently followed the user’s hand movements, demonstrating precise control and good reliability in different testing environments. The overall performance of the system met the project objectives, proving that gesture-based control is effective method for operating mobile robotic platforms.

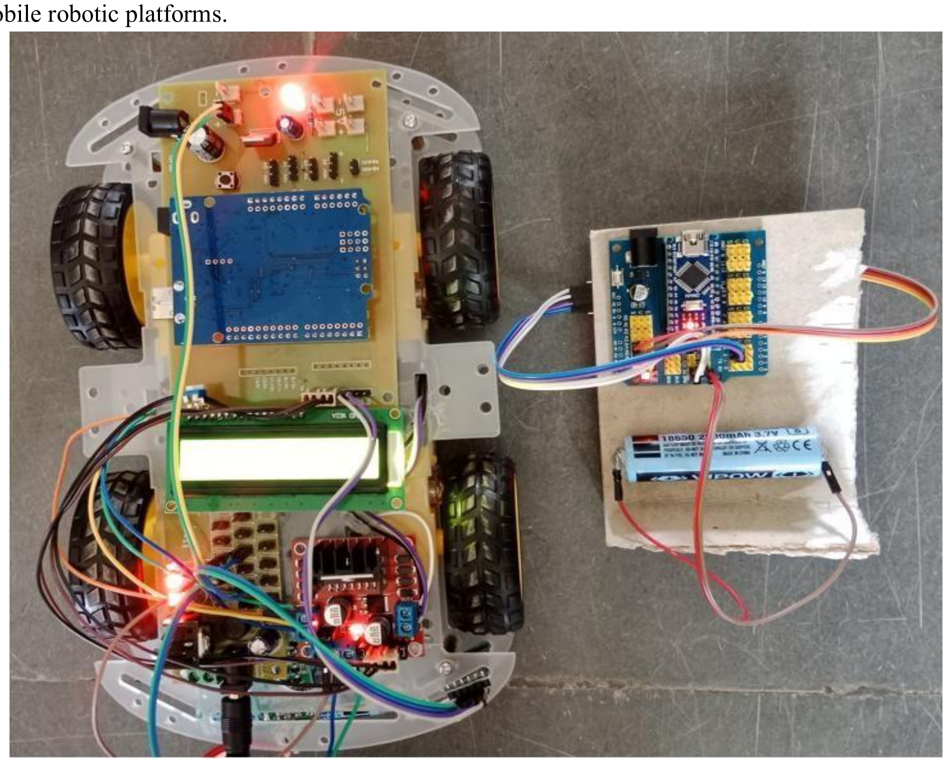

Fig 3: Output Of Arduino mobile robot with gesture control

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Fig 7: Displaying the commands in LCD

VII. CONCLUSION

The project successfully demonstrated the development of a gesture-controlled mobile robot using embedded system principles. The robot responded accurately to hand gestures, allowing real-time, wireless control without any physical contact. This system offers an intuitive, efficient, and user-friendly approach to controlling robotic platforms. Through systematic design, implementation, and testing, the project achieved its objective of creating a responsive and reliable gesture-based robotic control system. The performance observed during trials validates the effectiveness of gesture control as a viable alternative to conventional methods such as remote control or joystick-based navigation.

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