Gesture Controlled Robotic Driving System for Drivers

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Abstract: *The evolution of robot control systems has accelerated over time, and is one of the most recent innovations developed in the robot control system is for the gesture controlled robot. In this project we are going to design a gesture controlled robot using modern technologies to help driver specially in bad roads. A robot is usually an electro-mechanical machine that can perform tasks automatically. A gesture-controlled robotic driving system represents a significant advancement in automotive and robotics technology, aiming to enhance driver interaction and safety. This system allows drivers to control the vehicle through image, eliminating the need for traditional methods. Some robots require some degree of guidance, which may be done using a remote Control or with a computer interface. Soldiers would carry this equipment during combat. Sometimes the operator may get confuse in the switch control and button control, so a new concept is used to manage the gadget with the motion of the driver control, helps in preventing damage to the car and at the same time it will manage the motion of the device*

Keywords: Gesture recognition, Robot movement, sensor control ,Road condition

I. INTRODUCTION

A significant percentage of road accidents occur due to poor road conditions such as potholes, uneven surfaces, lack of proper signage, slippery roads, and inadequate lighting. Robots are used to do the work, that human cant perform. To raise the usage of robotics where restrictions that are not mandatory, for example, fire handling task or protection task. The device receives the input from the user and work out according to the received input. Human hand motion are received by the wire connected to the accelerometer. The robots travel by motion made by drivers.

To ensure safe driving and obstacle avoidance, the system integrates several sensors—most notably the Ultrasonic Sensor. This sensor operates by emitting ultrasonic waves and measuring the time it takes for the echo to return after striking an object. With a detection range of 2 cm to 400 cm and an accuracy of approximately ±3 mm, it effectively identifies nearby potholes, bumps, or obstacles that could lead to accidents.

A gesture-controlled robotic driving system represents a significant advancement in automotive and robotics technology, aiming to enhance driver interaction and safety. Integration with GPS and real-time traffic data can enable autonomous navigation in complex environments. Moreover, by combining gesture control with voice commands and eye-tracking technologies, multimodal interaction can be achieved, offering a safer and more intuitive driving experience. Enhanced sensor fusion using LiDAR, high-definition cameras, and advanced computer vision can improve the system's ability to detect road conditions, potholes, and dynamic obstacles with greater precision. The Smartphone has an accelerometer built in, which can be utilized for gesture detection and other functions. Even sensors are being used as one of means for gesture recognition. Once the robot is able to understand the gesture of humans, it acts accordingly and fulfill the requirements of humans. With ongoing innovations, gesture-controlled driving systems are positioned to be an integral part of the future of smart transportation, contributing to both efficiency and safety in modern driving.

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II. LITERATURE SURVEY

[1] This paper discusses a proposed hand gesture-based control design for mobile robots. Mobile robots can move in response to hand gestures that convey control signals. Image processing, image counter processing, and other techniques are used to recognize gestures. The control of a mobile robot is based on information that has been recognized and decoded.

[2] The user's gestures direct the movement of the mobile robot in this project. This model consists of transmitter unit with PIC Microcontroller for recognition of gestures. This system was created at a low cost and with a high level of efficiency.

[3] The goal of this project is to use gestures to operate a mobile robot. To do this, the recorded pictures are processed using a circular Hough transform-based method to determine the appropriate targets. Then, to regulate the robot's motion, control signals are supplied to the receiver unit.

[4] This paper describes how humans can communicate with robots using basic hand gestures. This can be done using a Leap motion sensor. We suppose that the robot is capable of emotional interaction in this scenario. This study helps us to understand how human can interact with a robot using effective hand gestures.

[5] In this paper, they show a gesture-based control interface for navigating a car-robot. human-machine interaction (HMI) in autonomous vehicles, focusing on gesture-controlled systems. The authors provide a comprehensive-less. analysis of how computer vision and machine learning are used to enhance driver comfort and vehicle safety through gesture recognition.

[6] This paper presents a method of controlling an automata with hand gestures using the Arduino Lilypad. A motion device attached on the hand gloves is used to control the projected model. This style's major goal is to control the robot victimisation hand gesture.

Author(s)	*Title*	*Year*	*Description*
Wang, Y., Li, J., & Chen, X.	Gesture Recognition for Autonomous Driving Using Deep Learning and Sensor Fusion	2023	Explores gesture recognition in autonomous driving using deep learning techniques combined with sensor fusion for improved accuracy.
Kumar, S. & Gupta, R.	Hand Gesture Control System for Smart Vehicles Using Convolutional Neural Networks	2022	Proposes a hand gesture control system for smart vehicles utilizing CNNs to interpret driver commands effectively.
Zhao, H., Zhang, T., & Liu, Y.	Human-Machine Interaction in Autonomous Vehicles: A Gesture-Controlled Approach	2021	Focuses on enhancing human-machine interaction in autonomous vehicles using gesture-based control methods.
Lee, K. & Park, M.	Multi-Modal Gesture Recognition System for Automotive Applications	2021	Introduces a multi-modal gesture recognition system combining visual and inertial data for robust vehicle control.
Sharma, P., Singh, A., & Yadav, P.	Real-Time Hand Gesture Recognition Using Depth Sensors for Autonomous Vehicles	2020	Presents a real-time gesture recognition framework using depth sensors to control autonomous vehicle functions.

Table 1: Outcomes of the paper refered.

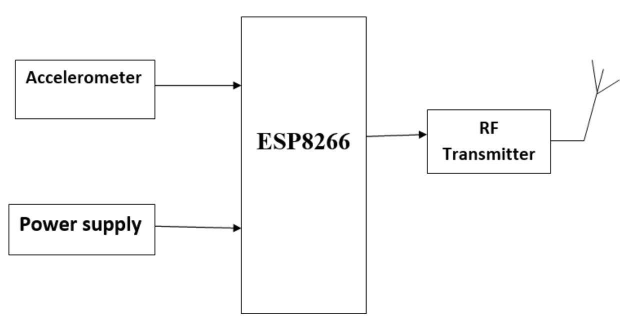

Figure 1: Transmitter block diagram

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III. OBJECTIVE AND SCOPE

The main goal is to Gesture-Based Vehicle Control: A fully functioning gesture-controlled system will allow drivers to control the vehicle through predefined gestures such as turning left or right, accelerating, and braking. Improved Safety and User Experience: The system will enhance driver safety by reducing the need for physical contact with traditional controls, minimizing distractions, and allowing for a more intuitive driving experience.

The scope of the work in this project has a greater potential for military applications. Additional features could be added to the robot to increase its performance and extend the range of communication between the transmitter and receiver.

IV. METHODOLOGY

a. TRANSMITTER BLOCK DESCRIBTION

The transmitter component of the robot is made up of an Arduino uno, four Flex sensors, a HC-05 Bluetooth module, and a power source. The flex sensor is used to navigate the robot to the right, left, forward, and backward positions. These flex sensors detect movement and send a signal to the Arduino. When the robot is turned on, the transmitter. The flex sensor will be continuously monitored by the Arduino and flex sensors. The Hc-05 Bluetooth module controls the wireless part's communication channel. Using two devices, the Bluetooth module may transmit and receive data wire

b. RECEIVER BLOCK DIAGRAM

The receiver is made up of an ESP 8266 controller, a gas sensor, a dht-11 (Temperature Humidity Sensor), a hc-05 Bluetooth module, a mobile camera, a battery, an L293d driving circuit, and two dc motors. We integrate a camera for live visual and a gas sensor to detect toxic substances in the course of the robot; these sensors will provide data to the ESP 8266 controller. The controller is used since it can interface with other systems to provide wifi and Bluetooth functionality. The controller sends the signal to the l293d driver circuit which controls the dc motors.

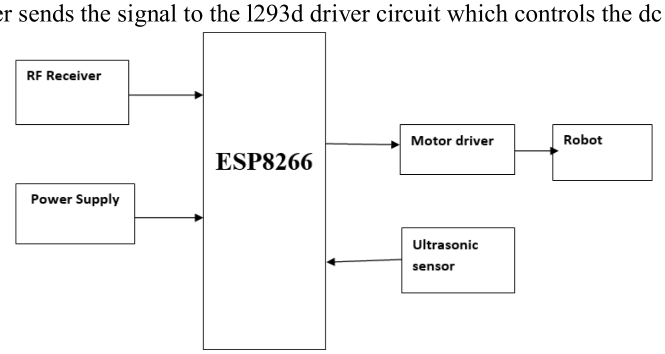

Figure 2: Receiver block diagram

c. FLOWCHART

The sensor does its function by communicating the degree of finger movement to the arduino. The module gets the feedback from the arm and delivers the updated processed signals to it. The handheld controller is a three-dimensional rigid body that recognizes hand motions by rotating along three orthogonal axes. In our research, all of the expected motions for robot navigation are simple gestures that only include one of the three elemental rotations.

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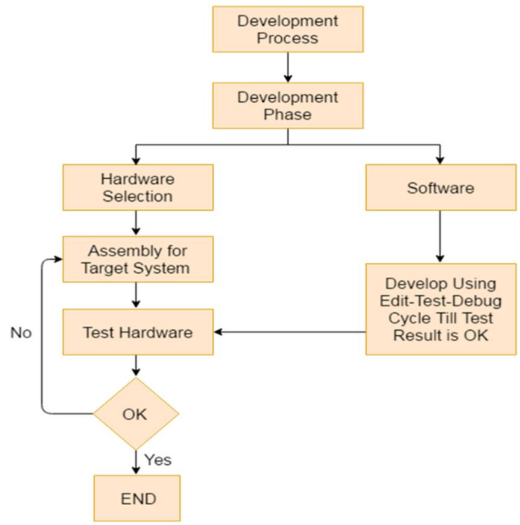

Figure 3: Flowchart of development of embedded system

V. RESULTS & ANALYSIS

TRANSMITTER SECTION WORKING PART FUNCTIONING OF TRANSMITTER

This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps – 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

RECEIVER SECTION WORKING PART FUNCTIONING OF RECEIVER

The functioning model of the robot's receiver section, which consists mostly of ESP 8266, DHT11, HC-05, motor driver, sensor, and camera installed to the chassis, is shown above. As shown, we have a chassis with four wheels at each corner. The Bluetooth HC 05 receives signals from the transmitter and responds appropriately. We employ a gas sensor to identify any dangerous gases in order to prevent life losses This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps – 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

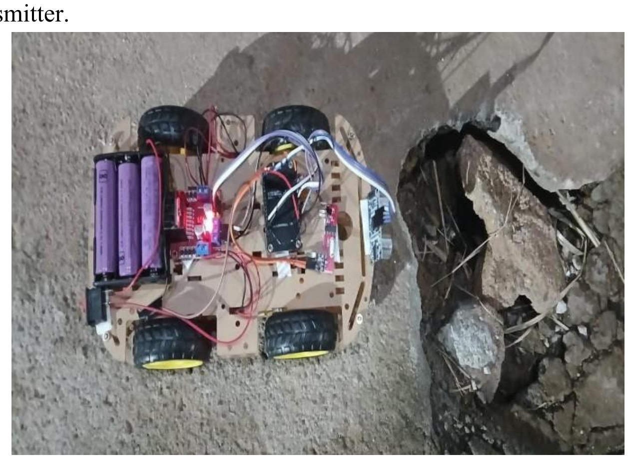

Fig 4: Real time Gesture control robot detection.

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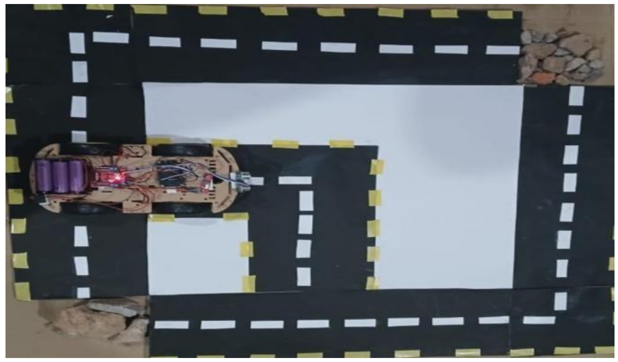
Fig 5: Gesture control robot

The five movements of the hand as backward, forward, left, right and stop. The transmitter is placed on hand and receiver on the robot. The robot is moved by the hand gesture. Based on tilt of the human hand and its acceleration calculated using accelerometer sensor the values is passed to the Arduino board and respective actions are formed. Then the signal is transmitted through the transceiver to the receiving block of the robot.

At the receiving end the data signal is decoded and respective pins are made high using the code written in Arduino IDE. The result of motion of the hand the digital signals from Arduino is given to the motor driver for respective movement of the DC motors for movement of wheelchair in a desired direction of the hand gesture.

MOVEMENT OF FINGER	INPUT FOR ARDUINO FROM GESTURE				DIRECTION
SIDE	D3	D2	D1	D0	
INDEX	1	0	1	0	FORWARD
MIDDLE	0	1	0	1	BACKWARD
RING	0	1	1	0	LEFT
LITTLE	1	0	0	1	RIGHT

Table 2: Conditions for the gesture controlled robot

VI. CONCLUSION

The gesture-controlled robotic driving system represents a significant step forward in the evolution of intelligent and user- friendly vehicular technology. By allowing drivers to control essential vehicle functions through simple hand gestures, this system enhances both convenience and safety, particularly in complex or hazardous driving conditions. The integration of sensors, such as ultrasonic modules, and gesture recognition algorithms, ensures accurate obstacle detection and effective human-machine interaction. With its potential to reduce road accidents caused by poor road conditions and human error, this system offers a practical solution for safer, smarter driving. As technology continues to advance, the scope for improving gesture- based control through AI, sensor fusion, and adaptive learning is vast—making this an exciting and impactful area for future research and innovation.

VII. FUTURE WORK

The development of gesture-controlled robotic driving systems opens several avenues for future research and enhancement. One major area is the incorporation of artificial intelligence and deep learning algorithms to improve the accuracy and adaptability of gesture recognition, even in diverse lighting or environmental conditions.

Future systems could employ multi-modal inputs, combining gestures with voice commands, facial expressions, or even eye movement tracking to offer a richer and more intuitive control interface. Integration with vehicle- to-everything (V2X) communication can allow the system to react not just to the driver's input, but also to real-time road, traffic, and weather updates, improving decision- making and safety. Advanced sensor fusion techniques using LiDAR, radar, and stereo vision can help the vehicle better understand complex road scenarios and respond more effectively.

This personalization could enhance both comfort and safety. Lastly, implementing cloud-based data analytics and remote diagnostics could enable large-scale monitoring and updates to the system without requiring direct user intervention, making the technology scalable and future- ready for commercial use.

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