Journal Publication of International Research for Engineering and Management (JOIREM)
Volume: 04 Issue: 01 | Jan-2026
ISSN (O) 3107-6696

Design and Implementation of an Accelerometer Based Gesture Controlled Robotic Car Using Arduino Uno

Ms. Madhura M. Lokhande[1], Ms. Vaishnavi R. Burlewar[2], Ms.Ruchita G. Jogdand[3], Ms. Pranita P. Kanadkhedkar[4]

s23_lokhande_madhura@mgmcen.ac.in[1], s23_burlewar_vaishnavi@mgmcen.ac.in[2], s23_jogdand_ruchita@mgmcen.ac.in[3], kanadkhedkar_pp@mgmcen.ac.in[4]

MGM's College of Engineering, Nanded, Department of Electronics & Telecommunication Engineering

---***---

Abstract - Gesture based control has emerged as an intuitive alternative to conventional robotic control interfaces. This paper presents the design and implementation of a gesture controlled robotic car using Arduino Uno and an accelerometer sensor. Hand gestures are captured through accelerometer-based tilt detection and translated into directional motion commands. Wireless communication is used to transmit control signals from the transmitter module to the robotic vehicle in real time. The receiver unit processes these commands and controls DC motors using a motor driver circuit. Experimental results demonstrate accurate gesture recognition, low-latency response, and stable vehicle navigation. The proposed system offers a cost-effective, reliable, and user-friendly solution suitable for educational, assistive, and experimental robotic applications.

Keywords - Gesture Control, Arduino Uno, Accelerometer, Wireless Communication, Robotic Car, Human Machine Interaction.

I. Introduction

The rapid advancement of embedded systems and robotics has increased the demand for intuitive human–machine interaction mechanisms[1][2]. Traditional robotic control methods such as joysticks, switches, and remote controllers impose physical and cognitive constraints on users. [2][3]Gesture-based control provides a natural and human-centric alternative by utilizing hand movements as control inputs [1][3][9].

The rapid advancement of embedded systems and robotics has increased the demand for intuitive human machine interaction mechanisms. Traditional robotic control methods such as joysticks, switches, and remote controllers impose physical and cognitive constraints on users. Gesture-based control provides a natural and human-centric alternative by utilizing hand movements as control inputs.

II. Literature Review

Previous studies have explored gesture-controlled robotic systems using both vision-based and sensor-based approaches[1][2][9]. Vision-based systems employ cameras and image processing algorithms but require high computational resources and controlled environments[1][9]. Sensor-based approaches using accelerometers and inertial sensors provide computational efficiency and reliability for embedded platforms[3][4][5].

Research indicates that accelerometer-based gesture recognition is suitable for real-time robotic navigation due to its low latency and ease of implementation[3][4][6].

Arduino-based robotic platforms are widely used because of their affordability and extensive open-source support[5][6]. Wireless communication techniques such as RF and Bluetooth have been successfully applied in gesture-controlled robotic vehicles[6][7][8]

III. System Architecture & Methodology

The system architecture consists of an transmitter and a receiver unit[3][5]. A accelerometer senses hand movements and sends data to an Arduino Nano for processing and angle conversion[3][4][5]. The processed data is transmited wirelessly using an RF transmitter and received by an Arduino Uno.[6][7][8].Based on the received commands, the Arduino Uno controls the DC motors through an L293D motor driver[5][6].

Journal Publication of International Research for Engineering and Management (JOIREM)
Volume: 04 Issue: 01 | Jan-2026
ISSN (O) 3107-6696

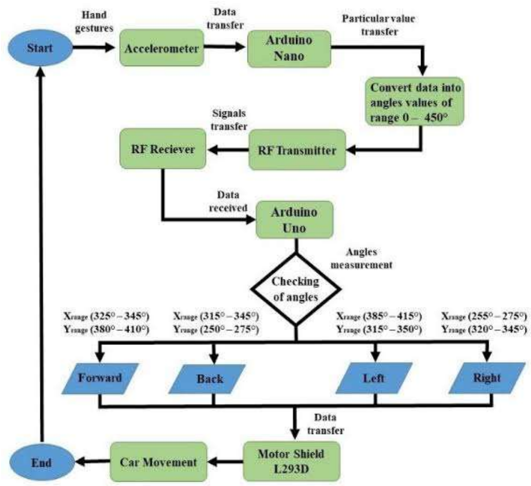

Fig. 1

Fig.1 Overall system architecture of the proposed gesture-controlled car using Arduino and RF communication

A. Hardware Setup

The proposed system uses an Arduino Uno as the main control unit[5][6]. An accelerometer sensor is interfaced with the Arduino to detect hand gestures[3][4]. The sensor outputs analog signals corresponding to hand orientation[3][4],which are processed by the microcontroller for gesture recognition[5][6]. Wireless communication is achieved using RF or NRF24L01 transceiver modules[6][7][8]. The receiver unit consists of a microcontroller and a wireless receiver module[5][6]. An L293D motor driver is used to control the DC motors[5][6].The motor driver provides an bidirectional control for vehicle movement. DC motors are mounted on the robotic chassis for motion execution[5],and Separate battery supplies are used to ensure stable and reliable operation[6].

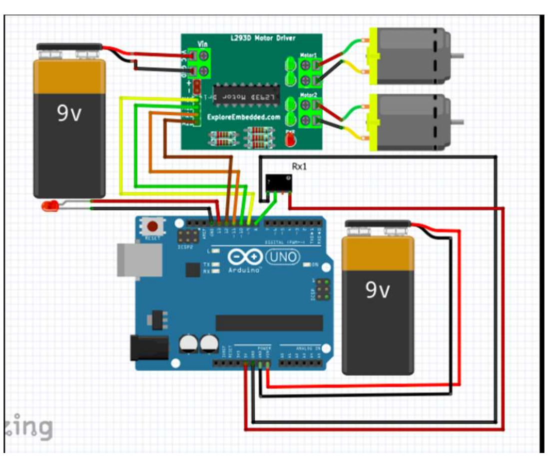

Fig. 2

Fig.2 Hardware implementation of the proposed system using Arduino Uno, L293D motor driver, DC motors, and battery power supply.

B. Data Communication

The proposed system employs wireless RF-based communication for transmitting gesture control commands from the transmitter unit to the receiver unit[6][7][8]. The microcontroller at the transmitter side processes accelerometer sensor data and encodes the recognized gestures into digital control signals[3][4][5]. These signals are transmitted using an RF transmitter module at regular intervals to ensure continuous and real-time control[6][7]. RF communication is selected due to its low latency, minimal complexity, and reliable short-range performance, making it suitable for real-time gesture-controlled robotic applications without the need for internet connectivity or complex networking infrastructure[6][7][8].

C. Gesture Recognition and Control Logic

Gesture recognition is achieved using an accelerometer-based sensing mechanism combined with threshold-based decision logic[3][4][5].

The accelerometer continuously measures hand orientation along the X and Y axes and generates corresponding signals[3][4]. These signals are converted into digital values by the microcontroller and compared with predefined threshold ranges to classify gestures such as forward, backward, left, right, and stop[5][6]. This rule-based gesture recognition approach ensures fast response, consistent interpretation, and reliable control across different users, making it suitable for real-time robotic vehicle operation[3][4][5].

D. Motor Driver and Actuation System

The receiver unit processes the incoming control commands and generates appropriate signals for vehicle actuation[5][6]. An L293D motor driver module is used to interface the microcontroller with the DC motors, enabling bidirectional control and safe current amplification[5][6].Based on the received gesture command, the motor driver controls the direction and movement of the motors, allowing smooth forward motion, reverse motion,and turning operations[5][6].

This actuation system ensures stable vehicle movement, quick response to user gestures, and reliable real-time performance[6][7].

IV. Result

The system was tested under indoor and semi-outdoor conditions.[3][6].The accelerometer demonstrated consistent gesture detection with minimal false activations[3][4][5]. Wireless communication exhibited low latency and stable performance within the operational range[6][7][8].The motor control subsystem provided smooth acceleration and accurate directional movement using PWM control.[5][6].The system showed real-time responsiveness and required minimal user training, validating the effectiveness of gesture-based control[6][7].

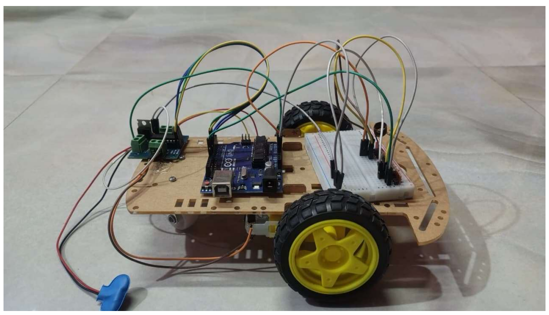

Fig. 3. Real time implementation and experimental setup of the Arduino Uno based Gesture Controlled Robotic Car

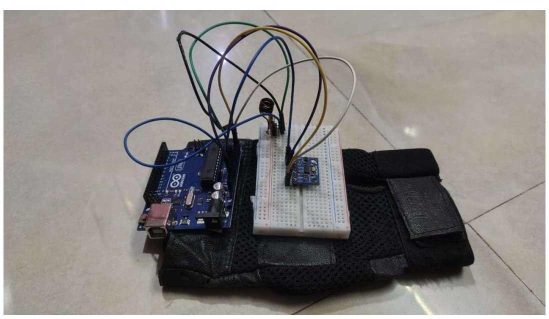

Fig. 4. Gesture-sensing glove used for controlling the Arduino Uno–based robotic car.

The Arduino Uno based Gesture Controlled Robotic Car successfully responded to hand gestures detected by the sensor-equipped glove, demonstrating precise real-time control and accuracy[3][5][6]. The system effectively translated flex sensor inputs into directional commands for the car, validating the reliability of the glove Arduino interface[5][6][10].The experimental setup confirmed the practical feasibility of gesture-based robotic control, and the live demonstration highlighted the smooth integration of hardware and software components for real-world applications[6][7][8].

V. Security & Challenges

To ensure secure data transmission, encrypted Wi-Fi communication and controlled cloud API access mechanisms were employed [5]. Regular firmware updates further enhance system security. Key challenges encountered include sensor drift associated with the MQ135 sensor, Wi-Fi connectivity interruptions, environmental noise affecting prediction accuracy, and the requirement for a stable power supply for continuous operation [4][8].

VI. Future Scope

Future enhancements include the integration of inertial measurement units (IMUs) for advanced gesture recognition[4][5], machine learning algorithms for adaptive gesture classification[1][2], and vision-based gesture control for contactless interaction[1][9]. Additional improvements can include obstacle detection sensors, IoT-based monitoring, long-range communication protocols, and assistive technology adaptations such as gesture-controlled mobility aids[2][10].

VII. Conclusion

This paper presents a gesture controlled robotic car using Arduino Uno and accelerometer-based sensing[3][5][6]. The system successfully demonstrates intuitive human machine interaction with reliable real-time performance[3][4][5].

The proposed design is cost-effective, scalable, and suitable for educational, assistive, and experimental robotic applications[5][6][10].

The project establishes a strong foundation for future research in gesture-based control and intelligent robotic systems[1][2][9].

References

[1] Z. Xia et al., Vision-based hand gesture recognition for human–robot collaboration: A survey, Proceedings of the 5th International Conference on Control, Automation and Robotics (ICCAR), IEEE, 2019

.[2] S. S. Rautaray and A. Agrawal, Interaction with virtual game through hand gesture recognition, Proceedings of the International Conference on Multimedia, Signal Pro- cessing and Communication Technologies, IEEE, 2011.

[3] X.-H. Wu, M.-C. Su, and P.-C. Wang, A hand-gesture-based control interface for a carrobot, Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems, Taipei, Taiwan, 2010, pp. 4644–4648.

[4] S.-O. Shin, D. Kim, and Y.-H. Seo, Controlling mobile robot using IMU and EMG sensor-based gesture recognition,

Proceedings of the 9th International Conference on Broadband and Wireless Computing, Communication and Applications, IEEE, 2014.

[5] P. Kale and N. Sakhare, Gesture based automation of a robot car, International Journal ofScientific Research in Science, Engineering and Technology, Vol. 7, Issue 2, pp. 508– 513, March–April 2020.

[6] M. Mhetre et al., Gesture controlled robot car, International Journal for Research in Applied Science and Engineering Technology (IJRASET), Vol. 11, October 2023, doi: 10.22214/ijraset.2023.56184.

[7] J. Mhatre et al., Real time gesture controlled robotic vehicle, International Journal for Research in Applied Science and Engineering Technology (IJRASET), March 2024, doi: 10.22214/ijraset.2024.59320.

[8] S.Kadam et al., Gestures controlled robot, International Journal for Research in Applied Science and Engineering Technology (IJRASET), March 2024, doi: 10.22214/ijraset.2024.58807.

[9] G. Baron et al., Gesture and voice driven mobile tribot robot using Kinect sensor, IEEE Conference Proceedings, 2015.

[10] N. Adithya and S. Chitti, Hand gesture controlled robot, International Journal of Recent Technology and Engineering (IJRTE), Vol. 8, Issue 1S4, June 2019.