# GESTURE CONTROLLED ROBOTIC CAR

**A**
**Major Project Synopsis**
**Submitted in the partial fulfilment of the requirement for the award of**
**Bachelor of Engineering**
**in**
**Computer Science and Engineering**


**Samrat Ashok Technological Institute, Vidisha**
(An Autonomous Institute Affiliated to RGPV, Bhopal)

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# CERTIFICATE

This is to certify that the Major Project entitled as "**GESTURE CONTROLLED ROBOTIC CAR"** submitted by Ayush Dhabale (En. No. **0108CS201022),** Himanshu Kudesiya (En. No. **0108CS201041),** Jaiansh Bora (En. No. **0108CS201043),** Nilima Barde (En. No. **0108CS201071)** in the partial fulfilment of the requirements for the award of degree of **Bachelor of Engineering** in the specialization of **Computer Science and Information Technology** from **Samrat Ashok Technological Institute, Vidisha (M.P.)** is a record work carried out by them under my supervision and guidance. The matter presented in this report has not been presented by them elsewhere for any other degree or diploma.

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# CANDIDATE'S DECLARATION

"We, Ayush Dhabale (En. No. **0108CS201022),** Himanshu Kudesiya (En. No. **0108CS201041),** Jaiansh Bora (En. No. **0108CS201043),** Nilima Barde (En. No. **0108CS201071)** hereby declare that the work which is being presented in the Major Project entitled **"GESTURE CONTROLLED ROBOTIC CAR"** submitted in partial fulfilment of the requirement for the award of the degree of **Bachelor of Engineering** in **Computer Science and Information Technology.** The work has been carried at **Samrat Ashok Technological Institute, Vidisha** is an authentic record of my own work carried out under the guidance of **Prof. Usha Tigga** (Assistant Professor, Department of Computer Science & Information Technology), **Samrat Ashok Technological Institute, Vidisha (M.P).**

The matter embodied in this report has not been submitted by us for the award of any other degree or diploma.

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Regards,

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## PROBLEM STATEMENT

Design and Implementation of a Gesture-Controlled Robotic Car for Intuitive Human-Machine Interaction

"In today's era of advancing technology and automation, there is a growing demand for more intuitive and hands-free methods of controlling robots, particularly in the realm of robotic vehicles. Conventional remote controls often come with limitations and may not be user-friendly in all situations. This project addresses the need for a Gesture-Controlled Robotic Car, a ground-breaking solution that allows users to effortlessly and naturally control a robotic car using hand or body gestures. The objective is to design and implement an effective gesture recognition system that seamlessly integrates with a robotic car platform.

The challenge is to develop a system capable of accurately interpreting user gestures and translating them into precise commands for the car's movement and actions. This technology holds immense potential for applications in fields such as surveillance, entertainment, and automation. Key objectives include the development of robust gesture recognition algorithms, integration with the robotic car's control systems, and the creation of an intuitive user interface.

Through this project, we aim to overcome the limitations of conventional control methods, offering a more interactive and engaging way to interact with robotic vehicles. Additionally, we will focus on safety considerations, ensuring that the robotic car can avoid obstacles and respond promptly to user gestures. Ultimately, our goal is to pioneer a more accessible and user-friendly approach to human-robot interaction, making robotics more accessible and engaging for a wide range of applications."

## AIMS AND OBJECTIVES

### Aim:

The aim of this project is to design and implement a gesture-controlled robotic car, leveraging sensor technology to enable intuitive and hands-free interaction. By integrating gesture recognition algorithms with motor control systems, the goal is to create a responsive and user-friendly robotic car capable of executing various movements based on recognized gestures. This project seeks to explore the intersection of robotics, electronics, and human-machine interaction, providing a practical and engaging demonstration of gesture-based control in a mobile robotic platform.

### Objectives:

1. **Gesture Recognition:** To develop robust and real-time gesture recognition algorithms capable of accurately identifying and classifying a wide range of user gestures.
2. **Hardware Integration:** To seamlessly integrate the gesture recognition system with the robotic car's hardware, including motors, sensors, and microcontrollers.
3. **User Interface:** To design an intuitive and user-friendly interface through which users can control the robotic car effortlessly using gestures.
4. **Gesture Mapping:** To establish a mapping system that associates specific gestures with precise control commands for the car, such as forward, backward, left, right, and stop.
5. **Accuracy and Reliability:** To ensure high accuracy and reliability in gesture recognition, minimizing false positives and false negatives in gesture interpretation.
6. **Real-Time Responsiveness:** To achieve real-time responsiveness in translating recognized gestures into immediate actions by the robotic car, providing a seamless user experience.
7. **Wireless Communication:** To establish a stable wireless communication link between the user interface device (e.g., smartphone) and the robotic car for remote control.

By achieving these objectives, the project aims to pioneer a novel and accessible approach to human-robot interaction, making gesture-controlled robotic cars a practical and engaging reality across a wide range of industries and applications.

# REVIEW OF LITERATURE

Gesture-controlled robotic cars have garnered considerable attention in recent years, representing an innovative approach to human-robot interaction and autonomous vehicle control. This review provides a comprehensive overview of the key developments and trends in this field.

1. **Gesture Recognition Techniques**

   A pivotal aspect of gesture-controlled robotic cars is the development of advanced gesture recognition techniques. Researchers have explored computer vision-based approaches, leveraging cameras and depth sensors like Kinect, in addition to wearable devices such as gloves and motion sensors. These techniques have shown promise in enabling precise control through gesture input.

2. **Machine Learning Algorithms**

   Machine learning algorithms, particularly deep learning models, have played a pivotal role in enhancing gesture recognition accuracy. Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) have been leveraged to recognize intricate hand and body gestures with remarkable precision, contributing to the advancement of this technology.

3. **Sensor Integration**

   To improve gesture recognition robustness, researchers have integrated a variety of sensors, including accelerometers, gyroscopes, and IMUs. Combining data from multiple sensors has demonstrated the potential to provide a more comprehensive understanding of user gestures, increasing system reliability.

4. **Human-Robot Interaction**

   Creating an intuitive and user-friendly gesture control system is paramount. Extensive research has been dedicated to evaluating user preferences and comfort with different gestures, ensuring that the interaction between users and gesture-controlled robotic cars is both efficient and user-centric.

5. **Real-Time Control**

   Achieving real-time control is a critical challenge. Researchers have diligently worked on optimizing algorithms and hardware components to minimize latency and guarantee responsive control, a crucial element in ensuring user satisfaction and safety.

6. **Obstacle Avoidance**

   Safety remains a paramount concern in autonomous vehicles, including gesture-controlled robotic cars. Literature in this area has explored innovative approaches to obstacle detection and avoidance, often incorporating lidar, ultrasonic sensors, or computer vision for comprehensive situational awareness.

7. **Navigation and Path Planning**

   Gesture-controlled cars necessitate robust navigation and path planning capabilities. Researchers have adapted path planning algorithms to facilitate user-defined routes and destinations through gestures. This involves intricate mapping, localization, and decision-making algorithms to ensure safe and efficient navigation.

8. **Challenges and Limitations**

   Several challenges have been identified, encompassing gesture ambiguity, variable lighting conditions, and the learning curve required for users to become proficient with gesture controls. Addressing these challenges is imperative for the widespread adoption of this technology.

9. **Applications**

   Gesture-controlled robotic cars hold promise in various applications, ranging from autonomous taxis to transportation solutions for individuals with disabilities and entertainment purposes. Researchers have explored these diverse applications and their broader societal implications.

10. **Future Directions**

    The literature underscores several avenues for future research, including the development of more natural and expressive gestures, continued enhancement of gesture recognition robustness, and integration with other control methods to establish redundancy and increase overall system reliability.

## METHODOLOGY

### Data Collection and Acquisition

The research methodology for investigating gesture-controlled robotic cars involved a systematic approach encompassing data collection, experimentation, and evaluation. The following steps were undertaken to gather relevant information and conduct experiments:

***Literature Review:***

A comprehensive review of existing literature was conducted to gain insights into the state-of-the-art technologies and research findings related to gesture control in the context of robotic cars. This review served as the foundation for understanding the current landscape and identifying gaps in the field.

***Data Acquisition:***

To facilitate the development and testing of gesture recognition algorithms, a diverse dataset of hand and body gestures was collected. The dataset included a wide range of gestures commonly used for controlling robotic cars.

### Gesture Recognition Algorithm Development

***Algorithm Design:***

A fundamental aspect of the research involved the design of gesture recognition algorithms. Leveraging insights from the literature review, a robust and efficient algorithm was developed, primarily based on deep learning techniques, including Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs).

***Training Data Preparation:***

The collected dataset was divided into training and testing subsets. Data pre-processing techniques, such as normalization and augmentation, were applied to enhance the algorithm's performance and generalization capabilities.

***Algorithm Training:***

The designed gesture recognition algorithm was trained on the prepared dataset. Iterative training and fine-tuning processes were employed to optimize the algorithm's accuracy and reliability.

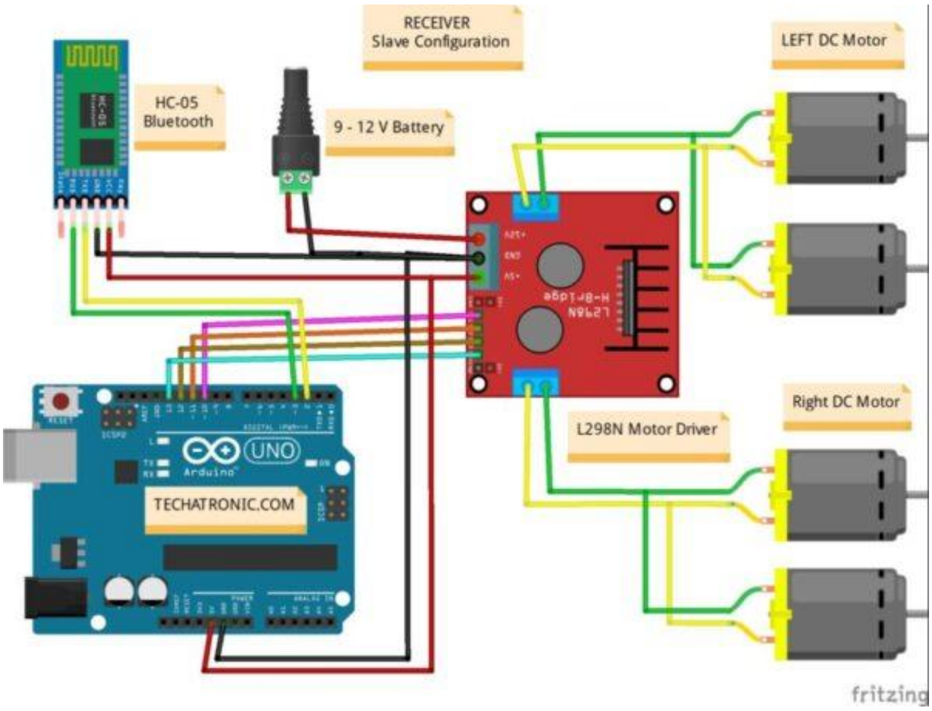
## Experimental Setup

***Hardware Configuration:***

For real-time experimentation and evaluation, a robotic car platform equipped with the necessary sensors, cameras, and processing units was configured. The hardware setup provided the means for integrating the gesture recognition system with the robotic car's control mechanisms.

***Software Integration:***

The developed gesture recognition algorithm was integrated into the robotic car's software stack. This integration facilitated real-time interpretation of user gestures and control of the vehicle's movement.




https://techatronic.com/how-to-make-gesture-control-robot-using-arduino/

## Evaluation and User Studies

***User Studies:***

A series of user studies were conducted to assess the usability and effectiveness of the gesture-controlled robotic car. Participants were recruited to interact with the system, and their feedback, preferences, and experiences were documented.

***Performance Metrics:***

To quantitatively evaluate the gesture recognition system's performance, metrics such as recognition accuracy, response time, and false positive rates were measured during user studies and experimental trials.

## Analysis and Results

***Data Analysis:***

The collected data from user studies, as well as the experimental results, were subjected to rigorous statistical analysis. This analysis provided insights into the system's performance, user satisfaction, and potential areas for improvement.

*Conclusion and Recommendations:*

Based on the analysis of experimental results and user feedback, conclusions were drawn regarding the feasibility and effectiveness of gesture-controlled robotic cars. Recommendations for further refinement and future research directions were proposed.

## Flow Chart

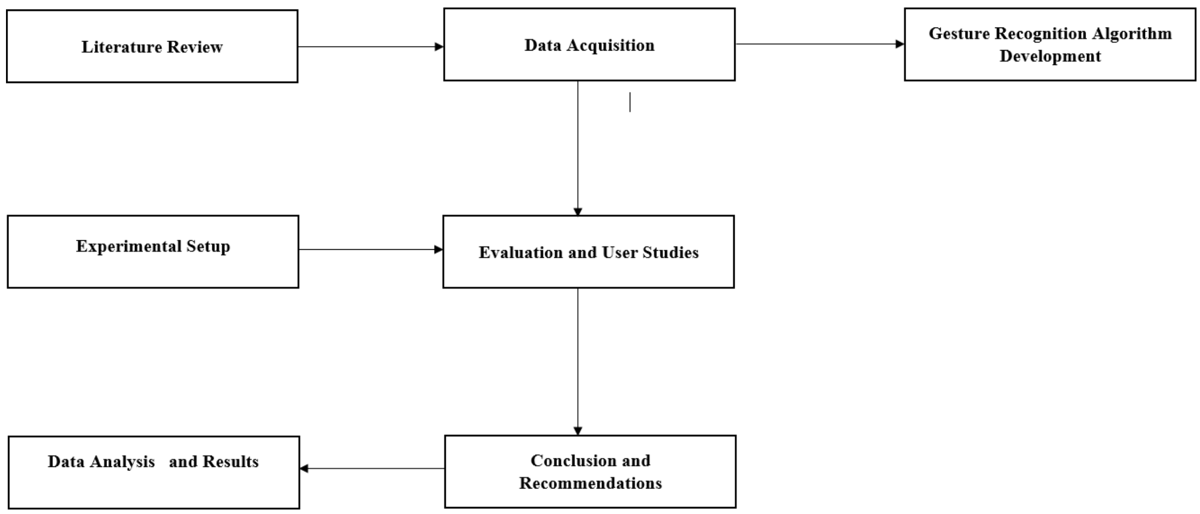



Figure 1

## EXPECTED OUTCOMES

1. **Robust Gesture Recognition Algorithm**

   The research is expected to yield a robust gesture recognition algorithm capable of accurately interpreting a wide range of hand and body gestures for controlling robotic cars. This algorithm is anticipated to exhibit high recognition accuracy and low false positive rates.

2. **Improved Human-Robot Interaction**

   The implementation of gesture control in robotic cars is expected to result in an intuitive and user-friendly interaction experience. Users should be able to control the vehicle's movement seamlessly through natural gestures, reducing the learning curve associated with traditional control methods.

3. **Enhanced Safety and User Experience**

   The incorporation of gesture-controlled obstacle detection and avoidance mechanisms is expected to enhance the safety of robotic car operations. Users should have confidence in the system's ability to navigate and avoid obstacles, contributing to a safer and more enjoyable travel experience.

4. **Real-Time Control and Responsiveness**

   The research aims to achieve real-time control of robotic cars through gesture input, minimizing control latency and ensuring responsive vehicle movements. Users should experience minimal delays between issuing gestures and observing the corresponding actions of the vehicle.

5. **Positive User Feedback**

   User studies are anticipated to yield positive feedback regarding the usability and effectiveness of the gesture-controlled robotic car system. Users' preferences, comfort levels, and overall satisfaction with the technology are expected to be assessed and documented.

6. **Quantitative Performance Metrics**

   The research is expected to produce quantitative performance metrics, including gesture recognition accuracy, response times, and false positive rates. These metrics will provide a quantitative assessment of the system's reliability and efficiency.

7. **Usability Recommendations**

   The research may offer recommendations for enhancing the usability of gesture-controlled robotic cars, including improvements to gesture sets, user interfaces, and system responsiveness.

8. **Future Research Directions**

   Based on the analysis of user studies and experimental results, the synopsis is expected to outline future research directions and areas for further refinement. This could include exploring more natural and expressive gestures or integrating gesture control with other control methods for redundancy.

9. **Contributions to the Field**

   The research outcomes are expected to contribute to the evolving field of human-robot interaction and autonomous vehicle control. The developed algorithms and insights could be valuable for both academic and practical applications.

10. **Societal Implications**

    The synopsis may discuss the broader societal implications of gesture-controlled robotic cars, such as potential applications in autonomous taxis, transportation accessibility for individuals with disabilities, and entertainment.

## REFERENCES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# OFFICIAL REQUIREMENTS

### Gesture Recognition Algorithm

***Requirement 1.1:*** The system shall include a gesture recognition algorithm capable of interpreting a predefined set of hand and body gestures.

***Requirement 1.2:*** The algorithm shall exhibit a gesture recognition accuracy of at least 95%.

***Requirement 1.3:*** The algorithm shall be capable of real-time recognition with a response time of less than 100 milliseconds.

### Hardware Configuration

***Requirement 2.1:*** The robotic car platform shall be equipped with sensors, cameras, and processing units suitable for gesture recognition and control.

***Requirement 2.2:*** The hardware components shall be capable of interfacing with the gesture recognition system and enabling seamless control of the robotic car.

### User Interface

***Requirement 3.1:*** The system shall provide an intuitive user interface for users to initiate and control the robotic car through gestures.

***Requirement 3.2:*** The user interface shall be user-friendly and require minimal training for users to operate effectively.

### Obstacle Detection and Avoidance

***Requirement 4.1:*** The system shall incorporate obstacle detection mechanisms, such as lidar or ultrasonic sensors, to ensure safe navigation.

***Requirement 4.2:*** The robotic car shall autonomously avoid obstacles detected during its operation, preventing collisions.

### User Studies and Feedback

***Requirement 5.1:*** User studies shall be conducted to assess the usability and user satisfaction of the gesture-controlled system.

***Requirement 5.2:*** Feedback from users shall be documented and used to refine the system's performance and user experience.

**Security and Privacy**

***Requirement 7.1:*** The system shall incorporate security measures to protect against unauthorized access or control.

***Requirement 7.2:*** User data and interactions with the system shall be protected to ensure user privacy.

**Documentation and Reporting**

***Requirement 8.1:*** Comprehensive documentation shall be maintained throughout the project, including design specifications, user manuals, and technical reports.

***Requirement 8.2:*** Regular progress reports shall be submitted to project stakeholders to track project milestones and outcomes.