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Car Genie -Designing A Prototype Of Automated Vehicle System.

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ABSTRACT:-

This project aims to develop a prototype of a robot car that can be controlled using a smartphone via Wi-Fi. The goal is to build a robust, flexible, and efficient system that requires minimal resources. At the heart of the system lies the ESP8266 microcontroller, which acts as the main processing unit. It connects with other modules, including a smartphone and a Wi-Fi interface, to facilitate wireless control of the robotic vehicle. To enhance the system's capabilities, a front-facing camera is integrated, allowing users to view real-time images and video feeds directly on their smartphones. This live video streaming feature offers precise control and monitoring of the robot's movements, making it suitable for applications like surveillance and remote monitoring. Creating reliable monitoring and surveillance systems presents numerous challenges. These systems must adapt to different environments and be capable of dynamic operation, such as mobile camera surveillance that can navigate a monitored area. For instance, monitoring a large multi-storey building traditionally requires installing numerous static cameras, which can be expensive and resource-intensive. By using a mobile surveillance unit like the proposed robot, it is possible to significantly reduce these costs. Furthermore, it addresses issues faced by security personnel, such as the time and effort needed to patrol vast areas. Thus, this system offers a practical and scalable solution for real-time monitoring, especially in locations where fixed surveillance is not feasible.

Keywords: *NodeMCU, ESP8266, Internet of Things (IoT), Wi-Fi, Motor Driver*

INTRODUCTION:-

In today's digital era, the internet has become an essential part of our everyday lives. People increasingly depend on it to perform a wide range of tasks efficiently and with ease. From communication, education, and entertainment to automation, data analysis, and problem-solving, the internet supports nearly every aspect of modern living.

A significant advancement in this domain is the emergence of the Internet of Things (IoT)—a concept that connects everyday devices and systems to the internet, enabling them to collect, exchange, and process data. This connectivity allows users to control and monitor devices remotely, making life more convenient and productive. The IoT landscape is generally divided into two main categories: consumer IoT, which includes applications in homes and personal gadgets, and industrial IoT, which is used in sectors like manufacturing, logistics, and smart infrastructure.

This project focuses on developing a robotic car controlled via a smartphone, using Wi-Fi technology—an example of an IoT-based application. It demonstrates how intelligent systems, when connected to the internet, can perform tasks remotely and autonomously. By combining mobile technology with embedded systems like the ESP8266 microcontroller, this robot car can carry out real-time surveillance and monitoring activities, showcasing the power and flexibility that IoT brings to modern engineering solutions

LITERATURE REVIEW

Numerous research efforts and projects have explored the application of Wi-Fi and IoT in robotic vehicles: Bluetooth-Controlled Robots were among the earliest forms, but their short-range capability made them unsuitable for surveillance or large-area coverage. Wi-Fi-Controlled Systems using ESP8266 demonstrated better range and connectivity. Researchers integrated motor drivers, IP cameras, and smartphone interfaces to control robots for real-time monitoring tasks. Video Streaming via IP Cameras was incorporated in several projects, allowing users to view surroundings remotely. These systems were particularly effective for applications in surveillance and inspection. Obstacle Avoidance Using Ultrasonic Sensors is another area studied

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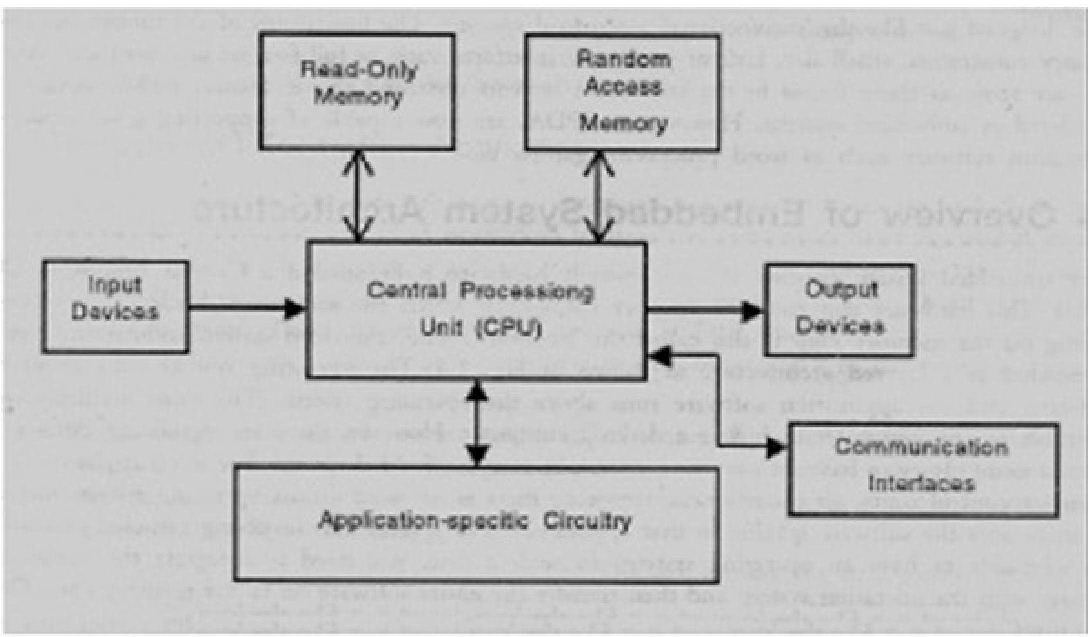
extensively, adding autonomous decision-making to robotic cars, making them safer and more efficient. AI Integration is an emerging trend, with researchers working on integrating object detection algorithms like YOLO (You Only Look Once) into live-streaming robots to identify threats or suspicious activity autonomously.

DEVELOPING METHODOLOGY:

The project follows the Waterfall Model, a step-by-step development approach. Each phase—requirement analysis, system design, implementation, testing, and deployment—is completed before moving to the next. This method ensures a clear structure and thorough development of the Wi-Fi-controlled robotic car with live streaming and obstacle detection.

ARCHITECTURE DIAGRAM:

SYSTEM ARCHITECTURE:



IMPLEMENTATION(ALGORITHM):

EXISTING TECHNIQUE:

In traditional surveillance and robotic systems, most setups are either static surveillance cameras or manually operated robots that lack internet connectivity. These systems have the following characteristics: Fixed Surveillance Cameras: Most existing security cameras are fixed in place and offer only a limited field of view. To monitor large areas, multiple cameras must be installed, increasing cost. Wired or Short-Range Wireless Robots: Some robots require manual operation through RF modules or Bluetooth, which are limited in range (typically 10–100 meters). No Real-Time Control over the Internet: Many of the existing mobile surveillance systems do not support remote access via the internet, restricting the ability to monitor from distant locations. Limited Autonomy: Most current systems lack features like obstacle detection and real-time path control, making them unsuitable for dynamic environments.

PROPOSED TECHNIQUE:

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The proposed system overcomes the above limitations by offering a smart, mobile, internet connected surveillance robot with the following improvements: Wi-Fi-Based Remote Control: The robot can be controlled from any location via a mobile device using a Wi-Fi connection, increasing the range and flexibility of operation. Integrated Obstacle Detection: The system uses ultrasonic sensors to detect and avoid obstacles automatically, reducing the risk of collision. Real-Time Video Streaming (Optional): By integrating a camera, the robot can stream live video to the user's device, allowing for visual monitoring of surroundings. Compact, Modular Design: All components are lightweight and modular, making the robot easier to maintain, upgrade, or modify. Cost-Efficient and Scalable: Using components like the NodeMCU ESP8266 makes the system both affordable and easily scalable for educational, security, or research applications

TESTING:

The primary objective of testing is to discover errors and weaknesses within a work product. It provides a structured approach to verify the functionality of individual components, their integration, and the overall system performance. Testing ensures that the software and hardware components meet user expectations and do not fail in an unacceptable manner.54 For robotic systems, testing is critical for validating navigation, obstacle detection, and control mechanisms, simulating real-world conditions to identify potential issues and optimize efficiency. A systematic approach to testing, progressing from isolated components to full real-world deployment, is essential for comprehensive validation.

Unit Testing:

Unit testing focuses on validating the internal logic of individual program units or hardware components in isolation.54 The objective is to ensure that each piece of code or hardware behaves as expected and produces correct outputs for given inputs. For the Wi-Fi controlled car, unit tests would involve:

• Arduino Motor Control Module: Testing individual motor functions (forward, backward, left, right, stop) by sending direct commands to the Arduino and verifying motor rotation and speed using PWM.

Integration Testing:

Integration testing verifies that multiple components or modules work together correctly when combined.54 The objective is to ensure that individually functioning units operate cohesively as a whole, identifying any issues that arise from their interaction. For this project, integration tests would include: • Raspberry Pi to Arduino Communication: Testing the end-to-end serial communication, ensuring that commands sent from the Raspberry Pi are correctly received and interpreted by the Arduino, and any status messages from the Arduino are received by the Pi.

Functional Testing :

Functional testing systematically verifies that the system's functionalities align with documented requirements and user expectations.54 It focuses on the external behavior of the system, ensuring that it performs its specified tasks correctly. For the Wi-Fi controlled car, functional tests would cover: 35

• Basic Movement Control: o Test Case: Send "Forward" command. Expected Output: Car moves forward.

o Test Case: Send "Backward" command. Expected Output: Car moves backward.

o Test Case: Send "Left" command. Expected Output: Car turns left.

o Test Case: Send "Right" command. Expected Output: Car turns right.

o Test Case: Send "Stop" command. Expected Output: Car immediately stops

System Testing :

System testing evaluates the entire integrated robotic system in a controlled environment, ensuring end-to-end functionality and adherence to overall system requirements. This phase confirms that all subsystems work harmoniously under realistic conditions before deployment.

White Box Testing:

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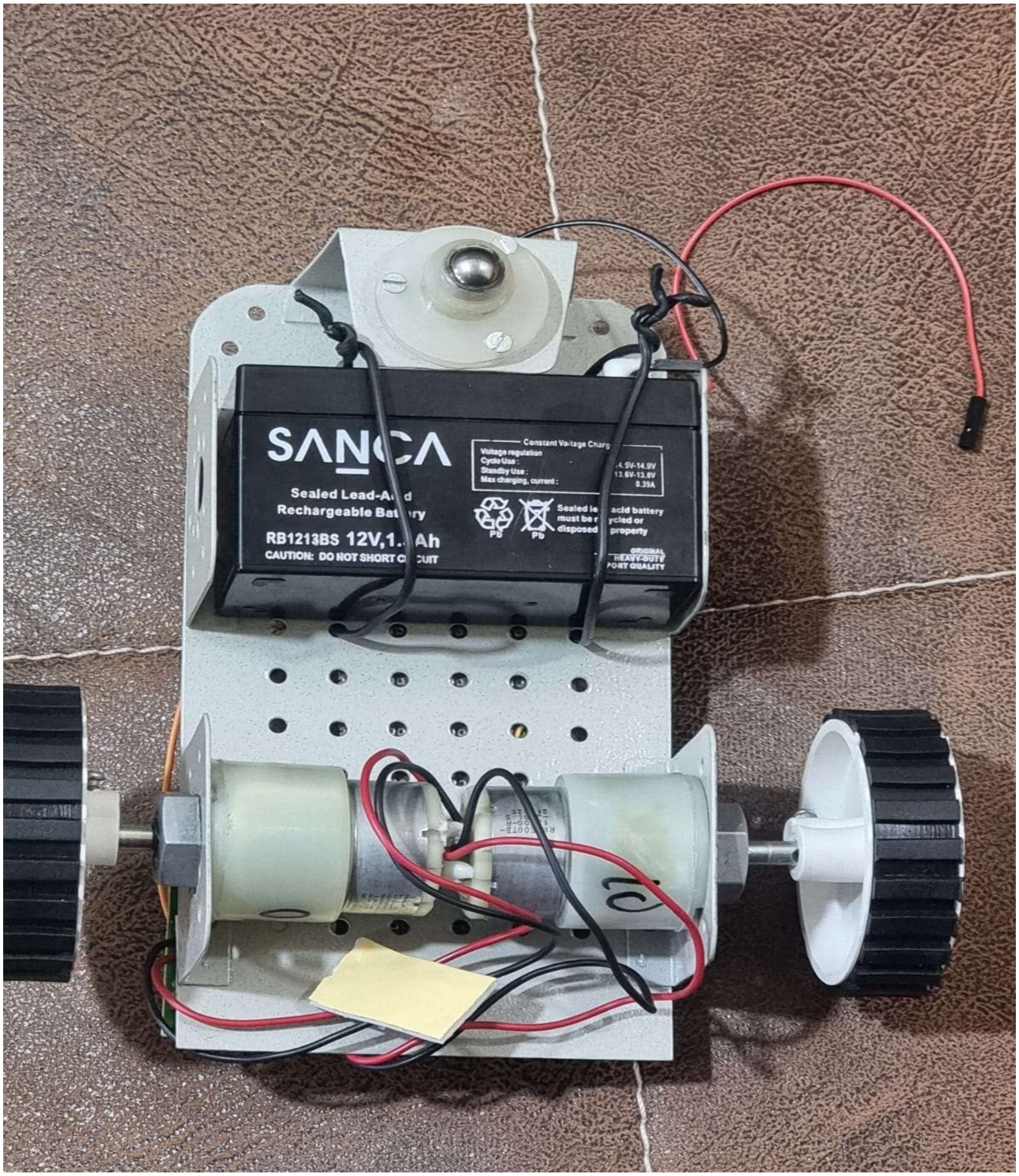
White Box Testing, also known as structural testing, involves testing the internal logic, structure, and code flow of the software. The tester has knowledge of the system's internal workings. For this project, white box testing would involve:

• Code Coverage Analysis: Ensuring that all critical code paths for motor control, sensor reading, and command processing are executed during testing.

• Conditional Logic Validation: Verifying that if-else conditions within the Arduino code for obstacle avoidance (e.g., if (distance < threshold)) are correctly evaluated and trigger the appropriate actions.

RESULTS / SCREENSHOTS



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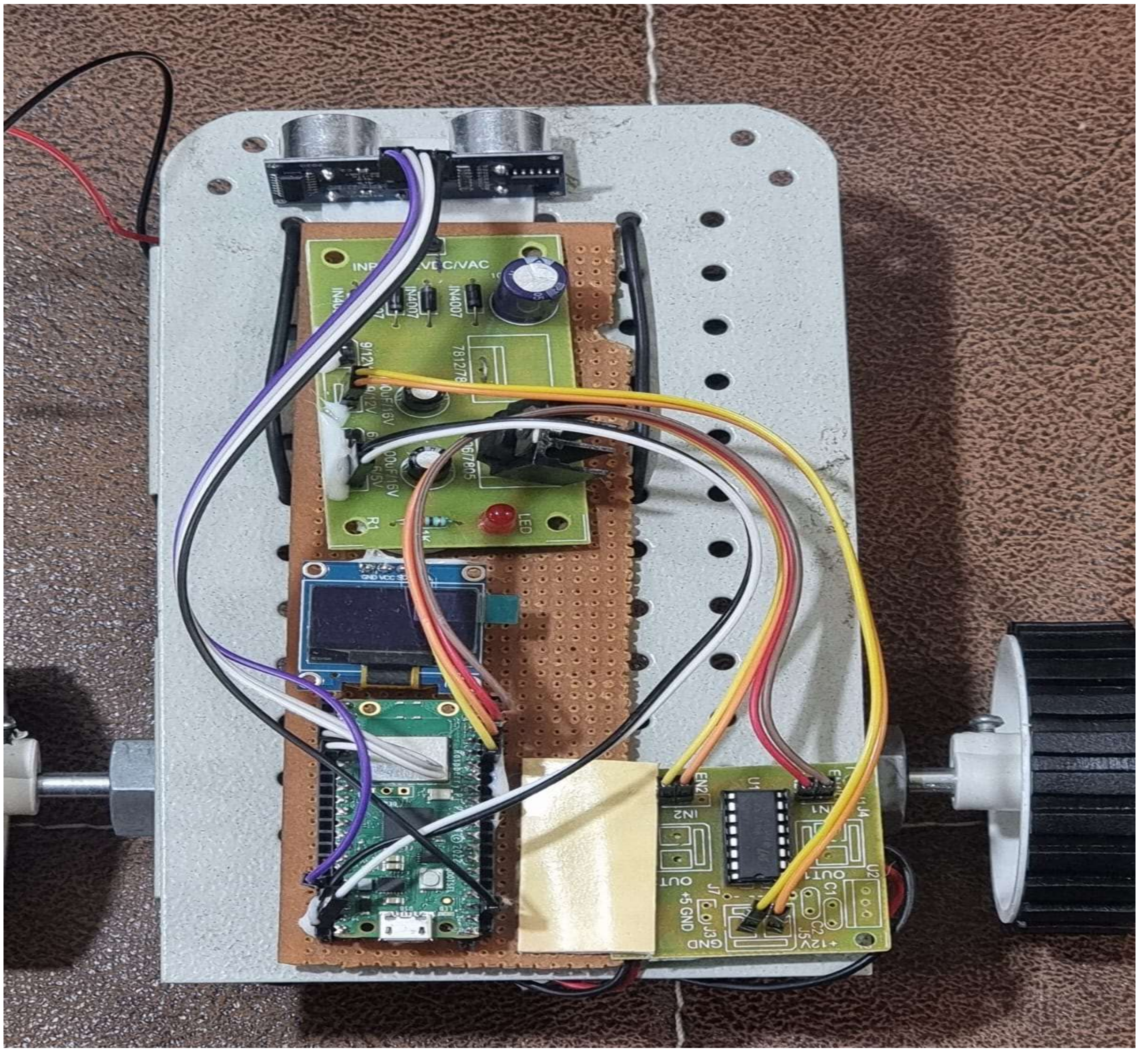

CONCLUSION:

This project successfully designed, developed, and implemented a functional Wi-Fi controlled car with an integrated object avoidance system, effectively addressing the limitations of traditional remote-controlled vehicles. The dual-microcontroller architecture, leveraging the Raspberry Pi for high-level web server hosting and Wi-Fi communication, and the Arduino for precise, real-time motor and sensor control, proved to be a robust and scalable solution. This modular design allowed for efficient task distribution and simplified the integration of diverse technologies.

FUTURE SCOPE:

The developed Wi-Fi controlled car with object avoidance lays a strong foundation for numerous future enhancements and expansions, transforming it into an even more sophisticated and versatile robotic platform:

• Enhanced Autonomy and Intelligence:

o Advanced Navigation: Implementing more sophisticated path planning algorithms (e.g., A* or Dijkstra's) and Simultaneous Localization and Mapping (SLAM) using additional sensors like LiDAR or cameras would enable the car to navigate complex, unmapped environments and build internal representations of its surroundings.

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o Machine Learning Integration: Incorporating machine learning techniques for object recognition (e.g., identifying different types of obstacles) or even learning optimal avoidance maneuvers from experience could significantly enhance its autonomous capabilities.

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