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# WI-FI BASED CAR SURVEILLANCE SYSTEM

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## ABSTRACT

The Field of robotics has been exponential growth with the amalgamation of multiple domains.

This research paper delves into the creation of a sophisticated WiFi-based remote control car surveillance system, integrating cutting-edge technologies such as an ultrasonic sensor, ESP32- CAM module, and NodeMCU microcontroller. The system's primary objective is to provide seamless remote monitoring and surveillance capabilities through the capture and transmission of live video footage. The ESP32-CAM module acts as the visual sensor, capturing high-resolution images and video streams of the car's environment, while the NodeMCU microcontroller facilitates wireless communication and remote control functionalities. Additionally, an ultrasonic sensor is incorporated to enable obstacle detection and navigation, enhancing the system's autonomy and safety. Through meticulous experimentation and testing, the system's performance is evaluated across various scenarios, including security surveillance and environmental monitoring. The research findings underscore the system's effectiveness in real-world applications, highlighting its potential to revolutionize surveillance and monitoring practices in diverse settings.

Through rigorous experimentation and testing, the system's performance is evaluated across a range of scenarios, demonstrating its potential forapplications in security surveillance, environmental monitoring, and research exploration. The research findings highlight the system's versatility, reliability, and potential to revolutionize surveillance practices in various domains.

## I. INTRODUCTION

### 1.1GENERAL INTRODUCTION

In recent years, advancements in wireless communication, robotics, and surveillance technologies have spurred the development of innovative solutions for remote monitoring and surveillance. One such solution is the WiFi-based remote control car surveillance system, which integrates components such as an ultrasonic sensor, ESP32-CAM module, and NodeMCU microcontroller to provide versatile and efficient surveillance capabilities. This research paper explores the design, development, and implementation of such a system, aiming to address the growing demand for remote surveillance solutions across various domains.

The integration of WiFi connectivity into a remote control car system offers several advantages, including enhanced flexibility, scalability, and accessibility. By leveraging WiFi technology, users can remotely control the movement of the car and access live video feeds from any location with internet connectivity. This capability enables the system to be deployed for a wide range of applications, including security surveillance, environmental monitoring, and research exploration.

The ESP32-CAM module serves as a central component of the surveillance system, providing high-resolution video capture capabilities.

Equipped with a camera sensor, onboard processing unit, and WiFi connectivity, the ESP32-CAM module allows for real-time video streaming and remote monitoring. The NodeMCU microcontroller complements the ESP32-CAM module by facilitating wireless communication between the car and a remote control interface, enabling users to interact with the system from a distance.

By exploring the capabilities of the WiFi-based remote control car surveillance system, this research aims to contribute to the advancement ofremote monitoring and surveillance technologies. The findings presented in this paper have the potential to inform future developments in the field.

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## II. LITERATURE SURVEY

1. Yuxin Jing, Letian Zhang et-al implemented "An android Remote Control Car Unit for search missions "It is used in mean to be in a search for natural disasters. It has accomplished with the autonomous development to avoid obstacles if they are not visible by driver. Requirements for it's implementation are Camera, Ultrasonic sensor, Bluetooth Servo Motor, Arduino UNO board, Wi-Fi router, Android studio. This application can make searchoperation more easier.
2. AyanMaity et-al implemented "Android application based Bluetooth controlled robotic car" Robot is controlled with the help of Bluetooth it is useful in moving vehicle forward, backward, left, right are Arduino UNO (ATMEGA 32), Bluetooth module (HC05), Smart phone, Motor driver (I293D).Main purpose of this robot is to detect hidden mines.
3. Rahul Kumar et-al implemented "Android Phone Controlled Bluetooth Robot" This paper dealswith design and control of vehicle capture live streams and videos at required location. Requirements for its implementation are Arduino Uno Board, DC Motors, Uart, L293D Motor Driver IC, Power adapter.
4. MehmetcanGule, Murat, Orthun et-al implemented "Android Based Wi-Fi Controlled robot using Raspberrpi" In this paper implementation is done for robot forward, backward, left, right and to display live stream of video using USB camera and raspberry pi board. Most inventive application is implemented to make people lives easier.
5. Jan Nadvornik, Pavel, Smutny et-al studied "Remote Control Robot Using Android Mobile Device". The application allow robot to control interaction with display or voice when we use graphical user interface we can monitor current distance of obstacle from vehicle. Ultrasonic sensors are used to find distance of obstacle from vehicle. 3
6. Ayesh George et-al implemented "Android controlled smart car In this application they are generating commands for acceleration, brake, clutch and transmitting it to Microcontroller with the helpof Bluetooth. Requirements for its implementationare microcontroller, Bluetooth HC05, DC geared motor, motor driver, Smart phone, Mikro C programming software, Pickit II Programmer, Tina Industrial Simulator, and Android Studio Android application helped in reducing difficulties in parking.
7. Benjir Ahmed et-al implemented "Android Apps Controlled ROBO Car by Microcontroller using Bluetooth" In this project they have developed a Robot named "ROBO car" controlled by Android apps from Smart phone through Bluetooth communication interfacing the microcontroller. According to the commands received from android phone, the direction, speed, sound and light of the car can be controlled. Requirements for its implementation are as follows Arduino UNO, Bluetooth module, Ultrasonic Distance Sensor, DC gear motor, Motor Driver, Boost Converter, worked successfully. It is easily controlled using Bluetooth communication between smart phone and microcontroller. It was observed that direction, speed, light, sound of the car will be controlled properly.
8. Chan Chung Hung et-al studied "Wi-Fi remotecontrol car via mobile device" goal of this project was to build Wi-Fi remote control car via mobile device. Mobile device screen is the consist of buttonsto plan distance, direction, mode of system but system has no accelerometer to show the readings for acceleration.
9. Raj Kumar Mistri et-al implemented "Wi-Fi controlled robot using node MCU" This is an embedded system. Aim of this project was controlling a robot from remote location of more than 1000 miles away. For its implementation are Power Supply, Node MCU, Motor and Motor Driver L293D, ESP2866 Wi-Fi module, wired interface. Controlling of the robot is tested successfully over the miles and application found efficient.

## III. SYSTEM MODELING

The system modeling for the WiFi-based remote control car surveillance system using an ultrasonic sensor ESP32 and NodeMCU microcontroller involves a comprehensive representation of the system's components, interactions, and behaviors through various modeling techniques.

Firstly, the identification of system elements is paramount, encompassing both hardware and software components. These include the remote control car chassis, ESP32-CAM module, NodeMCU microcontroller, ultrasonic sensor, andmotor drivers, alongside firmware code for motor control, camera operation, wireless communication, and user interface interaction.

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A critical aspect of system modeling is the creation ofa system architecture diagram, providing an overviewof the system's structure and interconnections between its components. This diagram illustrates the flow of data between sensors, microcontrollers, and actuators,as well as the communication protocols employed forwireless connectivity and data transmission to the remote control interface. It serves as a foundational reference for understanding the system's operation and interaction between its elements.

Further, a state diagram for remote control delineates the various states and transitions encountered during system operation. These states encompass idle, forward motion, backward motion, left turn, right turn, and emergency stop, with transitions triggered by user inputs received from the remote control interface. This representation aids in visualizing the system's behavior during remote control operation and guides the implementation of corresponding actions within the firmware code.

Additionally, a sequence diagram for camera operation delineates the sequence of actions involved in capturing and transmitting video footage using the ESP32-CAM module. It illustrates the initialization, image or video frame capture, data compression, and wireless transmission processes. This depiction elucidates the interactions between the camera module, microcontroller, and wireless communication module, providing insight into the system's behavior during camera operation.

Behavioral modeling with Finite State Machines (FSM) further enhances the understanding of the system's functionality. Finite state machines represent complex behaviors and interactions within the system through a set of states, transitions, and actions. Each component, such as the motor control system or camera operation module, can be modeled as a finite state machine with defined states and transitions. This modeling technique facilitates a structured analysis of the system's behavior and aids in the identification of potential issues or optimizations.

Lastly, simulation and verification using tools such as MATLAB/Simulink or Arduino IDE validate the system model and ensure that it meets its requirements. Through simulation, the system's behavior can be evaluated under various conditions, enabling the identification of discrepancies between expected and actual performance. Verification confirms that the system operates as intended and assists in refining the system model to achieve the desired specifications and performance criteria.

By employing these system modeling techniques, the WiFi-based remote control car surveillance system can be effectively designed, analyzed, and optimized to meet the desired functionality and performance requirements. The system model serves as a valuable tool for understanding the system'sbehavior, identifying potential issues, and guiding the development process towards a successful implementation.

**A. Node MCU:**

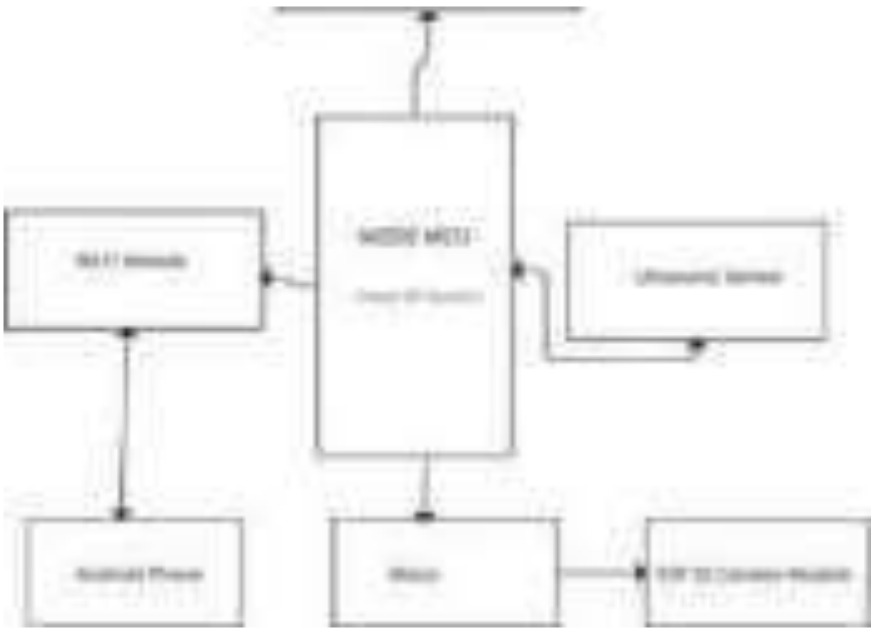

**Figure 3.1:** Block Diagram

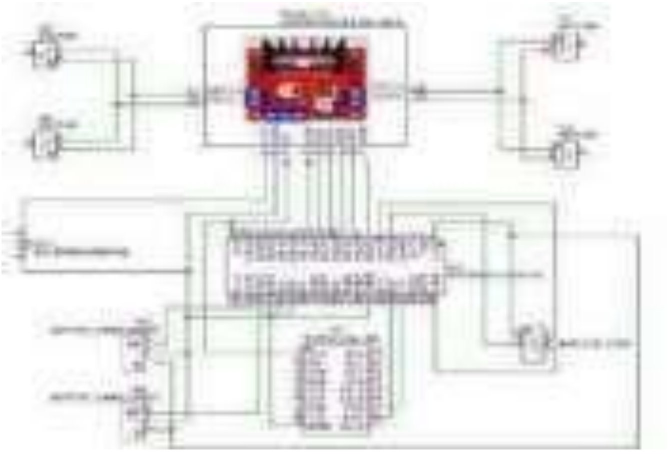

**Figure 3.2:** Circuit Diagram

Circuit Diagram of Wi-Fi controlled robot is given below. We mainly need a NODEMCU and ESP8266 Wi-Fi module. ESP8266's Vcc and GND pins are directly connected to 3.3 V and GND of Node MCU and CH_PD is also connected with 3.3V. Transmitter and Receiver pins of ESP8266 are directly connected to pin 2 and 3 of NODEMCU. Software Serial Library is used to allow serial communication on pin 2 and 3 of Arduino. We have already covered the Interfacing of ESP8266 Wi-Fi module to NODEMCU in detail. A L293D Motor Driver IC is used for driving DC motors Input pins of motor driver IC is directly connected to pin 8, 9, 10 and 11 of NODEMCU. And DC motors are connected at its output pins.

Here we have use 9 Volt battery for driving theCircuit and DC motors

## IV. REQUIREMENTSHARDWARE REQUIREMENTS

Node MCU o L239D Motor Driver o UltrasonicSensor o ESP32-CAM module o DC Motors o Servo Motor o Power Supply

In a WiFi-based remote control car with an ESP32 camera, the NodeMCU serves as a central controller for managing WiFi connectivity, interfacingwith sensors, controlling motors, and handling communication with the ESP32 camera module. It acts as the bridge between the car and the controlling device, enabling remote control, live video streaming, and sensordata processing.

**Figure 4.1:** Node MCU

**B. L239D Motor Driver:**

The L239D motor driver is essential for the WiFi- based remote control car surveillance system, providing precise control over the car's motors.

With its dual H-bridge configuration, it enables forward, backward, and braking actions for two DC motors. Additionally, built-in protections ensure reliability in challenging conditions.

Interfacing with the NodeMCU microcontroller, it regulates motor speed and direction, enhancing the car's maneuverability during surveillance tasks. In summary, the L239D motor driver is critical for translating electronic signals into mechanical motion, making it indispensable for the system's operation.

**Figure 4.2:** L239D Motor Driver

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**C. Ultrasonic Sensor:**

The ultrasonic sensor is a key component in the WiFi-based remote control car surveillance system, providing obstacle detection and navigation capabilities. It measures distances by emitting ultrasonic waves and detecting their reflection off obstacles. This allows the car to navigate safely by adjusting its trajectory to avoid collisions. Its compact size, low power consumption, and compatibility with microcontrollers make it an essential tool for enhancing the car's autonomy and safety during surveillance operations.

**Figure 4.3:** Ultrasonic Sensor

**D. ESP32-CAM module:**

The ESP32-CAM module is an essential component of the WiFi-based remote control car surveillance system, acting as the visual sensor for capturing live video footage. With its high-resolution camera and onboard WiFi connectivity, it enables real-time video streaming to a remote control interface. This compact and versatile module enhances situational awareness, facilitates remote monitoring, andprovides valuable visual feedback to users, making itindispensable for surveillance applications.

**Figure 4.4:** ESP32-CAM module

**E. Servo Motor**:

The servo motor is a crucial component of the WiFi-based remote control car surveillance system, providing precise control over the vehicle's steering mechanism. Unlike conventional DC motors, servo motors offer accurate angular positioning, making them ideal for steering control. They operate within a limited range of motion and feature a closed-loop control system for consistent positioning. Compact, lightweight, and energy-efficient, servo motors integrate seamlessly with microcontrollers. In the surveillance system, the servo motor interfaces with the NodeMCU microcontroller to adjust the steering angle of the car's front wheels, enabling smooth and responsive maneuvering during surveillance operations.

**Figure 4.5:** Servo motor

**Working:**

The WiFi-based remote control car surveillance system is an innovative integration of hardware and software components designed to provide effective monitoring and surveillance capabilities. At its core, the system comprises several key elements, including the ultrasonic sensor, ESP32-CAM module, NodeMCU microcontroller, and servo motor. These components work together seamlessly to enable remote monitoring and control of the car's movements and surveillance functions.

The hardware setup of the system includes the installation of the ultrasonic sensor at the front of the car, which serves as the primary obstacle detection mechanism. Meanwhile, the ESP32-CAM module captures high-resolution live video footage of the car's surroundings, transmitting it wirelessly to a remote control interface.

The NodeMCU microcontroller acts as the central processing unit, managing data transmission, motor control, and sensor data processing via a WiFi connection.

Additionally, the servo motor is responsible for precisely controlling the car's steering mechanism, ensuring accurate navigation through obstacles.

In parallel with the hardware components, the software implementation of the surveillance system plays a crucial role in its operation. Programmed using Arduino IDE or similar development environments, the software dictates the behavior of the NodeMCU microcontroller. It encompasses wireless communication protocols, motor control algorithms, obstacle detection logic, and user interface interactions. Through a combination of sensor data processing and video streaming functionalities, the software enables autonomous navigation, obstacle detection, and real-time monitoring of the car's surroundings.

During operation, the WiFi-based remote control carsurveillance system functions autonomously, continuously scanning for obstacles and providing live video feeds to the remote control interface.

Users can interact with the system remotely, issuing commands for movement and steering adjustments, and monitoring the car's surroundings in real-time. This capability makes the system highly adaptable and suitable for a wide range of surveillance applications, including security patrols, environmental monitoring, and research exploration. Overall, the system represents a versatile and effective solution for remote monitoring and surveillance tasks.

## V. ADVANTAGES AND APPLICATIONS OF PROPOSEDTECHNIQUE

The proposed WiFi-based remote control car surveillance system, utilizing ultrasonic sensor, ESP32-CAM module, and NodeMCU microcontroller, offers versatility, scalability, and cost-effectiveness. Its advantages include precise obstacle detection for navigation, high-quality live video streaming for real-time visual feedback, and affordability due to the use of off-the-shelf components. Applications range from security and industrial monitoring to environmental surveillance, making it a valuable tool for enhancing situational awareness and operational efficiency in various settings.

## VI. RESULT

The implementation of the WiFi-based remote control car surveillance system yielded promisingresults. During testing, the ultrasonic sensor effectively detected obstacles, enabling precise navigation. The ESP32-CAM module facilitated seamless live video streaming, providing clear visual feedback. The NodeMCU microcontroller managed wireless communication and motor control, ensuringresponsive operation.

Overall, the system demonstrated reliability and usability, making it suitable for various surveillance applications such as security patrols and environmental monitoring. Further enhancementscan be explored to expand its capabilities in real- world scenarios.

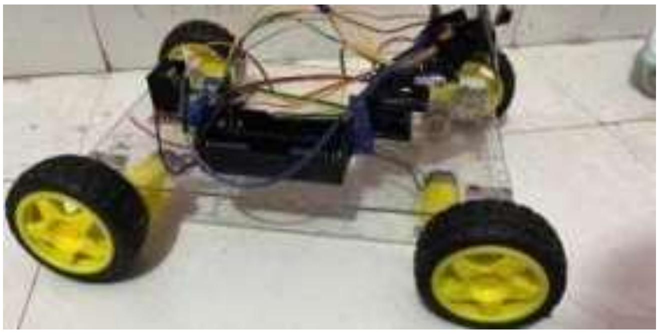

**Figure 6.1:** Hardware Implementation of theproject

## VII. CONCLUSION

'In summary, the WiFi-based remote control car surveillance system, incorporating ultrasonic sensor, ESP32-CAM module, and NodeMCU microcontroller, has proven its efficacy in providing real-time monitoring and surveillance capabilities. Throughout testing, the system exhibited reliable obstacle detection, precise navigation, and seamless live video streaming. The integration of advanced hardware components and software functionalities ensures responsive operation and user-friendly interaction, making it suitable for various

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surveillance applications such as security patrols and environmental monitoring.

The system reliably detects obstacles, navigates through environments, and streams clear live video footage. Its usability and versatility make it suitable for security patrols, environmental monitoring, and research exploration. Continued research and development efforts can further enhance its capabilities for diverse real-world applications.

## VIII. FUTURE SCOPE

In the realm of remote monitoring and surveillance, the WiFi-based remote control car system incorporating ultrasonic sensor, ESP32-CAM module, and NodeMCU microcontroller presents exciting prospects for future development. Potential avenues include the integration of advanced sensors like LiDAR for improved obstacle detection, optimization of wireless communication protocols for larger-scale deployments, and leveraging AI and ML algorithms for autonomous navigation and decision-making. Furthermore, the system could benefit from additional functionalities such as environmental sensors or specialized cameras for enhanced surveillance capabilities. These advancements promise to expand the system's reachand applicability in various real-world scenarios, making it a versatile tool for remote monitoring andsurveillance.

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