Upgraded Surveillance Camera Car Project

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***Abstract*— This project focuses on designing and building a smart surveillance car equipped with an ESP32 camera module. The car can be controlled remotely and capture real-time images through a mobile app, making it a useful tool for monitoring surroundings. To enhance its functionality, a pan-tilt mechanism allows the camera to move freely, providing a wider field of view. Key components of the system include an ESP32 camera for live streaming, servo motors for adjusting the camera angle, a 4-wheel drive (4WD) car chassis for mobility, and a motor driver module to control movement. The assembly process involves setting up wiring connections, managing the power supply, and programming the system using the Arduino IDE. The entire setup operates over a Wi-Fi network, ensuring seamless communication between the surveillance car and the user's smartphone. This project not only demonstrates practical applications of electronics and programming but also serves as an educational platform for exploring remote surveillance technologies.**

Key words:ESP32 Camera Module,Remote Control,Real-time Image Capture,Mobile Application,Pan-Tilt Mechanism,4WD Car Chassis,Motor Driver Module,Wi-Fi Communication,Electronics Integration,Remote Surveillance Technologies

I. INTRODUCTION

Over the past few years, the need for surveillance systems has grown tremendously as people have become increasingly concerned with security and safety in public and private areas. Conventional surveillance systems usually comprise fixed cameras that have limited coverage and mobility. To overcome these drawbacks, this project aims to design an enhanced surveillance camera car that integrates mobility with sophisticated imaging.

The main aim of this project is to design a remotely operated surveillance car with an ESP32 camera module that enables real-time video streaming and photo capture. The ESP32 is a high-performance microcontroller with integrated Wi-Fi, and hence it is suitable for IoT development. With this technology, the surveillance car can be operated through a mobile app, which makes it easy for users to monitor their environment remotely.

One of the main features of this surveillance vehicle is its pan-tilt mechanism, which enables the camera to dynamically change its angle and orientation. This feature improves the vehicle's capability to take pictures and video from different angles, giving complete coverage of the monitored area. The use of servo motors for pan-tilt control provides smooth and accurate movement, enabling users to zoom in on areas of interest.

The project also focuses on the need for user-friendly interfaces. Through the creation of a mobile app that interfaces with the car's Wi-Fi network, users can easily manipulate the car's movement and camera positioning. This ease of access is important for effective surveillance, as it enables users to react quickly to any incidents or changes in their surroundings.

Aside from its real-world applications in security and surveillance, this project is also an educational tool for learning the concepts of robotics, electronics, and programming. It is a hands-on learning experience in building electronic components, coding microcontrollers, and creating mobile applications. Therefore, it is a great learning experience for students and hobbyists to improve their technical skills and learn about the fast-changing world of surveillance technology.Overall, the enhanced surveillance camera car project is a major step forward in mobile surveillance solutions, bringing together technology and innovation to address the increasing demands of security and monitoring across different environments.

II.METHODOLOGY & EXPERIMENTAL SETUP

A. Components Required

Successful assembly of the upgraded surveillance camera car requires the following components, each with a designated function within the overall system:

The ESP32 camera module is a universal microcontroller that includes Wi-Fi features and a camera sensor. It provides real-time video streaming and image capture and is suitable for use in surveillance projects. The module is capable of supporting multiple resolutions and

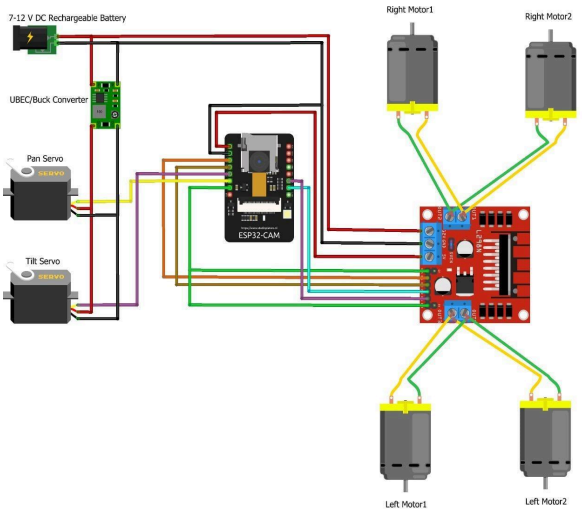

fig 1.1 "ESP32-CAM Robot Car Wiring Diagram with L298N Motor Driver and Servo Control"

can be set up to optimize its performance according to the project requirements.

Pan-Tilt Servo Assembly

This package includes two servo motors attached to a bracket that enables the camera to pan and tilt. This becomes important for surveillance of wide areas and zooming onto particular points of interest. The package must be light but robust in order to provide stable

camera movement.

SG90 Servo Motors (2 units):

The SG90 servo motors are small, lightweight, and cost-effective, making them suitable for controlling the pan-tilt mechanism. Each servo motor provides precise control over angular position, which is essential for adjusting the camera's viewpoint.

4WD Car Kit:

This pack contains a chassis, four TT gear motors, wheels, connectors, and screws. The 4WD arrangement provides assurance that the vehicle is able to traverse different environments, giving the surveillance system mobility. The chassis ought to be durable enough to handle the components' weight without difficulty in assembling them.

L298 Motor Driver Module

The L298 motor driver module is employed for the speed control and direction of the DC motors. It facilitates bidirectional control, allowing the car to drive forward, reverse, and turn. The module supports the current needs of the motors, thus ensuring stable operation.

UBC or Buck Converter

This element is crucial in providing the control of voltage supplied to the servo motors. It is used to transform the higher voltage of the battery into a stable 5V output, which is required for proper functioning of the servos.

7 to 12V DC Rechargeable Battery

A good power source, like a LiPo 2S battery, is needed to supply power to the whole system. The battery must have an adequate capacity so that the car and its devices can run for a long period of time.

Arduino Uno:

Arduino Uno is a microcontroller board employed to program and drive the ESP32 and other devices. It acts as the primary control unit that runs the code responsible for driving the movements and camera operations of the car.

Double-Sided Tape and Jumper Wires:

Double-sided tape is employed to hold components onto the chassis, whereas jumper wires provide electrical connections between different parts of the system.

B. Assembly Instructions

The assembly of the surveillance camera car is done through a number of systematic steps in order to make sure that all the components are properly integrated:

Pan-Tilt Assembly:

Start by mounting the pan-tilt bracket as per the manufacturer's instructions. Make sure the servos are securely attached to the bracket in a way that enables smooth rotation. The servos must be attached to the correct control pins on the ESP32 to enable communication.

Car Assembly:

Connect the wires to the gear motors by soldering them, making sure that the joints are secure and insulated to avoid short circuits. Install all four motors on the chassis using the connectors and screws provided, making sure that they are well-aligned for the best performance. Install the cartridge plate on the chassis to act as a solid foundation for the camera and other components.
Wiring Connections

Interconnect the DC motors with the L298 motor driver module such that the connections align to the respective input and output pins. Interconnect the motor driver to the power supply for feeding the motor its required voltage to operate. Further, interconnect the ESP32 camera module to the power supply and motor driver according to the wiring diagram available in the project manual.
Power Connections

Plug the rechargeable battery into the motor driver module and the servos. Make sure that the voltage ratings are compatible for each part so that damage does not occur. It is also important to double-check the polarity of the connections so that there are no short circuits.
Final Assembly:

Fix the wheels to the car, making sure that they are tightened in place and are able to rotate freely. Inspect all joints and make sure the parts are securely mounted to the chassis to eliminate any movement when it is in use.c

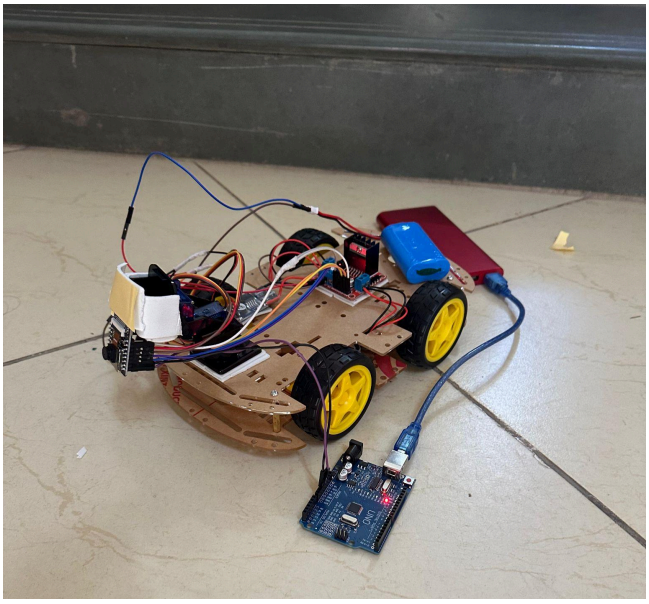

fig 1.2 Hardware model of ESP32-CAM Robot Car for wireless surveillance

III. RESULTS & DISCUSSION

The advanced surveillance camera car project effectively combines multiple electronic components and programming strategies to produce a working and remotely controllable surveillance system. The use of the ESP32 camera module enables high-definition image capture and real-time video streaming, which are essentials for efficient surveillance operations. The pan-tilt feature, realized through the application of SG90 servo motors, provides versatile camera positioning, which enables users to control the camera's angle dynamically to cover areas of interest.

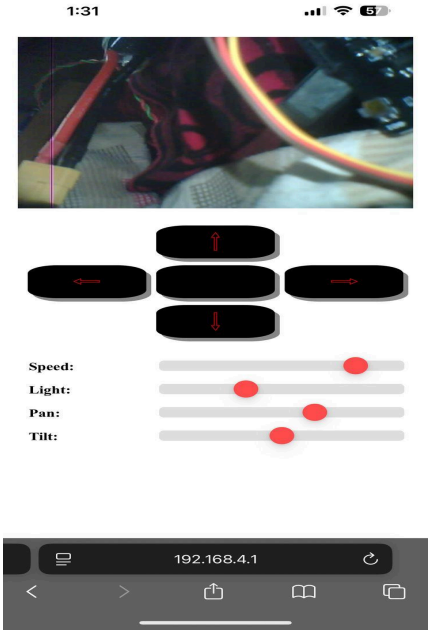

Fig 2.1 website or operator to control wireless surveillance

In testing, the system performed consistently well over a Wi-Fi link, with low latency in the delivery of video. Such functionality is necessary for real-time surveillance because it enables users to react in a timely manner to any anomalies or developments in the scene. The interface of the mobile app was simple and intuitive, with easy-to-use controls for car movement and camera direction. Users reported a high level of satisfaction with the responsiveness of the controls, which facilitated smooth navigation and effective surveillance.

Additionally, the project acts as a teaching aid, demonstrating the real-world applications of electronics and programming in robotics and surveillance technology. Effective integration of the hardware and software elements not only increases technical capabilities but also brings a

better appreciation of IoT systems. In all, the improved surveillance camera car represents the value of integrating mobility with sophisticated imaging capability for better security and monitoring solutions.

IV. CONCLUSION

The enhanced surveillance camera car project successfully demonstrates the combination of electronics and programming to develop a capable and efficient surveillance system. With the integration of the ESP32 camera module and the pan-tilt mechanism, the project maximizes monitoring features with real-time video streaming and adjustable camera positioning. This interactive experience not only enhances technical proficiency in robotics and programming but also offers practical implementation for remote monitoring technology in other sectors, including security and surveillance.

The easy-to-use mobile app provides intuitive control of the car and camera, illustrating the possibilities of real-world applications. Future enhancements may involve augmenting image processing functions, e.g., with more sophisticated features like object tracking and detection, which would enhance the effectiveness of the system. Further, enhancing the mobile app for improved usability and broadening the scope of functionalities can provide even more breakthrough solutions in surveillance technology. On the whole, this project provides a good base for future research in mobile surveillance systems.

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