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Surveillance Robot Using ESP32 CAM Module

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Abstract: In recent years robots have become a vital part of technology. Surveillance robots play a important role in enhancing security and monitoring capabilities in various domains, ranging from public safety and military applications to industrial facilities and private premises. These robots are equipped with advanced sensors, cameras, and communication systems to gather real-time data and provide situational awareness in both indoor and outdoor environments. This abstract highlights the key features and benefits of surveillance robots, focusing on their capabilities, deployment scenarios, and potential challenges. Surveillance robots are designed to navigate through complex environments autonomously or remotely, collecting visual and auditory information while transmitting it to a control center or human operators. They leverage technologies such as computer vision, machine learning, and sensor fusion to detect and track objects, recognize faces, identify anomalies, and monitor critical areas. These robots can be deployed in diverse settings, including public spaces, transportation hubs, critical infrastructure, and hazardous environments where human presence may be risky or impractical.

The use of surveillance robots offers numerous advantages. They can provide persistent surveillance without fatigue or distractions, cover large areas efficiently, and respond rapidly to security incidents or emergencies. Their ability to operate in challenging conditions, such as low-light environments or areas with restricted access, enhances overall security and threat detection capabilities. Additionally, surveillance robots can be equipped with additional functionalities, such as two-way communication, integration with existing security systems, and the ability to carry out routine patrols or inspections.

However, the deployment of surveillance robots also presents challenges. Ensuring reliable navigation and obstacle avoidance, maintaining continuous power supply, optimizing data transmission and storage, and addressing privacy concerns are among the key considerations. Ethical and legal frameworks must be established to define the boundaries of surveillance activities and protect individual privacy rights.

Keywords: Arduino UNO, ESP 32 CAM Module, Sensors, Metal detector, LDR, Surveillance.

I. INTRODUCTION

The advent of new high-speed technology and the growing computer Capacity provided realistic opportunity for new robot controls and realization of new methods of control theory. This technical improvement together with the need for high performance robots created faster, more accurate, and more intelligent robots using new robots control devices, new drivers and advanced control algorithms.

A surveillance robot is an advanced technological device designed to perform surveillance and monitoring tasks autonomously or under human control. These robots are equipped with various sensors, cameras, and communication systems that enable them to collect and transmit real-time data from their surroundings. Surveillance robots are utilized in a wide range of applications across industries such as security, law enforcement, industrial monitoring, search and rescue operations, environmental monitoring, infrastructure inspections, agriculture, event security, and border surveillance.

The primary purpose of surveillance robots is to enhance situational awareness, improve operational efficiency, and mitigate risks. By deploying these robots, organizations can monitor and secure areas that are difficult or dangerous for humans to access. They serve as reliable and efficient alternatives, complementing the capabilities of human personnel. ESP 32 Cam module is used for Surveillance. Where as Arduino UNO is used for controlling the robot where the UNO is connected to ESP 8266 WIFI module and serial communication takes place between these two which makes it easier to control the robot with the help of commands. Sensors such as metal detector and LDR are used.

These robots are equipped with high-resolution cameras that capture visual data, enabling real-time video feeds and recordings. Additionally, they may feature sensors such as infrared or thermal imaging to detect objects or individuals

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even in low-light or challenging environmental conditions. These robots can navigate autonomously, following pre-defined paths or using obstacle avoidance algorithms to ensure safe and efficient movement.

The collected data from surveillance robots can be transmitted wirelessly to a control center or a remote operator, allowing real-time monitoring and decision-making. Advanced robots may even incorporate artificial intelligence algorithms to analyze the data and identify potential threats or anomalies automatically. The applications of surveillance robots are diverse and continue to expand as technology advances. From securing critical infrastructure to assisting in search and rescue operations, these robots provide valuable support in numerous domains.

II. LITERATURE SURVEY

Anand Nayyar , Vikram Puri , Nhu Gia Nguyen and Dac Nhuong Le in their paper stated that Surveillance systems have become increasingly important in various fields, including security, monitoring, and automation. The advent of compact and affordable modules, such as the ESP32-CAM, has opened new avenues for the development of surveillance robots. This literature surveys aims to explore the existing research and developments in the field of surveillance robots utilizing the ESP32-CAM module [1].

T.Akilan ,Satyam,Chaudhary Princi Kumari ,Utkarsh Pandey have developed a low-cost module that integrates an ESP32 microcontroller and a camera. It provides wireless connectivity options, such as Wi-Fi and Bluetooth, making it suitable for remote surveillance applications. The module supports image and video capture, as well as real-time streaming, which are vital features for surveillance robots [2].

Nihar Ranjan, Zubair Ghouse & Nishika Hiwrale have focused on developing surveillance robots using the ESP32-CAM module as the central component. They have explored various approaches for hardware design and integration. For instance, some studies have employed Arduino-based platforms to control the motors and sensors, while others have utilized Raspberry Pi boards for enhanced computational capabilities [3].

Chaitanya Vijaykumar Mahamun and Zuber Mohammed Jalauddi have proposed a robot that offers image capture capabilities, making it suitable for vision-based object detection and tracking. Researchers have utilized popular computer vision libraries, such as Open CV, to implement algorithms for object detection, recognition, and tracking. Machine learning techniques, including deep learning, have been applied to enhance the accuracy and robustness of surveillance systems [4].

Nakshtra Popli , Kailash Masiwal, Sarthak Batra and Chaitanya Mamgain have drawn one of the key advantages of the ESP32-CAM module is its wireless connectivity options. Researchers have utilized Wi-Fi capabilities to enable remote monitoring and control of surveillance robots. By establishing a wireless connection, users can access the camera feed in real-time, receive notifications, and control the robot's movements from a remote location [5].

Aarya Aalase , Pranali Bandgar, Karuna Kamble , Shreya Bhosale , A. A. Udgave
have integrated additional sensors to enhance the capabilities of surveillance robots. These sensors include ultrasonic sensors for obstacle avoidance, infrared sensors for proximity detection, and microphones for audio monitoring. The integration of these sensors enables robots to gather more information from the environment and perform complex tasks [6].

Okey, D.O., Eze, C. and Ihekweaba, C have proposed an efficient power management is crucial for surveillance robots to ensure extended operational periods. Researchers have explored techniques to optimize power consumption, such as implementing sleep modes, adjusting camera settings [7].

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III. PROPOSED SYSTEM

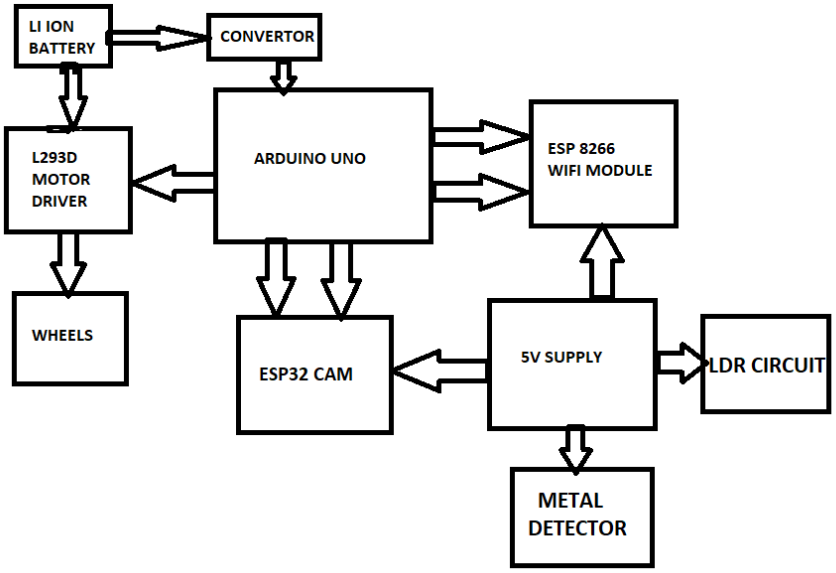

Fig 1 . System block diagram

This proposed device can show a live stream on a mobile phone since ESP 32 cam module is used. This robot is controlled with the help of WIFI by giving commands. This robot consists of a pan and tilt servo motors, which allows the movement of robot both horizontally and vertically of about 90 degrees. Several sensors such as Metal detector sensor and LDR.

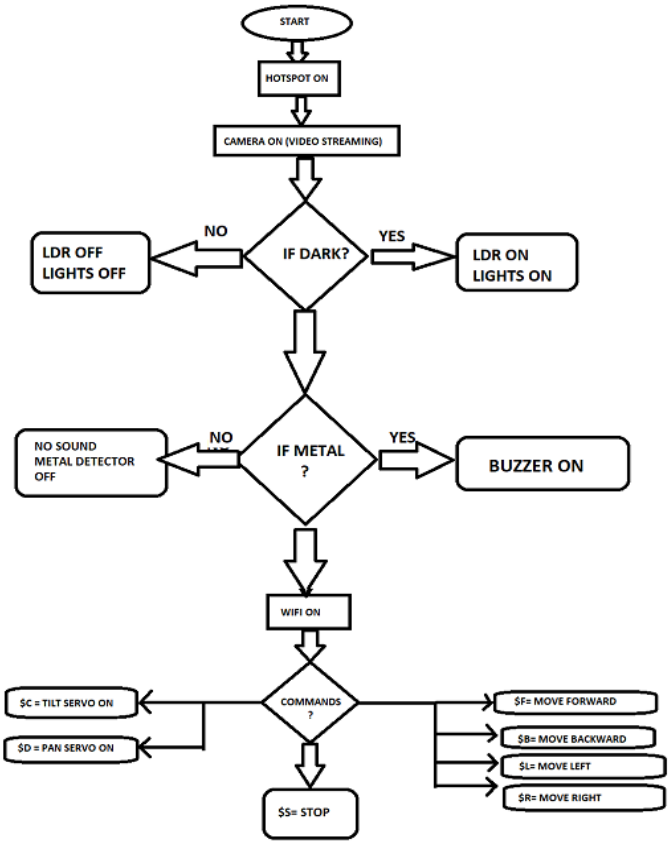

Fig 2. Flow chart

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IV. METHODOLOGY

Hardware Setup: Acquire an ESP32-CAM module, which combines an ESP32 microcontroller and a camera module. Connect the necessary power supply to the ESP32-CAM module, ensuring it is compatible with the required voltage and current. Establish the connections between the ESP32-CAM module and other components, such as motor drivers, sensors, and communication modules, as per your design requirements.

Software Development: Set up the Arduino IDE or the development environment of your choice for programming the ESP32-CAM module. Install the ESP32 board support package in the Arduino IDE . Write the firmware code to control the robot's functionality, including capturing and streaming video, object detection and tracking, navigation, and remote control features. Utilize libraries or develop algorithms for computer vision tasks such as object detection and facial recognition. Implement communication protocols like Wi-Fi or Bluetooth to enable remote control and video streaming capabilities.

Video Capture and Streaming: Utilize the ESP32-CAM's camera module to capture video frames. Implement video streaming protocols like RTSP (Real-Time Streaming Protocol) or WebRTC (Web Real-Time Communication) to transmit the captured video feed over a network connection. Ensure the video stream is optimized for real-time transmission and can be accessed remotely on a computer or mobile device.

Incorporate sensor like metal detecting sensor and utilize sensor data to control the robot's movements and ensure safe navigation. Implement LDR circuit for path finding at night, to enable autonomous navigation in the robot's environment.

HARDWARE IMPLEMENTATION:

This robot is made up of numerous different types of sensors, and the Arduino controller is the heart of the robot. Arduino is a microcontroller that is linked to other components. The Motor Driver is used to get the DC motor going. The system's input also includes a Metal detector sensor, ESP 32 CAM, ESP8266 WIFI module, LDR etc.

1) ESP 32 CAM MODULE: The ESP32-CAM is a small-size, low-power camera module based on ESP32**.** It comes with an OV2640 camera and provides an onboard TF card slot. This board has 4MB PSRAM which is used for buffering images from the camera into video streaming or other tasks and allows you to use higher quality in your pictures without crashing the ESP32. It also comes with an onboard LED for flash and several GPIOs to connect peripherals.

2) DC MOTOR: A DC motor is an electric motor that transforms DC electrical power to mechanical power, or translates a DC supply to rotation or movement. Despite the fact that the motor runs at 500 RPM at 12V, it runs smoothly from 4V to 12V and provides a wide range of RPM and torque.

3) ARDUINO UNO R3 :The Arduino UNO R3 is frequently used microcontroller board in the family of an Arduino. This is the latest third version of an Arduino board and released in the year 2011. The main advantage of this board is if we make a mistake we can change the microcontroller on the board. The main features of this board mainly include, it is available in DIP (dual-inline-package), detachable and ATmega328 microcontroller. The programming of this board can easily be loaded by using an Arduino computer program. This board has huge support from the Arduino community, which will make a very simple way to start working in embedded electronics, and many more applications.

4) MOTOR DRIVER MODULE **:** The L298N Motor Driver module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit. A motor driver module is a simple circuit used for controlling a DC motor**.** It is commonly used in autonomous robots and RC cars (L298N and L293D are the most regularly utilized motor driver chips). A motor driver module takes the low voltage input from a controller like Arduino.

5) LDR CIRCUIT**:** An electronic component like LDR or light-dependent resistor is responsive to light. Once light rays drop on it, then immediately the resistance will be changed. The resistance values of an LDR may change over several orders of magnitude. The resistance value will be dropped when the light level increases.

6) SERVO MOTORS: A servomotor is a linear or rotary actuator that can control linear or angular position, acceleration, and velocity with precision. A motor is connected to a position sensor. It also necessitates a complex controller, which is frequently a separate module created exclusively for servomotor use. A servo motor is used when you need to spin an object at a specified angle or distance. It's simply a servo mechanism with a simple motor. DC servo motors use DC power, while AC servo motors use AC power.

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7) METAL DETECTING MODULE **:** A metal detector sensor module is a device that uses electromagnetic induction to detect the presence of metal objects**.** The module typically consists of a transmitter coil that generates a magnetic field, and a receiver coil that detects changes in the magnetic field caused by the presence of metal.

V. CONCLUSION

The aim of this project was to build a robot which is useful for military personnel, for crime inspection, search and rescue operations etc. With the help of ESP 32 CAM surveillance in any tough environmental situations is possible. Metal detector enables the robot to detect metal which has significant applications in border security. LDR sensor allows the camera to capture video even in dark conditions.

VI. FUTURE SCOPE

Future work can include the transformation of the experimental robot prototype into a practical robot, which requires improvement in its overall performance. Face detection system and AI with Computer vision can be incorporated which will help the military personnel to recognize enemies easily. More sensors like PIR and Ultrasonic sensors can be incorporated as well.

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