VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JnanaSangama, Belagavi – 590002, Karnataka

A MINI PROJECT WORK (Course code: 18ECMP68) ON

"Surveillance Robot using ESP 32 CAM Module"

Carried out

by

Aditi Dubey	:	1KS20EC002
Gandhamani CM	:	1KS20EC030
Meghashree M	:	1KS20EC057

Submitted in partial fulfillment for the award of

BACHELOR OF ENGINEERING
IN
ELECTRONICS AND COMMUNICATION ENGINEERING

Under the guidance of

Dr. Rekha N

Associate Professor, Dept of ECE, KSIT

2022-23

K. S. INSTITUTE OF TECHNOLOGY

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CERTIFICATE

This is to certify that the mini project work(Course code: 18ECMP68) entitled

"Surveillance Robot using ESP 32 CAM Module"
is a work carried out by

Aditi Dubey	:	1KS20EC002
Gandhamani CM	:	1KS20EC030
Meghashree M	:	1KS20EC057

is a bonafide work carried out at K.S. institute of Technology, Bangalore in partial fulfillment for the award of Bachelor of Engineering Degree in Electronics and Communication from Visvesvaraya Technological University, Belgavi during the year 2022-2023. It is certified that all corrections and suggestions indicated during internal assessment have been incorporated in the report deposited in the department library. The project report has been approved as it satisfies the academic requirements in respect of Project Work prescribed for Bachelor of Engineering Degree.

Signature of Guide Signature of HOD Signature of Principal

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DECLARATION

We Aditi Dubey USN:1KS20EC002, Gandhamani CM USN:1KS20EC030, Meghashree M USN:1KS20EC057 students of 6th semester B.E., Department of Electronics and Communication Engg., K.S. Institute of Technology, Bengaluru declare that the mini project entitled "Survelliance Robot using ESP 32 CAM Module" has been carried out by us and submitted in partial fulfillment of the course requirements for the award of degree in B.E. in Electronics and Communication, Visvesvaraya Technology University, Belgaum during the academic year 2022-2023. Further, the matter embodied in the report has not been submitted previously by anybody for the award of any Degree or Diploma to any other University.

Signature of the candidates

Place: Bengaluru
Date:

ACKNOWLEDGEMENT

The successful project is culmination of efforts of many people who have rendered their unconditional support. We would be dishonest without acknowledging these people.

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We are thankful to our project Coordinators**Dr. B. Sudarshan, Professor and Mrs. Vishalini D** AssistantProfessor ,Department **Electronics and Communication Engg. Department**, K.S. Institute of Technology, for their cooperation and help throughout.

Last but not the least the project would not have been a success without the grace of **god** and support of our **parents** and **friends**.

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 circumstances or emergencies.

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CHAPTER 1
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.

This project describes a new economical solution of robot control systems .In general; the robots are controlled through wired network. The programming of the robot takes time if there is any change in the project the reprogramming has to be done. The modern technology has to be implemented to do this This idea is the motivation for this project and the main theme of the project. In this modern environment everybody uses smart phones which are a part of their day-to-day life. They use all their daily uses like newspaper reading, daily updates, social networking, and all the apps like home automation control, vehicle security, human body anatomy, health maintenance, etc has been designed in the form of applications which can be easily installed in their hand held smart phones.

This project approached a robotic movement control trough the smart phones. Hence a dedicated application is created to control an embedded robotic hardware. The application controls the movement of the robot. The embedded hardware is developed on 8051 micro-controller and to be controlled by a Smart phone on the basis of Android platform. 8051 controller is to receive the AT commands from the Smart phone and takes the data and controls the motors of the robot by the motor driver L298N. The robot can able to move forward, reverse, left and right movements.

The Smart phone is been interfaced to the device by using Wi-Fi. A wireless camera is mounted on the robot body for spying purpose even in complete darkness by using an LDR circuit and a metal detector is attached to the robot to detect any metal particles in its surrounding.

CHAPTER 2.

LITERATURE SURVEY

For more insights on this project, Literature survey was done. Realised the pros and cons of various methods to build this project.

The work [1] has a 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 survey aims to explore the existing research and developments in the field of surveillance robots utilizing the ESP32-CAM module.

In the work mentioned 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].The proposed system[3] has 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 capabilitiesThe work [4] has 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.The proposed work has 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].The work[6]has 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, and utilizing low-

power hardware components. Some studies have also investigated solar-powered solutions to enhance the autonomy of surveillance robots.The propsed work has 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].The work [7] has Analyzed the utilization of surveillance robots with ESP32-CAM modules has found applications in various fields. Researchers have implemented these robots for home security, wildlife monitoring, environmental monitoring, and industrial surveillance. Case studies have highlighted the effectiveness of these systems in real-world scenarios, showcasing their potential in enhancing safety and efficiency.

2.1 PROBLEM IDENTIFICATION

1. Incomplete understanding of the control system of robot.
2. Camera remained stationary in most of the proposed systems.
3. There was no proposed system to support the robot in dark conditions.
4. Although sensors were added they were mostly of PID sensors.
5. Some proposed systems had limited rotation of camera.
6. Humans cannot be present everywhere, as a result a surveillance robot is necessary to monitor risky locations.

2.2 OBJECTIVES

1. To develop a surveillance robot with a pan and tilt servo motors which allow the camera to rotate both horizontally and vertically.
2. To build a web environment on mobile phone from which the movement of robot controlled through commands with the help of ESP 8266 WIFI Module.
3. To build a connection between a ESP 32 CAM module and a webserver.
4. To install Metal detector sensor module and LDR circuit.

CHAPTER 3

METHODOLOGY

WORKING:

1. 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.

2.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.

3.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.

4.Incorporate sensor like metal detecting sensor and LDR:

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.

ALGORITHM

1. Video streaming is displayed on the mobile phone
2. Robot is controlled with the help of WIFI.
3. Metal is detected if any.
4. LED is turned on during dark conditions.

3.1 FLOW CHART

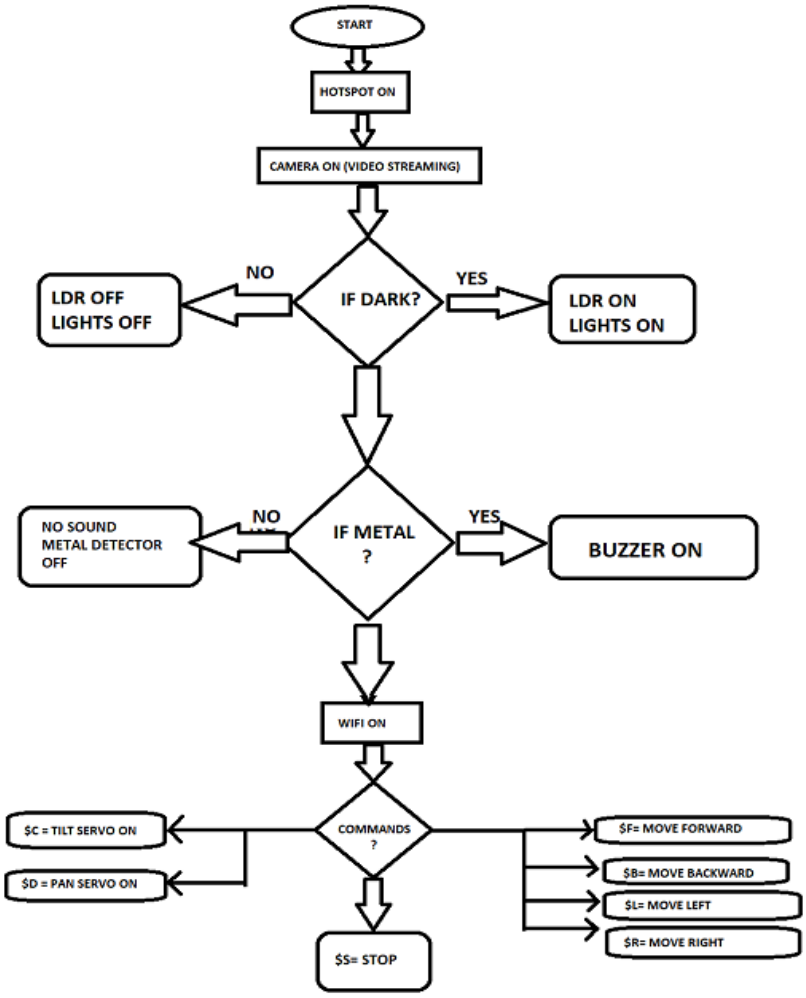

Fig 3.1 Flow chart of Surveillance robot

3.2 BLOCK DIAGRAM

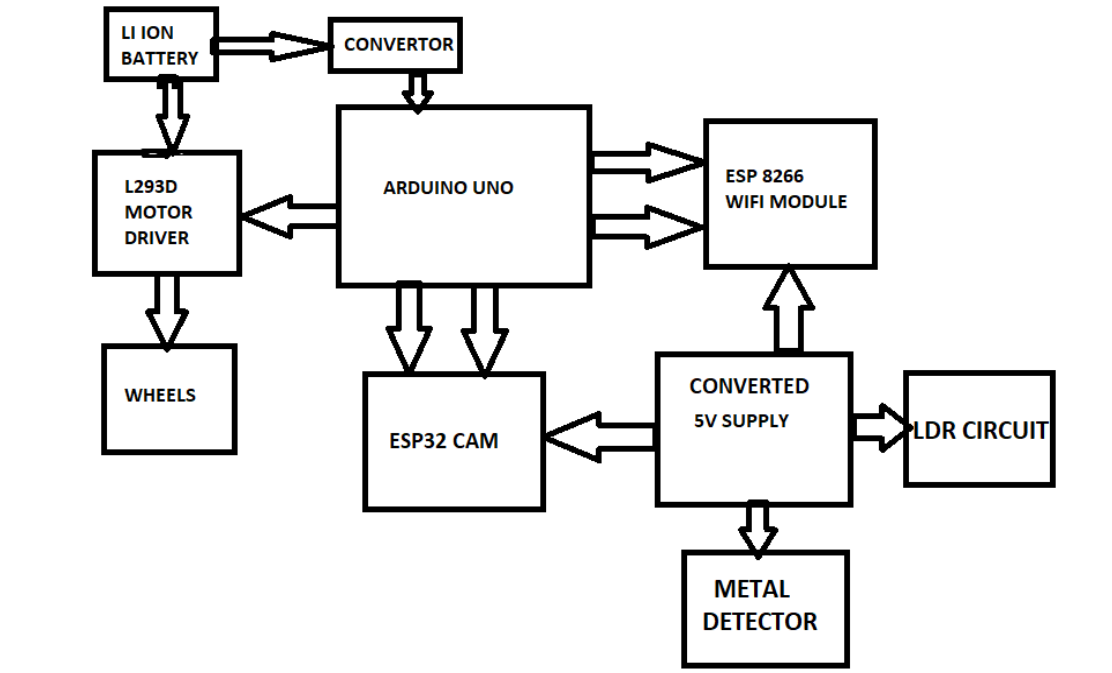

Fig 3.2 block diagram of Surveillance Robot

3.3 WORKING:

The main agenda of a surveillance robot using the ESP32-CAM module is to create an autonomous robot capable of capturing and transmitting video footage in real-time for surveillance purposes. The robot should be able to navigate its environment, detect and track objects or individuals of interest, and relay the captured video feed to a remote location for monitoring.

Enable the robot to capture high-quality video using the ESP32-CAM module's built-in camera and stream it in real-time to a designated location, such as a computer or a mobile device, over a wireless network

Equip the robot with sensors such as metal detecting sensor to enable it to detect any metal objects like mines in the surrounding and be able to function in night as well by making use of LDR circuit.

CHAPTER 4

HARDWARE AND SOFTWARE COMPONENTS

4.1 HARDWARE COMPONENTS

1. ESP 32 CAM Module
2. Arduino Uno R3
3. ESP 8266 WIFI Module
4. L298N Motor Driver Module
5. LDR Circuit
6. Metal Detector sensor Module
7. D C Motor
8. Servo Motor
9. Li-Ion Battery
10. D C Power convertor module

4.2 SOFTWARE

1. Arduino IDE
2. TCP/ICP Link

4.1.1 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.

Fig 4.1.1 ESP 32 CAM Module

4.1.2 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.

Fig 4.1.2 Arduino UNO R3

4.1.3 ESP 8266 WIFI Module

Espressif systems designed the ESP8266 Wi-Fi module to support both the TCP/IP capability and the microcontroller access to any Wi-Fi network. It provides the solutions to meet the requirements of industries of IoT such as cost, power, performance, and design.It can work as either a slave or a standalone application. If the ESP8266 Wi-Fi runs as a slave to a microcontroller host, then it can be used as a Wi-Fi adaptor to any type of microcontroller using UART or SPI. If the module is used as a standalone application, then it provides the functions of the microcontroller and Wi-Fi network.

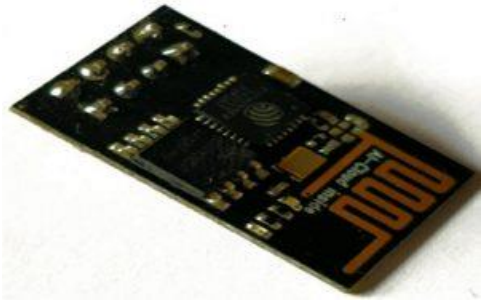

Fig 4.1.3 ESP 8266 WIFI Module

4.1.4 L298N 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.

Fig 4.1.4 L298N driver module

4.1.5 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. The resistance values of LDR in darkness are several megaohms whereas in bright light it will be dropped to hundred ohms. So due to this change in resistance, these resistors are extremely used in different applications. The LDR sensitivity also changes through the incident light's wavelength.

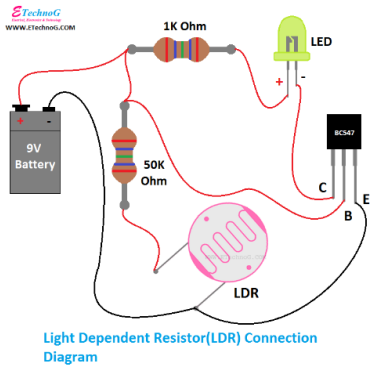

Fig 4.1.5 LDR Circuit

4.1.6 METAL DETECTOR SENSOR

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.

Fig 4.1.6 Metal Detector Sensor module

4.1.7 D C MOTOR

DC Gear Motor Each of the Mobile Robot's four wheels is attached to a DC Gear Motor for the purpose of movement. The Operating Voltage of the DC Gear Motor is between 3-12 Volts. The Maximum Torque of the DC Gear Motor is 800 gf.cm. The Load Current of the DC Gear Motor ranges from 70 mA to 250 mA. It is rated at 148 RPM Dimension of the DC Gear Motor is 7cm x 2.2cm x 1.8 cm.

Fig 4.1.7 D. C .Motor

4.1.8 SERVO MOTOR

A **servo motor** is a type of motor that can rotate with great precision. It is just made up of a simple motor which runs through a **servo mechanism**. If motor is powered by a DC power supply then it is called DC servo motor, and if it is AC-powered motor then it is called AC servo motor.

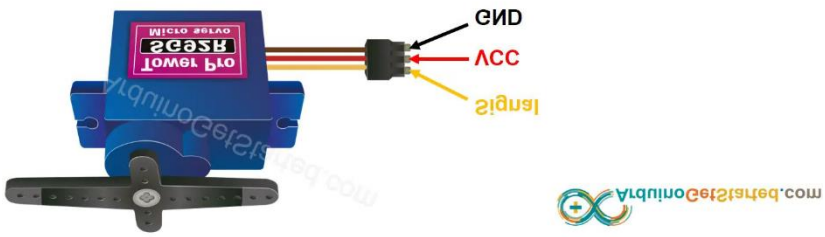

Fig 4.1.8 Servo Motor

4.1.9 Li-Ion Battery

A **lithium-ion** or **Li-ion battery** is a type of rechargeable battery which uses the reversible reduction of lithium ions to store energy. The negative electrode of a conventional lithium-ion cell is typically graphite, a form of carbon. This negative electrode is sometimes called the anode as it acts as an anode *during discharge*. The positive electrode is typically a metal oxide; the positive electrode is sometimes called the cathode as it acts as a cathode *during discharge*. Positive and negative electrodes remain positive and negative in normal use whether charging or discharging and are therefore clearer terms to use than anode and cathode which are reversed during charging.

Fig 4.1.9 Li-Ion Battery

4.1.10 DC POWER CONVERTOR Module

When semiconductor technology was in its initial stages, the **conversion** of **direct current (DC) supply voltage** to a higher voltage was done by converting it to alternating current (AC) intermediately using the vibrator, step-up transformer, and the rectifier assembly.

Fig 4.1.10 Dc convertor

4.2.1 ARDUINO IDE

The Arduino Software (IDE) makes it easy to write code and upload it to the board offline. We recommend it for users with poor or no internet connection. This software can be used with any Arduino board.

There are currently two versions of the Arduino IDE, one is the IDE 1.x.x and the other is IDE 2.x. The IDE 2.x is new major release that is faster and even more powerful to the IDE 1.x.x. In addition to a more modern editor and a more responsive interface it includes advanced features to help users with their coding and debugging.

The following steps can guide you with using the offline IDE (you can choose either IDE 1.x.x or IDE 2.x):

1. Download and install the Arduino Software IDE:

- **Arduino IDE 1.x.x** (Windows, Mac OS, Linux, Portable IDE for Windows and Linux, ChromeOS).
- **Arduino IDE 2.x**

2. Connect your Arduino board to your device.

3. Open the Arduino Software (IDE).

The Arduino Integrated Development Environment - or Arduino Software (IDE) - connects to the Arduino boards to upload programs and communicate with them. Programs written using Arduino Software (IDE) are called **sketches**. These sketches are written in the text editor and are saved with the file extension .ino.

Fig 4.2.1 Arduino IDE Logo

4.2.2 TCP/IP Link

TCP protocol operations may be divided into three phases. Connections must be properly established in a multi-step handshake process before entering the data transfer phase. After data transmission is completed, the connection termination closes established virtual circuits and releases all allocated resources.

CP Test Tool is a TCP testing application that provides the ability to both initiate and capture TCP packets from any PC to or from any PC, server, or IP device - providing a complete solution for debugging TCP session connectivity issues.It provides 2 tools in one:

1. a TCP CLIENT (ender) for initiating outbound TCP traffic.
2. a TCP SERVER (receiver) for receiving inbound TCP session requests.

Reference is often made to the TCP/IP stack. This consists of layers of mini applications which perform the discrete job of sorting and filtering the data packets picked up by the NIC and then passing the packet on to the next layer for further processing. Eventually a coherent message pops out of the top of the stack into the operating system for the user to read.

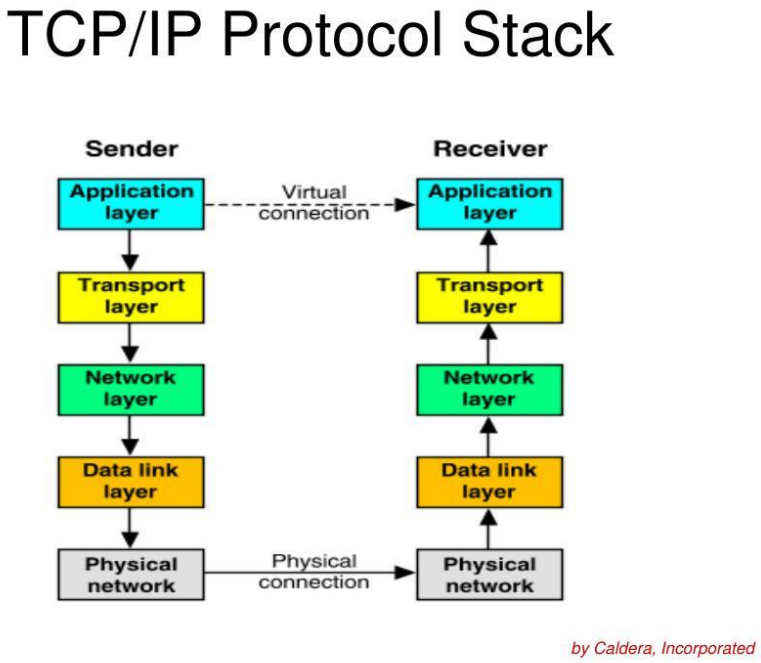

Fig 4.2.2 TCP/IP protocol Stack

CHAPTER 5
RESULTS

1.The robot could take in commands through TCP Link Server.

2.ESP 32 cam module Could provide a high quality video which was streamed on mobile phone through hotspot.

3.With the help of LDR circuit the robot is able to travel in dark places.

4. Metal Detector sensor module could sense the metal.

5. Surveillance Robot is equipped with a Camera, Metal detector module and LDR circuit.

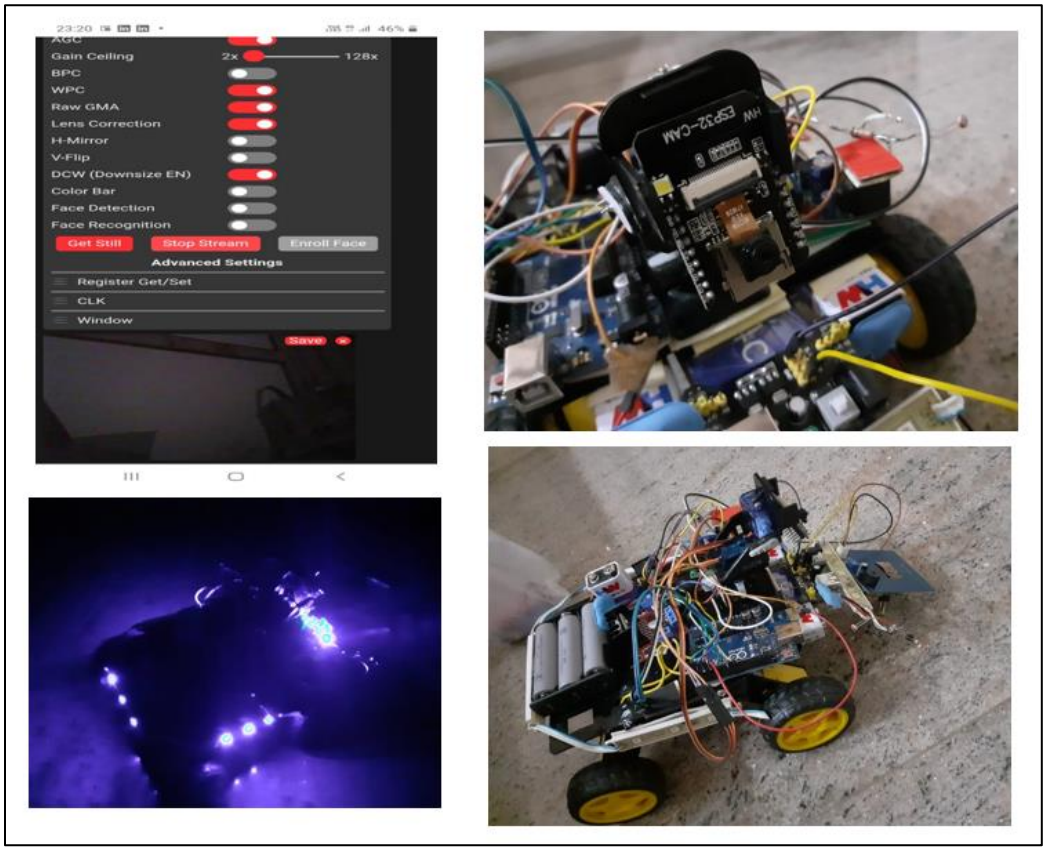

Fig 5. Overall Result of robot

CHAPTER 6
APPLICATIONS

Security and Surveillance: Surveillance robots are commonly used in security applications to monitor and protect various environments, including:

1 .Public Spaces: They can patrol public areas such as parks, shopping malls, airports, or train stations, detecting suspicious activities and ensuring public safety.

2. Industrial Facilities: Robots can monitor critical infrastructure, manufacturing plants, or warehouses to prevent unauthorized access, theft, or damage.

3.Border Security: Surveillance robots can be deployed for border surveillance, detecting illegal crossings and assisting border control personnel in remote or rugged areas.

4. Event Monitoring: Robots can be used to enhance security during large-scale events or gatherings, providing real-time surveillance and crowd monitoring.

5. Search and Rescue Operations: Surveillance robots play a crucial role in search and rescue missions, providing situational awareness and aiding in locating missing persons or survivors in challenging environments. They can navigate through debris, rubble, or hazardous terrains, helping rescuers assess the situation and plan their operations effectively.

6. Industrial Inspection: Surveillance robots equipped with cameras and sensors are used for inspection and monitoring purposes in industrial settings, including.

7. Oil and Gas Facilities: Robots can inspect pipelines, tanks, or offshore platforms for leaks, structural integrity, or other safety concerns.

8. Power Plants: They can monitor equipment, identify potential failures, and detect anomalies in power generation facilities.

9. Infrastructure Inspection: Robots can inspect bridges, tunnels, or other critical infrastructure to assess their condition and identify maintenance needs.

10.Environmental Monitoring: Surveillance robots are utilized to monitor and assess environmental conditions in various scenarios, such as.

11.Forest Fire Detection: Robots can be deployed in forested areas to detect and monitor early signs of wildfires, providing valuable information for fire suppression efforts.

12. Air and Water Quality Monitoring: Robots can collect data on air pollution, water quality, or hazardous substances in remote or inaccessible areas, aiding in environmental monitoring and protection.

13. Law Enforcement: Surveillance robots are used by law enforcement agencies for crime prevention, investigations, and public safety

14. Traffic Monitoring: Robots can monitor traffic flow, detect violations, or identify stolen vehicles, contributing to traffic management and law enforcement efforts.

15. Crowd Control: Robots can assist in managing large crowds during public events or protests, ensuring safety and facilitating crowd control measures.

16. Forensic Support: Robots can be used to collect evidence, document crime scenes, or navigate hazardous areas during investigations.

17. Home Security: Surveillance robots can provide an added layer of security for residential properties, allowing homeowners to remotely monitor their homes, detect intruders, or receive alerts in case of suspicious activities.

CHAPTER 7
CONCLUSION AND FUTURE SCOPE

CONCLUSION

The proposed system was successfully implemented, the working of the wireless video surveillance robot controlled using android mobile device. The robot is successfully controlled using the android application through the WiFi technology. Even the real time video is successfully achieved using the Wi-Fi technology on our designed android application. Sensors such as metal detector module and LDR circuits were successfully implemented.

FUTURE SCOPE

Considering the final assembled Robot is just a prototype, it holds a lot of scope for improvement. The current system can be improved by using Industrial grade sensors to improve efficiency and accuracy of its sensed data. This will also improve the sensing range of the system drastically. Furthermore, more sensors can be incorporated to sense more environmental parameters. By making the Robot chassis out of more durable and temperature resistant materials, we can deploy it in more hostile environments. Replacing the Robot's wheels with tracks will give it more maneuverability. The use of a HD camera and a more powerful Micro-computer will enable the Mobile Robot to be used in more challenging surveillance and monitoring tasks. Higher functionality can be achieved by reprogramming the Mobile Robot to have variable speeds. This will make the Mobile Robot easier to control. By incorporating fail safe measures for the loss of internet connectivity and by including a power backup, the Mobile Robot will become more fool-proof.

CHAPTER 8
8.1 PROJECT PLAN

WEEK	WORK DONE
1	Embedded C Algorithm implementation
2	Implement Arduino algorithm
3	To evaluate the Embedded C program's Complexity
4	To estimate Arduino program's complexity
5	To verify functionality of ESP 32 CAM
6	To test ESP 32 CAM's functionality
7	Using ESP 32 CAM for Algorithm Testing
8	Testing DC Motors and Servo Motors
9	Testing ESP 8266 WIFI Module
10	Testing Metal Detector Sensor module
11	Assembling LDR circuit
12	Assembling all the peripherals on to the robot
13	Testing WIFI and Hotspot Connectivity
14	Publishing Implementation Paper
15	Analyzing and Redrafting the report
16	Submission of Project and Report

8.2 PROJECT COST ESTIMATION

Sl no	COMPONENT	QUANTITY	COST ESTIMATION	ACTUAL COST
1.	ESP 32 CAM	1	Rs. 600	Rs. 500
2.	SERVO MOTORS	2	Rs. 400	Rs. 360
3.	PAN AND TILT ASSEMBLY	1	Rs. 500	Rs. 430
4.	MOTOR DRIVER (L298N)	1	Rs. 500	Rs. 200
5.	ESP 8266 WIFI	1	Rs. 200	Rs. 170
6.	DC MOTORS	4	Rs. 300	Rs. 200
7.	ROBOT CHASSIS	1 SET	Rs. 1500	Rs. 1200
8.	LDR	2	Rs. 20	Rs. 12
9.	BC 547 TRANSISTOR	2	Rs. 20	Rs. 20
10.	RESISTORS	2	Rs. 10	Rs. 10
11.	METAL DETECTOR MODULE	1	Rs. 300	Rs. 200
12.	9V BATTEY	3	Rs. 90	Rs.90
13.	LI-ION BATTERY	6	Rs. 300	Rs. 240
14.	CHARGER	1	Rs. 200	Rs. 150
			TOTAL	Rs. 3782/-

CHAPTER 9

PROJECT DEMONSTRATION

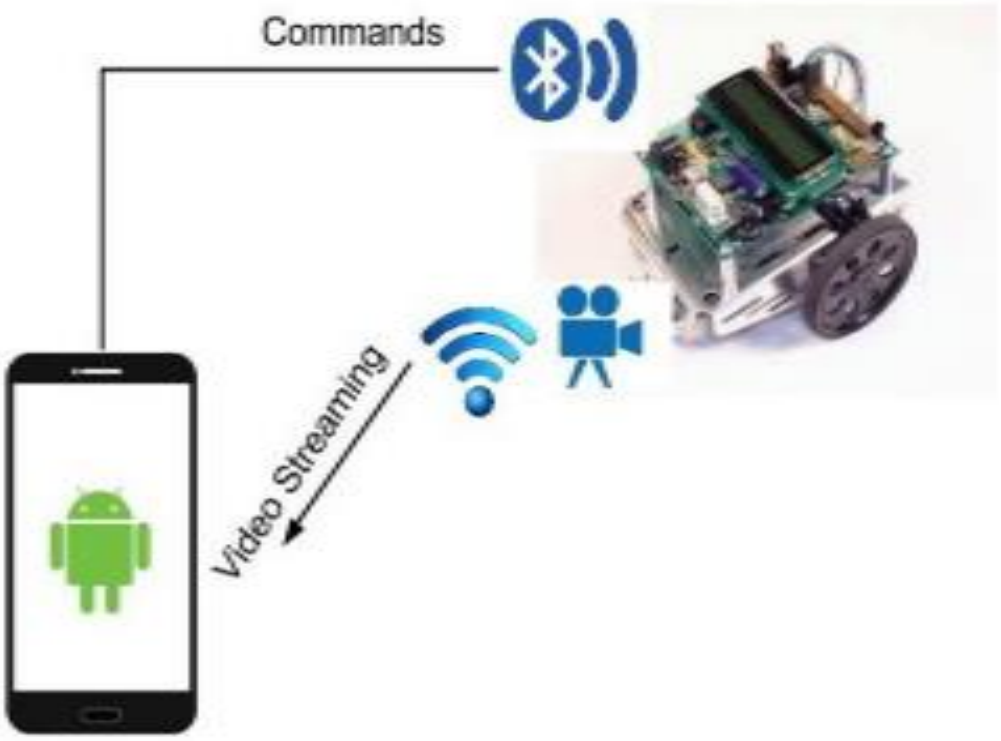

Fig 9 Demonstration plan

CHAPTER 10
INDIVIDUAL AND TEAM CONTRIBUTION

NAME	INDIVIDUAL	GROUP
Aditi Dubey	1.Tested the components. 2.Established connections of ESP32 cam module and servo motors. 3. Established the TCP link server and developed commands to control the robot and the servo motors. 4. Programmed the ESP 32 Cam module.	1.Preparation of Report. 2. Redrafting PPT's before review. 3. Reference of existing papers and drafting of Literature survey. 4. Establishing connections between the modules effectively.
Gandhamani C M	1.Purchased the components. 2. Established the connection of ESP 8266 WIFI module. 3. Installed the Metal detector module and LDR circuit. 4. Programmed the Arduino UNO R3 and discovered the IP Address for video streaming.	1.Preperation of PPT's 2. Redrafting Report before submission. 3. Programming the modules and debugging the errors and tested the sensors. 4. Bringing the collected information together and publication of paper.
Meghashree M	1.Established connection between the motor driver module and DC motors 2. Established connection between wheels and DC motors. 3. Debugged the errors in code.	1.Block diagram. 2. Flow chart. 3. Making of Poster. 4. Assembling the robot.

CHAPTER 11

IMPLEMENTATION PAPER DETAILS

CHAPTER 12
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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

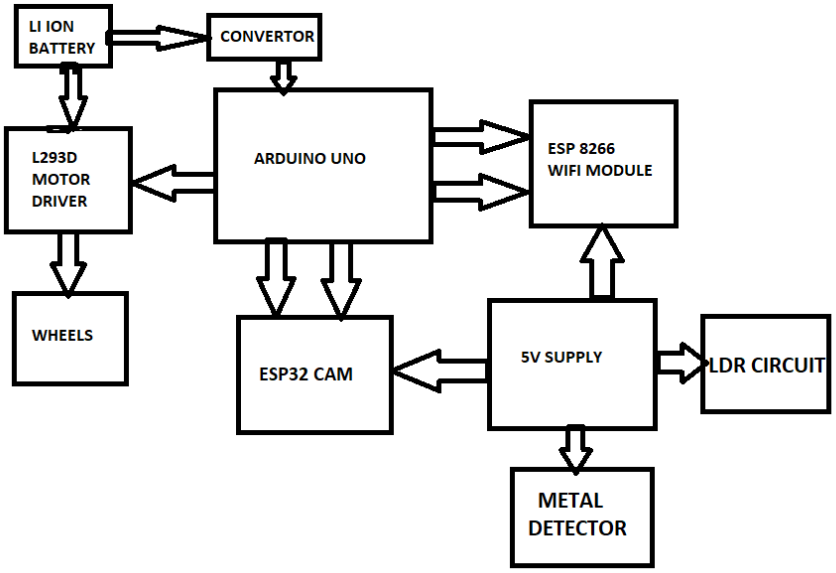

Fig 1 . System block diagram

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.

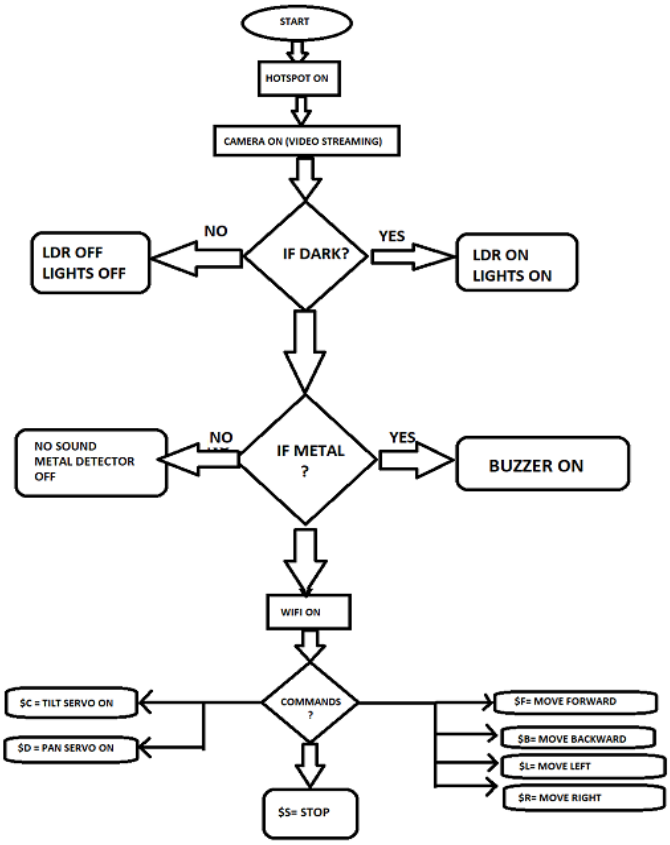

Fig 2. Flow chart

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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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