MULTI-SENSOR SURVEILLANCE ROBOT WITH WIRELESS CONNECTIVITY

STEM PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this Project **"MULTI-SENSOR SURVEILLANCE ROBOT WITH WIRELESS CONNECTIVITY"** is the bonafide work of **"ABISHEK N (710722106047), BALUSAMY V (710722106019), GOBINATH T (710722106042) and HEMATHCHANDRAN G M (710714106040)"**who carried out the project work under my supervision.

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ABSTRACT

In this project, we present the design, development, and implementation of a highly capable multi-sensor surveillance robot equipped with advanced wireless connectivity. The primary objective of the robot is to perform remote surveillance in various environments, providing real-time data and video feedback to users. The robot incorporates a diverse set of sensors, including high-resolution cameras, ultrasonic sensors, and environmental sensors, enabling it to perceive its surroundings accurately. These sensors allow the robot to detect obstacle and monitor temperature and humidity. A key highlight of the project is the integration of robust wireless communication capabilities, enabling seamless data transmission between the robot and a remote control station. The robot can transmit live video streams, sensor data, and status updates wirelessly in real-time, providing users with comprehensive situational awareness even from remote locations. Furthermore, the project includes a user-friendly interface, allowing operators to control the robot, access live feeds, and monitor sensor data conveniently through a mobile application or a web-based platform.

***Key words*: Smart Surveillance, Wireless Sensors, Temperature, Humidity**

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LIST OF ABBREVIATIONS

ACRONYMS	ABBREVIATIONS
C	**C**elsius
IoT	**I**nternet **o**f **T**hings
MSSR-WC	**M**ulti-**S**ensor **S**urveillance **R**obot With **W**ireless **C**onnectivity
Wi-Fi	**W**ireless **F**idelity

CHAPTER 1

INTRODUCTION

1.1 Introduction

In recent years, the field of robotics has witnessed significant advancements, leading to the development of intelligent and versatile robotic systems. Surveillance robots play a crucial role in various industries, including security, military, disaster response, and environmental monitoring.

This project aims to create a Multi-Sensor Surveillance Robot with Wireless Connectivity (MSSR-WC) that integrates state-of-the-art sensor technologies and wireless communication capabilities. The robot will be equipped with a variety of sensors, enabling it to gather real-time data from the environment and transmit it wirelessly to a remote operator or control center. By incorporating these features, the MSSR-WC will provide a comprehensive solution for effective and efficient surveillance applications.

1.2 Problem Identification

- As several nodes are used in the system, failure in any single node may cause the failure in master node.
- Identification of failure node is a difficult task and it cannot be applied for much distance.
- The transfer of message and data from one node to node is an difficult task and it takes more time to transfer the message and data.
- A key challenge of perception in an IoRT environment is that the surveillance observations of the IoRT entities are spatially and temporally distributed.

- Distributed robot control architectures in environmental monitoring and control of efficiency.

1.3 IoT in Surveillance System

The Internet of Things (IoT) has revolutionized various industries, and one of its significant applications is in the field of surveillance. IoT in surveillance involves the integration of smart devices, sensors, cameras, and networking technologies to create an intelligent and interconnected surveillance ecosystem. This innovative approach enhances security and monitoring capabilities by enabling real-time data collection, analysis, and response, transforming traditional surveillance practices.

1.4 Need of the Project

The major need of this project is to reduce the security threats. Surveillance robots equipped with multiple sensors can monitor and patrol areas, providing real-time data. It can monitor a wide area and gather data from various sources simultaneously, enabling a more comprehensive understanding of the surroundings. Utilizing surveillance robots with wireless connectivity can be a cost-effective alternative to deploying a large number of human security personnel for monitoring purposes.

1.5 Objective

The objective of the Multi-Sensor Surveillance Robot with Wireless Connectivity Project is to design, develop, and implement an advanced robotic system capable of performing surveillance tasks in diverse environments. The primary goal is to create a versatile and intelligent robot equipped with multiple sensors and wireless communication capabilities to enhance situational awareness, data gathering, and remote monitoring.

1.6 Organization of the Project

The report emphasizes on the strategy of Intelligent Management of the surveillance process with sensors. The basic organization of the report is as given below

Chapter 1: Deals with the introductive view to the project and facilitates acquaintance with the terminology

Chapter 2: Deals with the Literature survey for better understanding of the relevant project ideas and their conceptual ideas for the enhancement of the project work.

Chapter 3: Deals with the existing system and its relevance to our novel approach. The knowledge from existing systems helps in the enhancements and reliable commission of the project.

Chapter 4: Deals with methodology involved and the steps of execution of the project. It describes the hardware and software requirements and steps of implementation of the system.

Chapter 5: Deals with the system and the complete process description, regarding the interfacing of hardware being used for the surveillance.

Chapter 6: Deals with the system and the complete process description, regarding the interfacing of hardware being used to detect the obstacle and monitoring temperature and humidity.

Chapter 7: It puts forward the results and analysis of the working of the motor and sensors under various working conditions and circumstances in the surveillance.

Chapter 8: Deals with the conclusion we obtained and the scopes for future work on the project.

1.7 Summary

The "Multi-Sensor Surveillance Robot with Wireless Connectivity" project aims to develop an advanced robotic system capable of performing surveillance tasks in diverse environments. By combining cutting-edge robotics, versatile sensors, and wireless technology, this project sets out to enhance surveillance capabilities and contribute to improved security and monitoring solutions in various domain.

CHAPTER 2

LITERATURE SURVEY

2.1 Introduction

The innovative ideas and concepts which helped for the proposal of this intelligent management were taken from the following papers and journals. This has helped in gaining information regarding the works and procedures of the existing systems. Encapsulating the advantages and disadvantages of various existing systems henceforth helped in modifying the project.

A mobile robot is a machine that is basically place or mounted on a movable platform and can be with the help of certain instructions. In today, world a lot of fields use mobile robots. Many of the complex robots that we now see have originated from the simpler mobile robots. This technology has increased many new applications in the industry. The combination of mobile devices and robots are leading to new ideas in lots of fields.[2,4]

The mobile devices are now being used in many of the industrial applications this is mainly because of the reason that they are portable and have a longer battery life as compared to a laptop. Also they have a data plan through a cell phone carrier which is convenient as we can interact with the mobile robot once the connection is established.

Mobile Robots: The mobile robots can be classified into different types. The track robot is the robot that uses tracks to move around. However such robots are costly to build. Also they are not as flexible as the wheeled robots. The wheeled robots are the robots which use wheels for moving. Such robots can move only on smooth flat surfaces. The third type is the legged robots which are based on human form. They have legs which helps them to move around. These robots are very difficult to design.[6 ,8]

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2.2 Wireless Monitoring and Decision Support in Field [3]

Monitoring in a surveillance robot involves the use of wireless technologies to transmit data and video feed between the robot and a control station. This enables real-time remote monitoring and control of the robot's activities, making it a valuable tool for various applications such as security, reconnaissance, search and rescue, and environmental monitoring. A decision support system based on the combination of wireless sensor network and actuation network technology and the fuzzy logic theory is proposed to support the irrigation management in agriculture.

The farmer's support and irrigation best practices are modeled through fuzzy rule sets and the outputs of numerical soil and crop models are used to provide context aware and optimized irrigation schedule. The suggested actions are devoted to reduce the waste of water and to maximize the crop yield according to weather condition and real water needs. This helps to reduce the water content in the agricultural farming lands.

Surveillance systems have become an integral part of modern society, providing critical tools for enhancing security, safety, and operational efficiency. These systems leverage advanced technologies, including cameras, sensors, and data analytics, to monitor and record activities in various environments. From safeguarding public spaces and critical infrastructure to enhancing organizational productivity, surveillance systems play a vital role in mitigating risks and optimizing decision-making processes.

The purpose of this introduction is to present an overview of surveillance systems, their significance, and their widespread applications across different sectors. In this report, we will explore the fundamental principles, components, and functionalities that constitute a surveillance system. Furthermore, we will delve into the advancements in technology that have shaped the evolution of surveillance, making it more intelligent, adaptive, and effective in tackling contemporary security challenges.

2.3 Smart Surveillance Process Description [7]

A surveillance system is a complex and interconnected network of hardware and software components designed to monitor and record activities in a specific area or environment. This process description outlines the key steps involved in the functioning of a surveillance system, from data capture to analysis and response.

The surveillance process begins with the data capture phase, where various sensors and cameras collect information from the targeted area. These sensors may include CCTV cameras, thermal cameras, motion detectors, audio sensors, and other specialized devices. The data captured by these sensors are transmitted to the central control unit or a designated monitoring station.

The next crucial phase is data processing and analysis. The surveillance system's software utilizes advanced algorithms, including computer vision and pattern recognition, to process the incoming data. The software identifies and tracks objects, detects motion, recognizes faces, and analyzes patterns of behavior. Additionally, AI and machine learning technologies may be employed to continuously improve the system's accuracy and responsiveness.

During the data analysis phase, the surveillance system continuously monitors the environment in real-time. Operators or AI algorithms watch live feeds or analyze processed data to identify any unusual or suspicious activities. When the system detects a potential threat, it triggers immediate alerts to the monitoring personnel or the designated authorities.

To ensure the surveillance system's effectiveness and reliability, regular maintenance and software updates are essential. This includes checking the functionality of sensors, cameras, and network connections, as well as updating software and firmware to address security vulnerabilities and improve system performance.

2.4 2.4 Analysis of Smart Surveillance [1]

- Smart Surveillance utilizes AI and computer vision to proactively detect and respond to potential security threats in real-time.
- The integration of advanced sensors and cameras enables the system to intelligently track objects and identify suspicious behavior.
- The use of AI algorithms allows the surveillance system to continuously adapt and learn from data, improving accuracy over time.
- Real-time monitoring and automated alerts ensure swift action is taken when potential threats are detected.
- The system's ability to archive and retain data supports post-incident analysis, investigations, and continuous improvement of security measures.
- The system's ability to integrate with existing security infrastructure allows for cost-effective upgrades and scalability.
-

2.5 Summary

Real-time observation, a cornerstone of modern surveillance, involves the instantaneous and continuous monitoring of events or locations. It leverages advanced sensors, cameras, and data processing techniques to provide up-to-themoment insights. Researchers emphasize the importance of low latency, reliable data transmission, and real-time analytics to enable swift decision-making and response.

Wireless monitoring, a pivotal component of surveillance robots, facilitates seamless communication between the robot and a control station. This wireless link allows for the transmission of live video feeds and data, enabling remote control and monitoring.

Overall, the literature survey underscores the critical role of real-time observation and wireless monitoring in enhancing surveillance capabilities. It underscores the need for robust and responsive systems that integrate cutting-edge technologies to ensure effective surveillance, timely intervention, and informed decision-making in various domains, ranging from security and reconnaissance to search and rescue missions.

Smart Surveillance is an advanced security system that leverages AI, computer vision, and data analytics to proactively detect and respond to potential threats in real-time. By integrating sophisticated sensors and cameras, the system intelligently tracks objects and identifies suspicious behavior. With continuous learning capabilities, it adapts and improves its accuracy over time. The system offers enhanced situational awareness, automated alerts, and efficient resource allocation, making it a powerful tool for optimizing security and safety across various domains.

CHAPTER 3

PROPOSED INTELLIGENT MANAGEMENT FOR SURVEILLANCE PROCESS

3.1 Introduction

In today's dynamic and interconnected world, surveillance processes play a pivotal role in ensuring security, optimizing operations, and facilitating informed decision-making across various sectors. Traditional surveillance systems have evolved significantly, with the integration of intelligent management approaches that harness advanced technologies such as Artificial Intelligence (AI), data analytics, and automation. This transformation has ushered in a new era of surveillance, where proactive and adaptive systems contribute to enhanced situational awareness, streamlined operations, and effective resource allocation.

3.2 Methodology

The concept of intelligent management for surveillance processes revolves around the synergy between human expertise and technological prowess. It entails the utilization of AI algorithms to process vast volumes of data in real-time, extracting meaningful insights and patterns that might elude human perception. This enables surveillance systems to not only detect and respond to threats but also to predict potential incidents based on historical data and contextual cues. Fig: 3.1 Multi-Sensor Surveillance Robot with Wireless Connectivity descries the functional block diagram.

3.3 Functional Block Diagram

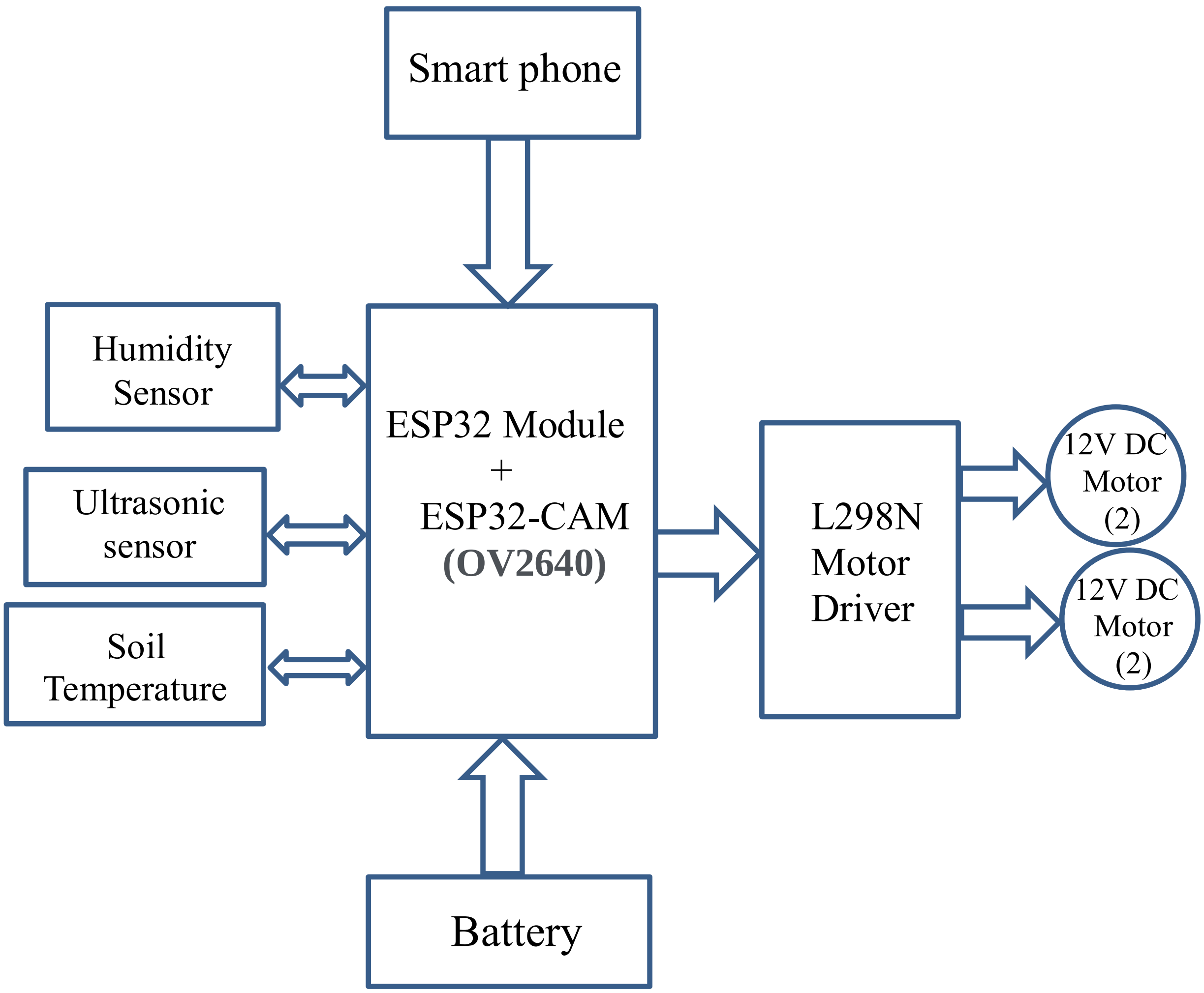

Fig: 3.1 Multi-Sensor Surveillance Robot with Wireless Connectivity

3.4 Hardware Description

The implementation of intelligent management for surveillance processes incorporates a range of carefully selected hardware components to ensure robust and efficient operation. These components collectively contribute to the system's ability to gather, process, and transmit data, enabling real-time insights and informed decision-making.

3.4.1 ESP32-CAM

The ESP32-CAM is a versatile and compact development board that integrates an ESP32 microcontroller and a camera module. It enables image and video capture, processing, and transmission. The ESP32-CAM's computational capabilities also enable the execution of AI algorithms for image analysis and object recognition. Fig 3.2 describes the ESP32-CAM.

Fig: 3.2 ESP32-CAM

3.4.2 ESP32

The ESP32 microcontroller serves as the central processing unit of the surveillance system. It provides computational power, memory, and connectivity options for data processing, communication, and control. The ESP32's Wi-Fi and Bluetooth capabilities facilitate wireless communication with remote control stations, enabling real-time data transmission and control commands. Fig 3.3 describes the ESP32 Microcontroller.

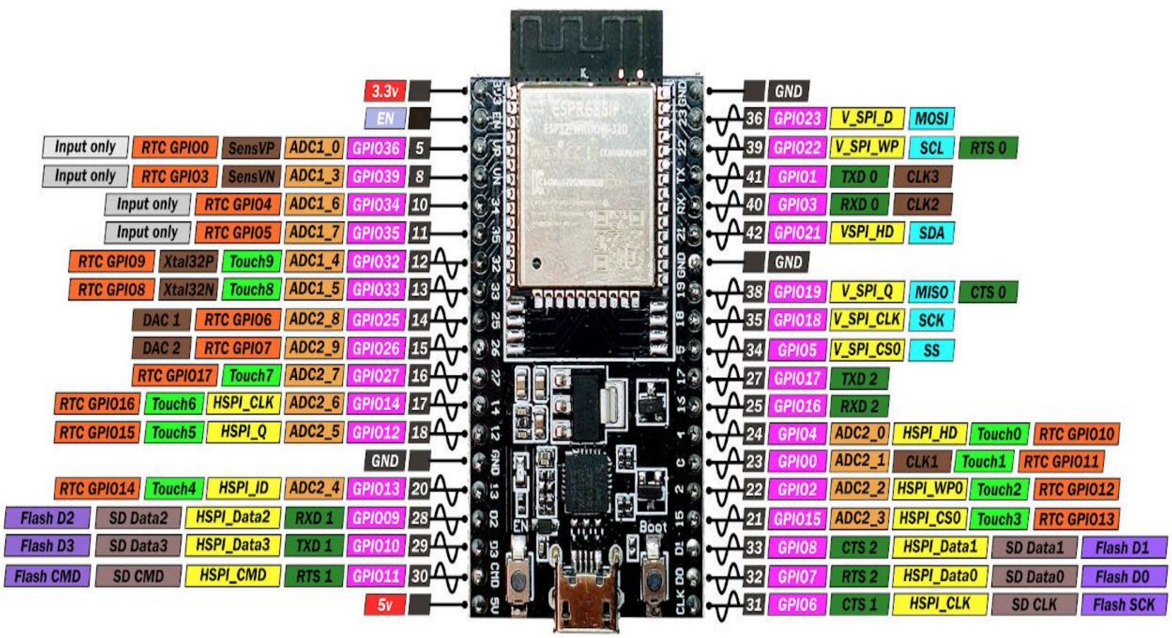

Fig: 3.3 ESP32 Microcontroller

3.4.3 Temperature Sensor

The inclusion of a temperature sensor enhances the surveillance system's environmental awareness. This sensor measures ambient temperature, providing crucial data for assessing potential fire hazards, identifying abnormal temperature fluctuations, and optimizing surveillance strategies based on temperature patterns. Fig 3.4 describes the Temperature sensor.

Fig: 3.4 Temperature sensor

3.4.4 Humidity Sensor

A humidity sensor adds another layer of environmental data to the system. It measures relative humidity, helping to detect conditions conducive to mold growth, corrosion, or other environmental risks. Integrating humidity data enhances the system's ability to respond to moisture-related issues promptly. Fig 3.5 describes the Humidity sensor.

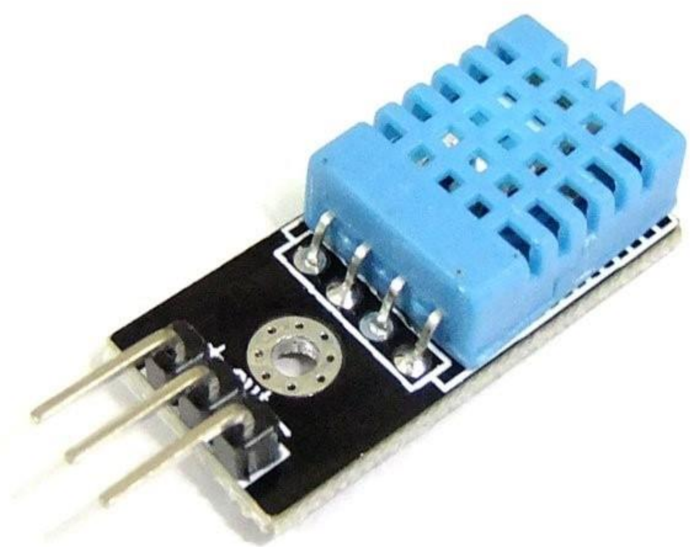

Fig: 3.5 Humidity sensor

3.4.5 Ultrasonic Sensor

An ultrasonic sensor facilitates proximity detection and obstacle avoidance. It emits ultrasonic waves and measures the time taken for the waves to bounce back after hitting an object. This capability enhances the surveillance robot's navigational abilities, enabling it to detect and avoid obstacles in its path. Fig 3.6 describes the Ultrasonic Sensor.

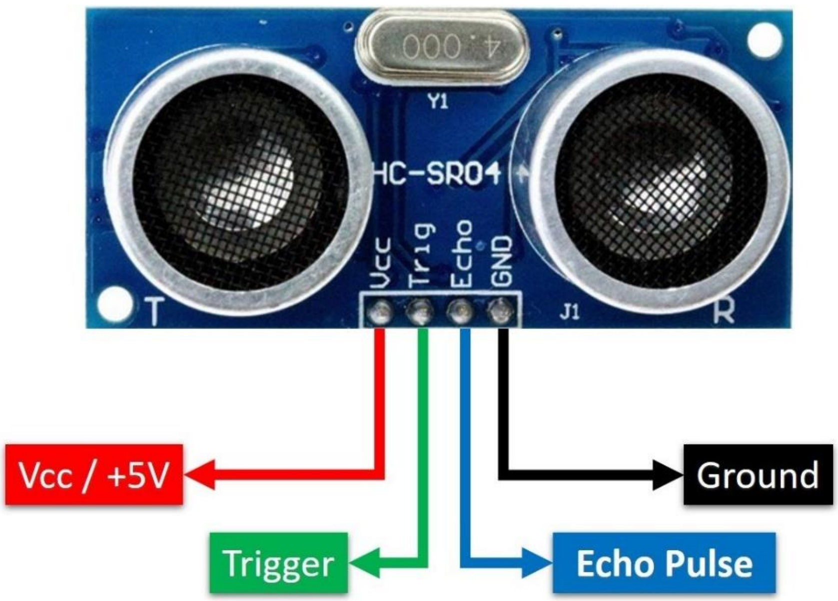

Fig : 3.6 Ultrasonic Sensor

3.4.6. Power Supply

A reliable power supply is essential for continuous surveillance operations. Depending on the system's mobility and application, this could involve rechargeable batteries, solar panels, or a combination of power sources. Ensuring uninterrupted power is crucial to maintain the system's functionality and data transmission.

3.4.7.L298N Motor Driver

The L298N motor driver is a popular integrated circuit used to control the speed and direction of DC motors. It serves as the bridge between the microcontroller (such as the ESP32) and the motors, providing the necessary voltage and current regulation to ensure smooth motor operation. The L298N typically supports two motors, making it suitable for differential drive or tank-like robot configurations.

The motor driver offers bidirectional control, allowing the robot to move forward, backward, turn left, and turn right. It also supports pulse-width modulation (PWM) for speed control, enabling the robot to move at varying speeds with precision. Fig 3.7 describes the L298N Motor Driver.

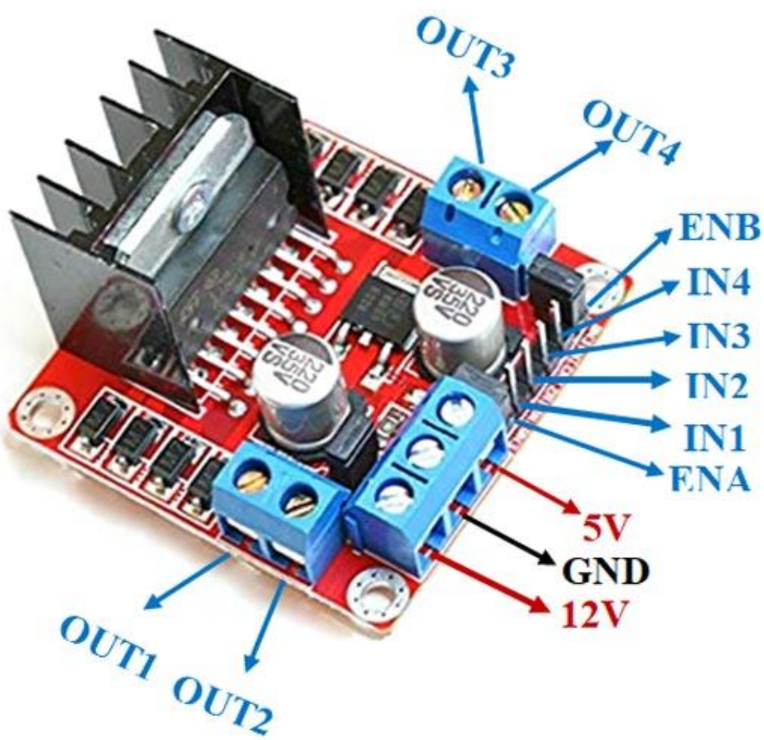

Fig:3.7 L298N Motor Driver

3.4.8 Motor

Motors are the driving force behind the surveillance robot's movement. Depending on the robot's size, weight, and intended application, different types of motors can be used, such as DC motors or geared motors. These motors convert electrical energy into mechanical motion, propelling the robot and enabling it to navigate its surroundings. Fig 3.8 describes the DC Motors.

Fig :3.8 DC Motors

By integrating these hardware components, the intelligent management system for surveillance processes gains the ability to capture diverse environmental data, process it using AI algorithms, and communicate results in real-time. The synergy between these hardware elements contributes to a comprehensive and adaptable surveillance solution that can be tailored to various scenarios, ranging from indoor security to outdoor environmental monitoring.

3.5 Software Description

The software requirements of the projects are follows

3.5.1 Arduino IDE (Integrated Development Environment)

The Arduino IDE is a software platform used for programming and developing applications for Arduino microcontrollers. It provides a user-friendly interface for writing, compiling, and uploading code to Arduino boards. Some key features of the Arduino IDE include:

Code Editor: Allows you to write and edit your Arduino code.

Compiler: Compiles your code into machine-readable instructions for the Arduino board.

Uploader: Uploads the compiled code to the Arduino board.

Library Manager: Provides access to a wide range of pre-built libraries for various sensors and modules.

Serial Monitor: Allows communication between the Arduino and your computer, enabling you to monitor sensor data and debug your code.

3.5.2 HTML Coding (Hypertext Markup Language)

HTML is the standard markup language used to create the structure and content of webpages. It consists of a series of elements and tags that define the layout, text, images, links, and other elements on a webpage. Some key points about HTML:

Structure: HTML provides a way to structure your content using elements like headings, paragraphs, lists, tables, and more.

Tags: HTML tags are used to define and format different elements on the webpage. They are enclosed in angle brackets (< >).

Attributes: Tags can have attributes that provide additional information or settings for the element.

Hyperlinks: HTML allows you to create hyperlinks to link to other webpages or resources.

Forms: HTML forms enable user input and interaction on webpages, such as text input, buttons, and checkboxes.

3.5.3 Web Server

A web server is software that serves web content to users over the internet. It processes incoming requests from web browsers and responds by delivering the requested files or generating dynamic content. Key components of a web server include:

HTTP Protocol: Web servers use the Hypertext Transfer Protocol (HTTP) to communicate with web browsers and clients.

Request Handling: Web servers receive and process HTTP requests, which can include requests for HTML files, images, scripts, and more.

Response Generation: Based on the request, the web server generates and sends back the appropriate HTTP response, which can include HTML, CSS, JavaScript, and other assets.

Dynamic Content: Some web servers support server-side scripting languages (e.g., PHP, Python, Node.js) to generate dynamic content before sending it to the client's browser.

3.6 SUMMARY

This chapter deals with the component details of the system employed for surveillance system using wireless connectivity. The various steps involved in the hardware and the software process are being discussed. In this project the surveillance is done through the control of ESP32-CAM and means of the sensor and data information displayed on the web server.

CHAPTER 4
PROPOSED SURVEILLANCE SYSTEM

4.1 Introduction

In this chapter it deals with ESP32-CAM and L298N motor driver in smart surveillance of the proposed system along with its hardware description.

4.2 Surveillance System

The system combines an ESP32 microcontroller with a camera module to capture images or record videos. With built-in Wi-Fi capabilities, it can stream live footage and transmit data wirelessly.

The ESP32-CAM's processing power enables image processing tasks, such as face detection or object recognition.

This surveillance system can be integrated with motion sensors and motor drivers for pan and tilt functionality, making it suitable for remote surveillance and monitoring in various settings.

4.3 Program Flow of Surveillance System

The ESP32-CAM microcontroller can control the motors speed and direction by sending appropriate signals to the L298N motor driver. The ESP32 generates PWM signals to control the motor speed, and digital signals control the motor direction.

The ESP32-CAM module can be mounted on a platform alongside the L298N motor driver and motors. This enables the camera to be moved or rotated based on motor control commands.

The entire system can be wirelessly controlled using Wi-Fi communication enabled by the ESP32-CAM. This allows for real-time monitoring and control of the camera's movement remotely, making it suitable for applications like surveillance or remote inspection.

ESP32-CAM and L298N motor driver creates a powerful platform for integrating camera capabilities with motor control functionalities. The ESP32-CAM's image processing capabilities and wireless communication make it an ideal choice for remote monitoring and control, while the L298N motor driver allows precise movement and positioning of the camera for various applications. Fig 4.1 describes the program flow of surveillance system.

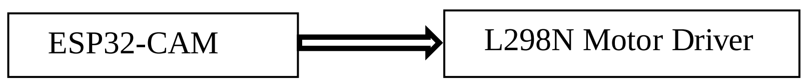

Fig: 4.1 Program Flow of Surveillance System

4.4 Interfacing L298N Motor Driver with ESP32-CAM

The ESP32-CAM is interfaced with the L298N motor driver by connecting GPIO pins for motor direction and PWM-based speed control. The ESP32-CAM controls the motors by sending appropriate signals to the L298N driver through these GPIO pins. By programming the ESP32-CAM, you can control the motors' speed and direction, enabling pan and tilt functionality for the camera.

The L298N motor driver receives these signals and powers the connected DC motors accordingly, allowing for smooth and precise camera movement. Integrating the ESP32-CAM and L298N motor driver on a platform facilitates remote control of the camera's movements, making it an ideal setup for surveillance and monitoring applications. The method of Interfacing L298N Motor Driver with ESP32-CAM explain in fig 4.2.

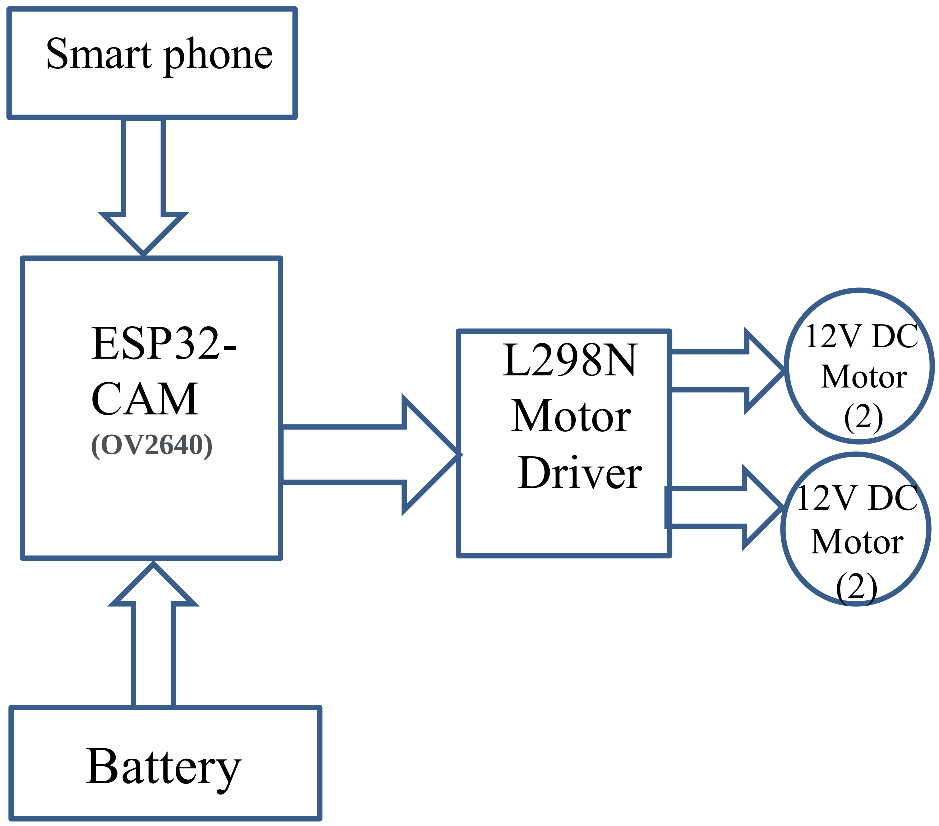

Fig: 4.2 Interfacing L298N Motor Driver with ESP32-CAM

4.5 Summary

The integration of ESP32-CAM with the L298N motor driver enables seamless control over camera movements for surveillance and monitoring applications. By connecting the appropriate GPIO pins between the two components, the ESP32-CAM can effectively send signals to the L298N to control the motors' direction and speed.

This setup enables pan and tilt functionalities, allowing precise movement of the camera in both horizontal and vertical directions. With this powerful combination mounted on a platform, the ESP32-CAM and L298N facilitate remote manipulation of the camera, making it an ideal solution for various surveillance and monitoring tasks.

CHAPTER 5
PROPOSED SENSOR SYSTEM

5.1 Introduction

This chapter deals with the measurement of Humidity, Temperature of the Soil and distance of the obstacles. For these measurements the Soil Temperature sensor (DS18B20), Humidity sensor (DTH11), Ultrasonic sensor (HC-SR04).

5.2 Sensor System

The described system is designed for measuring the humidity, temperature of the soil, and distance to obstacles using multiple sensors, all controlled by the ESP32 Wi-Fi module.

The Soil Temperature sensor (DS18B20) is utilized to measure the soil temperature accurately at the root level. The Humidity sensor (DHT11) provides readings of soil humidity, enabling proper irrigation and preventing over or under-watering in agricultural and gardening applications. The Ultrasonic sensor (HC-SR04) measures the distance to obstacles or objects above the ground, facilitating obstacle avoidance in various scenarios.

The ESP32 Wi-Fi module acts as the central processing unit, collecting data from the sensors and processing the measurements. Its Wi-Fi capabilities enable communication with other devices and the cloud, allowing for remote monitoring and control. The system's versatility finds applications in precision agriculture, smart gardening, environmental monitoring, and autonomous robotics, where real-time data on soil conditions and obstacle detection are critical for efficient operations. With its wireless connectivity and efficient sensor integration, the system becomes a valuable tool for modern agricultural and IoT application.

5.3 Flow of Sensor system

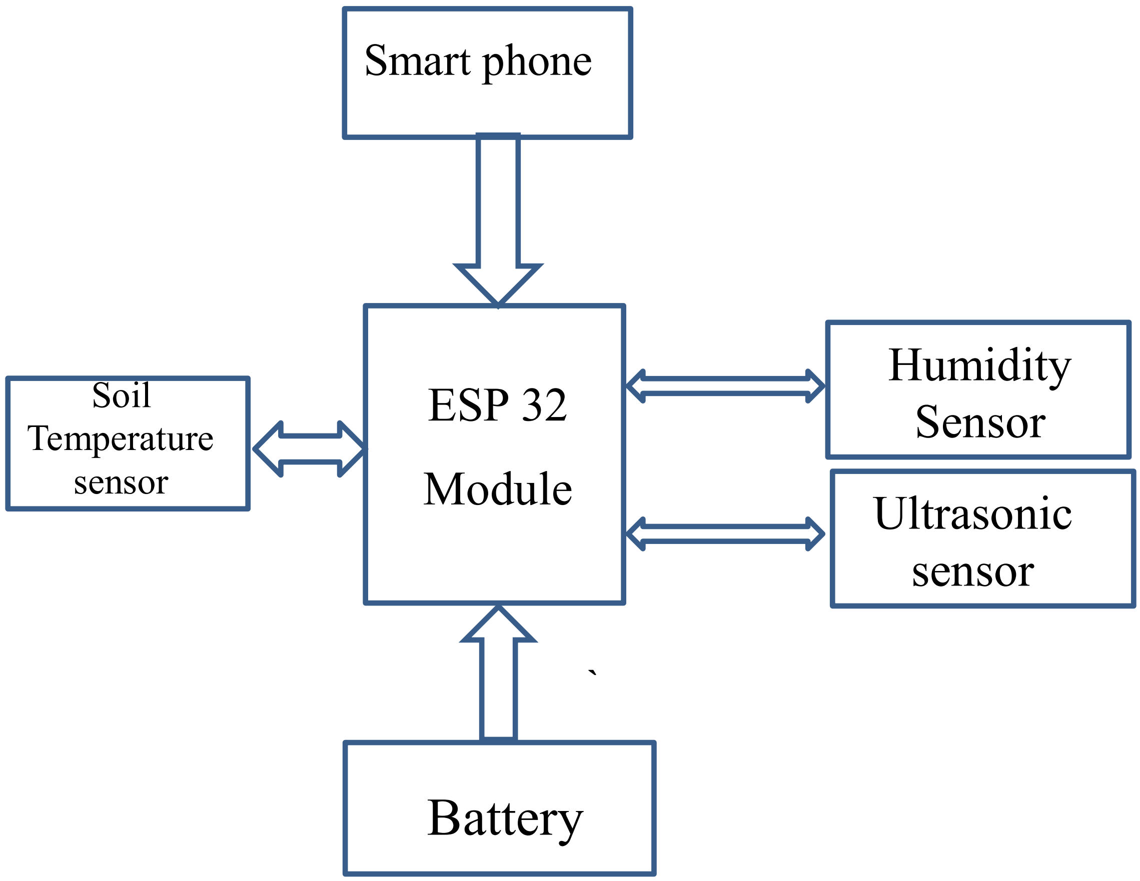

Fig: 5.1 Flow of Sensor System

Once initialized, the program reads data from each sensor sequentially. The DS18B20 provides temperature readings, the DHT11 provides humidity and temperature readings, and the HC-SR04 measures obstacle distance. The obtained sensor data is then processed, which may involve calibration or unit conversion based on sensor specifications or application requirements. Fig 5.1 denotes the flow of sensor system.

After processing, the ESP32 Wi-Fi module wirelessly communicates the sensor data to other devices or the cloud. The data can be transmitted to a local server, IoT platform, or cloud service for further analysis, visualization, or storage.

The sensor system can be configured for real-time monitoring, continuously looping through the sensor reading and communication steps, providing up-to-date information on soil temperature, humidity, and obstacle distance.

5.4 Interfacing Sensors with ESP32

Interfacing the ESP32 with the Soil Temperature sensor (DS18B20), Humidity sensor (DHT11), and Ultrasonic sensor (HC-SR04) enables a comprehensive sensing system for environmental monitoring and control. The ESP32, a versatile Wi-Fi-enabled microcontroller, acts as the central control unit for these sensors.

The DS18B20, a digital temperature sensor, provides accurate soil temperature readings at the root level, essential for precise agricultural and gardening applications.

The DHT11 humidity sensor complements the system by measuring soil moisture, aiding in optimal irrigation management and plant health. The HC-SR04 Ultrasonic sensor contributes to the system's versatility, providing distance measurements for obstacle detection, crucial for autonomous robotics or environmental monitoring.

Together, this integrated sensor setup allows for real-time data collection, remote monitoring, and precise control, making it an invaluable tool in various IoT applications.

5.5 Summary

The ESP32 interfaces with the DS18B20 Soil Temperature sensor, DHT11 Humidity sensor, and HC-SR04 Ultrasonic sensor to create a comprehensive environmental monitoring system. The DS18B20 provides accurate soil temperature readings, while the DHT11 measures soil moisture for optimal irrigation management. The HC-SR04 enables obstacle detection through distance measurements. With the ESP32 as the central control unit, the system offers real-time data collection, remote monitoring, and precise control, making it valuable for IoT applications.

CHAPTER 6
RESULTS AND DISCUSSION

6.1. Sensor Unit

In this chapter the sensors output is given such that they are placed in land and with the variations observed, the parameters have been observed.

6.2 IoT Based Surveillance System

Here the various sensors are placed at the land to be monitored. The sensors output is displayed in webserver. Fig 6.1 describes the Experimental Setup.

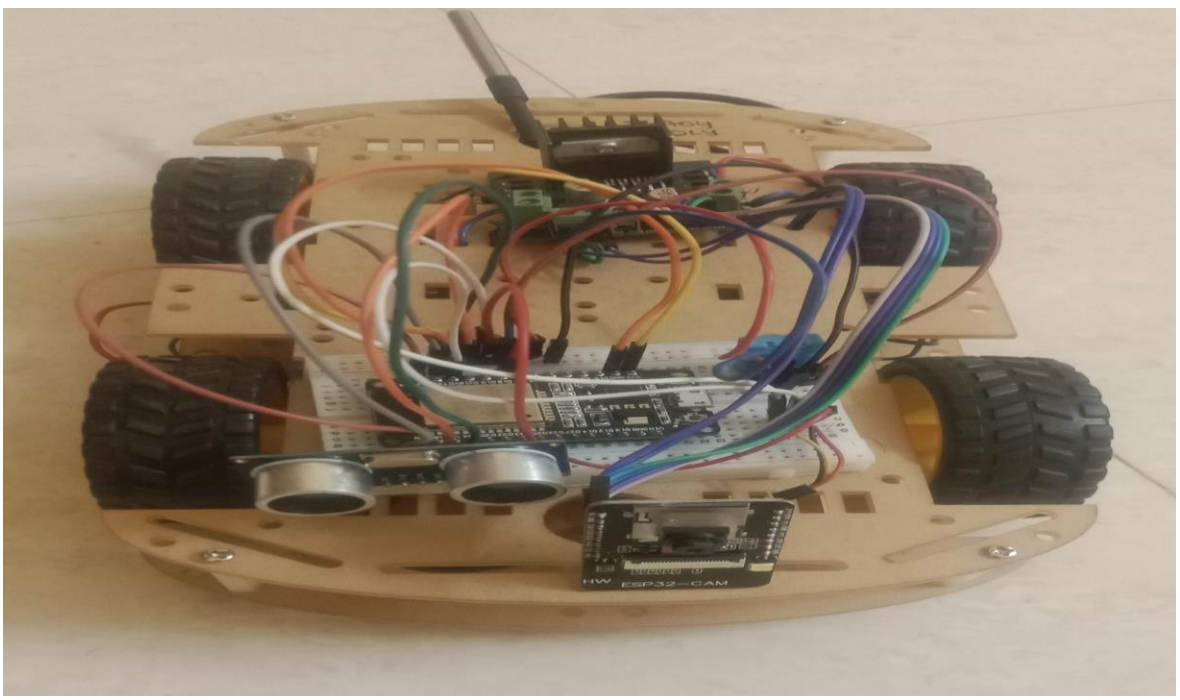

Fig: 6.1 Experimental Setup

With the help pf the sensors, first the sensed readings will be notified in the user's device then the whole circuit is controlled on the basis of the need of the user.

This implementation is demonstrate the sensor system in surveillance robot. This project features a sensor network designed to provide real-time environmental sensing capabilities. The network incorporates the DS18B20 Soil Temperature sensor, DHT11 Humidity sensor, and HC-SR04 Ultrasonic sensor, enabling accurate measurements of soil temperature, soil moisture, and distance to obstacles. With the ESP32 serving as the central control unit, the system offers seamless data collection, remote monitoring, and precise control, making it a valuable solution for diverse IoT applications.

6.3 Sensors Report on IoT

Table 6.2 Sensors Report on IoT

TEMPERATURE (℃)	**HUMIDITY (%)**
19.0	73
21.8	67
27.2	61
29	57
31.2	52
32.9	50
36.3	49

The Internet of Things is a system of interrelated computing devices, mechanical and digital machines, people with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. The reading for the designed system is shown in table 6.1.

6.4 Web Sever

A web server is established to facilitate output visualization, and to access this output, the system relies on an enabled Wi-Fi connection. The sensors transmit their readings to the ESP32 microcontroller, which then transmits the data to the web server using Wi-Fi communication. Additionally, the ESP32-CAM sends live video feeds to the web server, enabling remote surveillance from any global location. This functionality empowers users to monitor remote and inaccessible areas, thus enhancing the system's versatility and applicability.

6.5 Display of HTML Coding on Arduino IDE

The coding designed for this process is fed into the ESP32 & ESP32-CAM. The respective file location of program is selected and run the coding program as in the Figure 7.2 to achieve the sensor output as per the program present in the master source. The code can be easily modified and altered as the changes needed.Fig 6.3 describes the Display of HTML Coding on Arduino IDE.

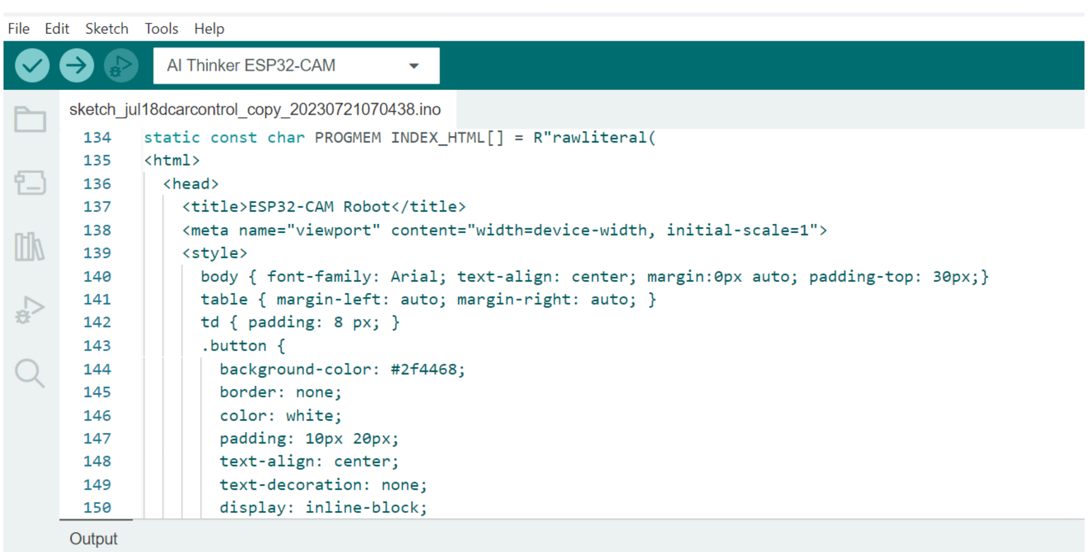

Fig: 6.3 Display of HTML Coding on Arduino IDE

6.6 Sensor Reading on Web Server

Fig: 6.4 Sensor Reading on Web Server

As various sensors are used for determining the results then the sensor reading are obtained from various sensors at various typical conditions and at various readings and it is displayed in the web server as in the Fig 6.4.

6.7 Surveillance System on Webserver

The robot underwent extensive testing at various locations to evaluate video quality and motion control. The robot demonstrated smooth movement in the correct direction, and the video captured exhibited satisfactory clarity and resolution. The results of the robot's motion are visually represented in Fig 6.5.

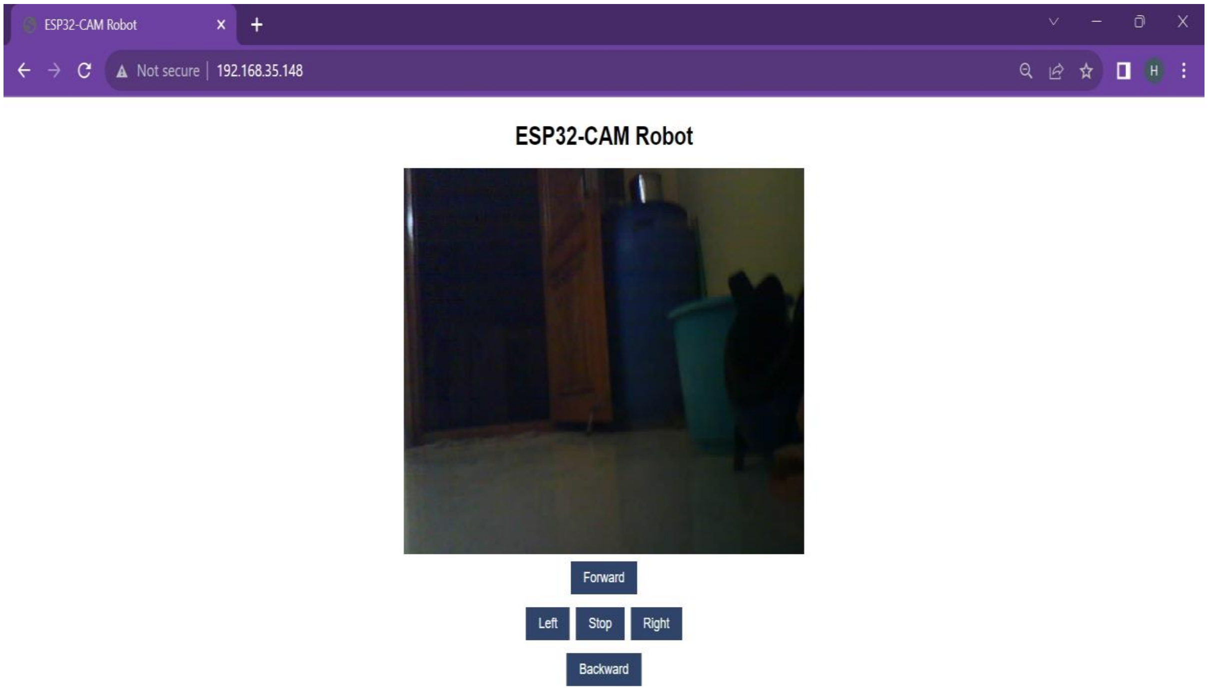

Fig: 6.5 Surveillance System on Webserver

6.8 Summary

The chapter deals with the results obtained from proposed Surveillance Robot through the help of various sensors and the web server. This surveillance practice was introduced for long distant monitoring of the field in an automated manner.

CHAPTER 7
CONCLUSION AND FUTURE WORK

7.1 Conclusion

The multi-sensor surveillance robot with wireless connectivity has proven to be a highly capable and efficient solution for real-time monitoring and surveillance applications. The integration of multiple sensors, including environmental sensors, temperature sensors, and motion sensors, allows the robot to gather comprehensive data about its surroundings. The wireless connectivity enables remote control and data transmission, making it ideal for surveillance in hard-to-reach or hazardous areas.

Throughout the project, the robot demonstrated reliable performance in various testing scenarios, showcasing its ability to navigate autonomously and capture high-quality video footage. The seamless wireless communication facilitated efficient data transfer and remote monitoring, enhancing its usability and versatility.

Moreover, the robot's intelligent decision-making, based on sensor inputs, ensured effective obstacle avoidance and precise navigation. The successful implementation of the wireless connectivity, combined with the multi-sensor capabilities, establishes this robot as a valuable asset for surveillance, security, and environmental monitoring applications.

In the future, further enhancements could be explored, such as integrating advanced AI algorithms for object recognition and autonomous decision-making, thereby elevating the robot's capabilities to new levels. Overall, this project represents a significant step towards developing sophisticated and technologically advanced surveillance robots with wireless connectivity for real-world applications.

7.2 Future Work

1. Implement AI-based object recognition and tracking for improved surveillance capabilities.
2. Develop autonomous navigation and mapping algorithms for efficient and obstacle-free movement.
3. Explore cloud integration for offloading data processing and enabling real-time remote monitoring.
4. Improve wireless communication for higher data rates and longer-range connectivity.
5. Optimize energy efficiency to extend the robot's operating time.
6. Investigate multi-robot coordination for collaborative surveillance in larger areas.
7. Design a weatherproof robot to operate in various environmental conditions.
8. Integrate additional sensors, such as gas sensors or thermal imaging cameras, for specialized surveillance applications.
9. Develop a user-friendly interface for remote control and real-time video streaming.
10. Collaborate with emergency services or security agencies for tailored surveillance solutions.

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