A Report on

Surveillance Robot using ESP32 CAM

For

Mini Project-2A Embedded System Project (ECM-501) of Third Year (Semester-V)

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CERTIFICATE

This is to certify that Tojas Bharambe,Karan Bhardwaj ,Pratik Chauhan, Rishabh Chauhan and Neeraj Chaurasia are the bonafide students of St. Francis Institute of Technology, Mumbai. They have successfully carried out the project titled "Surveillance Robot using ESP32 CAM" in partial fulfilment of the requirement for the award of Mini project 2A of third year (Semester-V), in Electronics and Telecommunication Engineering of Mumbai University during the academic year 2023-2024. The work has not been presented elsewhere for the award of any other degree or diploma prior to this.

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Principal

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Signatures of all the students in the group

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ABSTRACT

In an ever-evolving world where security and surveillance play pivotal roles in ensuring safety and efficiency, the development of innovative technologies has become imperative. The Surveillance Robot project presented herein leverages the ESP32-CAM module, a versatile and cost-effective solution for capturing images and videos, to create a mobile surveillance platform. This project aims to design, build, and demonstrate a robust surveillance robot that combines the power of the ESP32-CAM with various sensors, enabling real-time monitoring, remote control, and autonomous operation. By harnessing the capabilities of this compact yet powerful module, our surveillance robot promises to provide a flexible and efficient solution for a wide range of applications, including home security, industrial monitoring, and remote exploration. This report outlines the project's objectives, methodology, hardware and software components, as well as the anticipated impact and future enhancements of the surveillance robot.

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List of Abbreviations

V	Voltage
A	Current
GHz	Giga Hertz
KB	Kilo Bytes
°C	Degree Celsius
MW	Multi watt
ms	Milliseconds
Cam	Camera Module

Chapter 1

Introduction

Our Surveillance Robot with Cam Pan Tilt Control is an innovative solution designed to address the need for remote monitoring and surveillance. Equipped with a high-resolution camera and a pan-tilt mechanism, this robot offers dynamic control over its field of view

1.1 Motivation

In a world marked by rapid technological advancements, the need for effective surveillance and live monitoring solutions has never been greater. Our project seeks to address this imperative by harnessing the power of the ESP32-CAM module to create a versatile surveillance robot. The motivation behind this endeavor lies in the desire to enhance security, efficiency, and convenience across various domains. Whether it's safeguarding homes, optimizing industrial processes, or exploring remote environments, the capabilities of our surveillance robot have the potential to make a significant impact.

1.2 Scope of Project

Our project focuses on creating a surveillance robot using the ESP32-CAM module. The robot will be capable of remote surveillance, and real-time data transmission. Users can control it manually. We plan to include additional sensors for various applications, like home security, avoiding obstacles and environmental monitoring. A user-friendly interface will be provided for easy control, and we'll ensure reliability through thorough testing. The project is designed with future enhancements in mind, aiming to meet the demand for effective surveillance solutions in different scenarios.

1.3 Organization of Project

- Literature survey
- Software Used
- Hardware Used
- Working Principle
- Simulation and Results

Chapter 2

Literature Survey

2.1 Literature Review:

Our research focuses on the development of a versatile surveillance robot, incorporating features such as pan-tilt camera control and live streaming capabilities using the ESP32-CAM module. The following literature review encompasses three key sources that provide insights into the integration of pan-tilt mechanisms, live streaming technologies, and their relevance to our project. [**?**] . Effective surveillance relies on real-time video streaming capabilities. Research in this domain emphasizes the importance of low-latency and high-quality video transmission for applications like remote monitoring and security. Utilizing live streaming technology, our project aims to ensure that users can access and analyze surveillance data in real-time, enhancing situational awareness and response capabilities. [**?**] The operation of the surveillance robot through a mobile device offers unparalleled convenience and accessibility. Users can effortlessly control and monitor the robot remotely, granting them the ability to oversee surveillance tasks, respond to situations, and gather real-time data from virtually any location with network connectivity. This feature not only ensures flexibility but also empowers users with the capability to adapt the robot's actions promptly, making it an invaluable tool for a wide range of surveillance and monitoring applications. [**?**]. project leverages the ESP32-CAM module, known for its capacity to capture and stream video. Research shows that this module is capable of supporting live video streaming over Wi-Fi, making it a suitable choice for our objectives. Understanding the ESP32-CAM's capabilities and potential limitations is crucial to ensuring seamless live streaming functionality in our surveillance robot. By combining these literature sources, our project aspires to create a surveillance robot that not only captures images and videos but also dynamically adjusts its camera angles using a pan-tilt mechanism. This feature enhances the robot's versatility and surveillance coverage. Additionally, we aim to employ the ESP32-CAM module's capabilities for efficient and low-latency live streaming, providing users with real-time access to surveillance data.

Table 2.1: Summary of existing works on object detection

Title with Author	Work Done	Results or Remarks
Surveillance Car Bot Future of Surveillance Car Bot [Nakshtra Popli]	Surveillance Car Bot that can collect video and display the user's real-time environment.	Although these robots simply offer us with the live footage of the scene, it can't engage or offer facts about different aspects.
Surveillance monitoring using ESP32-CAM module. Author: Dr. P.D. Selvam	The theme of this project is intelligent visual surveillance systems. In recent times, we used surveillance cameras for monitoring and recording moments, but manual surveillance and real-time monitoring is one of the most important and challenging branches of computer vision, which has been widely applied in peoples' life, such as monitoring security.	By this project, we are implementing a smart surveillance system using ESP32-CAM module. So, by using this system, if an intruder is entered into the home or any suspects were walking around your home one can get an immediate alert to their mobile through SMS along with-it buzzer will generate an alarm.
Automated Guided Vehicle for Surveillance [Srinivas K]	A machine that is mounted or put on a mobile platform and can be operated according to predetermined instructions is referred to as a mobile robot	Through the use of wireless Bluetooth technology, the web server is successfully used to operate the robot

Chapter 3

Software Used

3.1 Fritzing

Fritzing is an open-source hardware initiative that makes electronics accessible as a creative material for anyone. We offer a software tool, a community website and services in the spirit of Processing and Arduino, fostering a creative ecosystem that allows users to document their prototypes, share them with others, teach electronics in a classroom, and layout and manufacture professional PCBs.

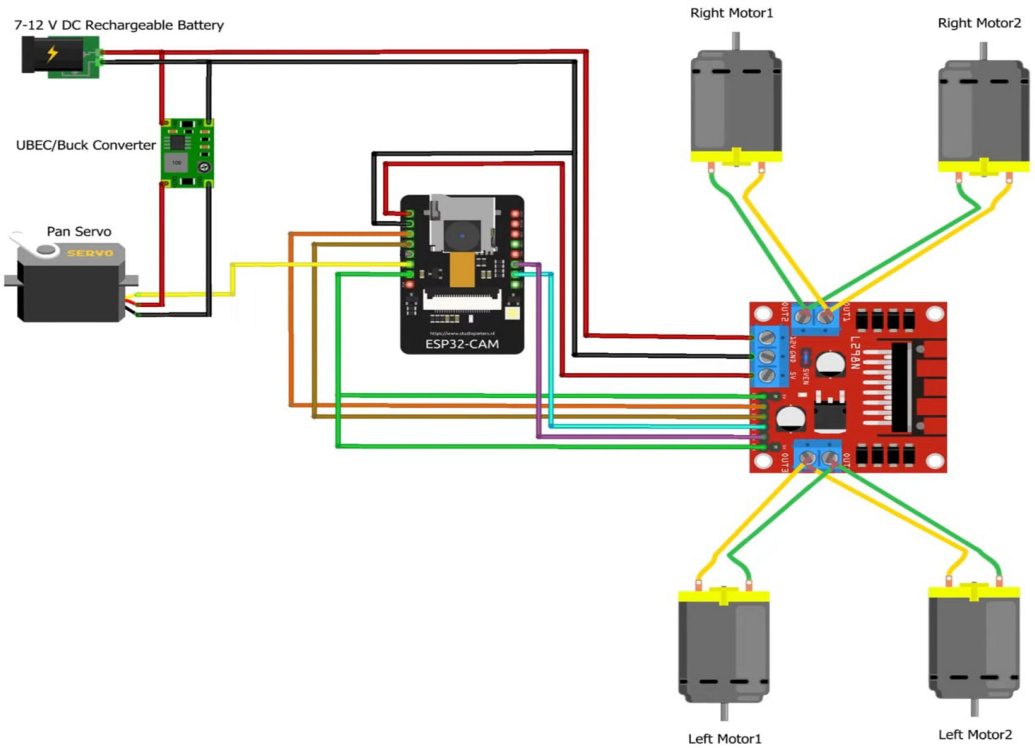

Figure 3.1: Circuit Diagram Using Fritzing Software.

3.2 Web Controller

Using this web we were controlling the moment of robot and moment of pan tilt.

Figure 3.2: Web Controller.

Chapter 4

Hardware Components Used

4.1 ESP 32 CAM MODULE:

Flash Memory: 4 MB , RAM: 520 KB SRAM , GPIO: 26 digital input/output pins , Analog Input Pins: 1 (3.3V max) , Bluetooth: Bluetooth 4.2 (Classic and BLE) , Wi-Fi: 802.11 b/g/n (2.4 GHz) with onboard antenna , Camera Sensor: OV2640 2MP CMOS image sensor , Operating Voltage: 5V DC via micro USB port or 5V pin , Camera Resolution: 2 Megapixels (UXGA 1600x1200 resolution) , Operating Temperature: -40°C to +85°C.

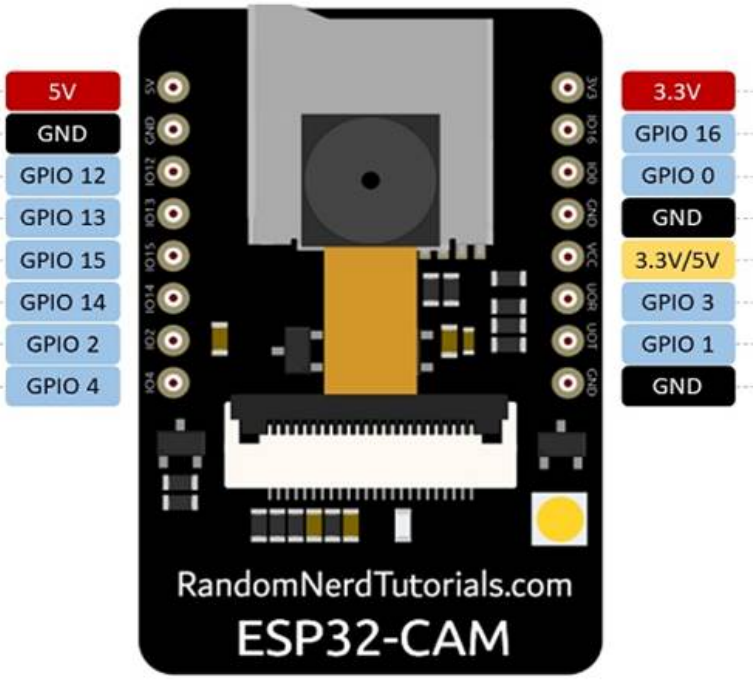

Figure 4.1: ESP 32 CAM MODULE

4.2 Motor Driver(L298N):

Motor Type: DC motors and bipolar stepper motors , Motor Voltage: 4.5V to 46V DC , Motor Current: 2A continuous (3A peak) per channel , Number of Channels: 2 H-

bridge channels , Operating Temperature: 0°C to 70°C , PWM Support: Accepts PWM signals for motor speed control , Built-in Protection: Thermal shutdown and over-current protection , Heat Sink: Recommended for high-power applications to dissipate heat , Control Logic: Four digital control inputs for full functionality (forward, reverse, and braking) , Package Options: Available in Multiwatt15 (MW15) and PowerSO20 packages.

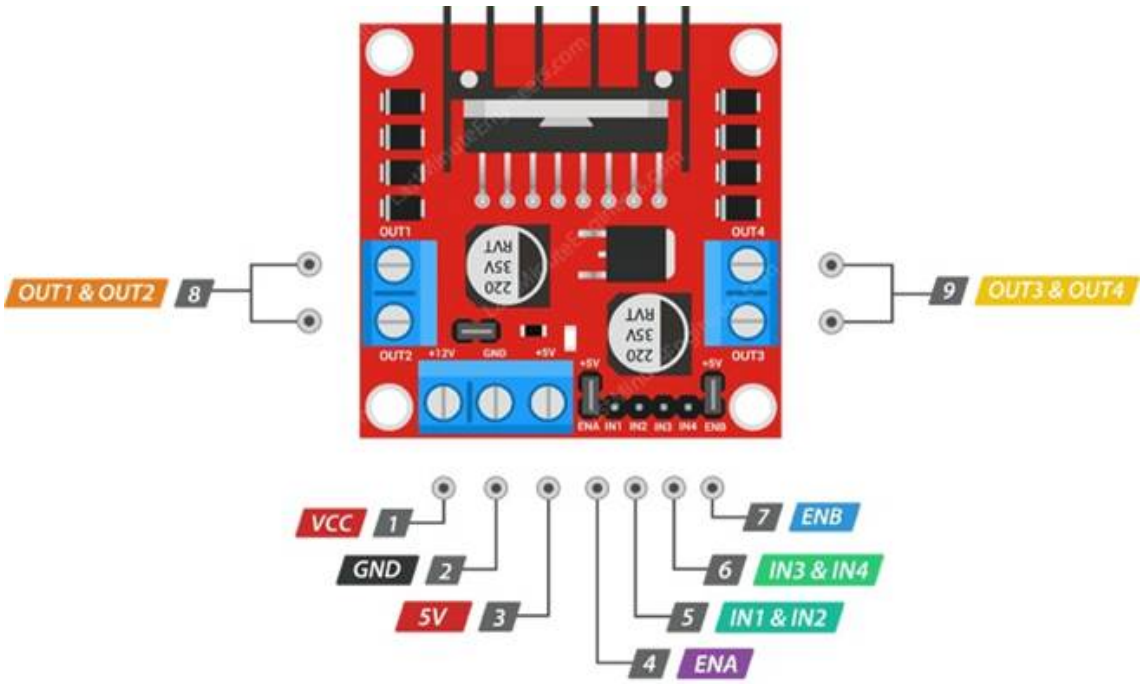

Figure 4.2: Motor Driver(L298N)

4.3 UBEC:

Universal Battery Elimination Circuit (UBEC) , Used in radio-controlled (RC) hobbies like airplanes, cars, boats , Eliminates the need for a separate receiver battery , Regulates voltage from the main power source to a stable, lower voltage , Powers the receiver and servos directly from the main battery , Simplifies setup and reduces weight in RC vehicles.

4.4 Buck Converter:

DC-DC voltage converter , Steps down higher input voltage to a lower output voltage , Uses pulse-width modulation (PWM) for voltage regulation , Highly efficient in converting voltage , Widely used in various electronic devices and power systems , Commonly found in power supplies, battery chargers, LED drivers, etc. , General-purpose voltage regulator with broad applications.

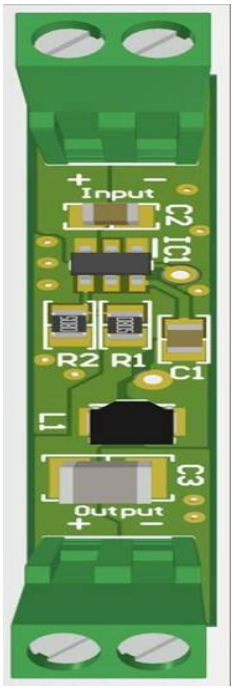

Figure 4.3: Buck Converter

4.5 Servo Motor:

Operating Voltage: 4.8V to 6V , Rotation Range: 180 degrees or 360 degrees , Size: Available in various sizes - micro, mini, standard, and large , Control Signal: Controlled using Pulse Width Modulation (PWM) signals , Torque: Typically specified in ounce-inches or kilogram-centimeters (kg-cm) , Speed: Measured in degrees per second or milliseconds per 60 degrees (ms/60°) , PWM Signal Range: Approximately 1 ms to 2 ms with a repetition rate of around 50 Hz Operating Temperature: Typically within 0°C to 70°C , Gear Type: May have plastic, metal, or hybrid gears.

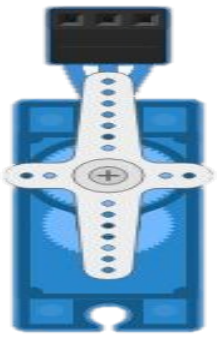

Figure 4.4: Servo Motor

Chapter 5

Working Principle

The project entails the creation of an advanced surveillance robot, leveraging the capabilities of the ESP32-CAM module. This robot is meticulously designed to be remotely controlled via a mobile device over a Wi-Fi connection, offering an exceptional level of flexibility and convenience for surveillance purposes. At its core, the robot boasts a highly sophisticated pan-tilt mechanism, elegantly driven by two servo motors. This mechanism allows for the precise control of the camera's orientation, enabling it to pan horizontally and tilt vertically.

To ensure seamless mobility, the project employs the L298N Motor Driver, a versatile motor control solution that efficiently manages four motors. These motors are strategically positioned to facilitate smooth and responsive movement, enabling the robot to navigate a wide range of terrains and environments with agility and precision.

Moreover, the project is underpinned by robust power management infrastructure. A Buck Converter and Universal Battery Eliminator Circuit (UBEC) have been integrated to effectively harness and distribute power from a 12-volt source. This design ensures a stable and reliable power supply for all components, guaranteeing uninterrupted operation throughout the robot's surveillance missions.

One of the standout features of this project is its real-time video streaming capability. The ESP32-CAM module captures high-quality video and images, which can be instantly transmitted and viewed on a mobile device. This live video streaming functionality enhances the robot's surveillance capabilities by providing users with immediate access to visual data from the robot's perspective, facilitating remote monitoring and decision-making.

Chapter 6

Results and Conclusion

6.1 Experimental Results

One of the project's notable achievements is the impressive operational range, which extends up to 100 meters. This extended reach ensures that the system can effectively cover larger areas, providing valuable insights and surveillance capabilities over significant distances.

A key highlight is the successful integration of pan and tilt functionality for camera control. This enhancement allows for precise and flexible positioning of the camera, enabling comprehensive visual data capture and surveillance adaptability.

Throughout the project's development, we encountered and successfully addressed several challenges. Notably, issues related to power management and network stability were meticulously tackled. Careful design and rigorous testing played a pivotal role in resolving these challenges, resulting in a robust and reliable system.

In summary, this project stands as a testament to our ability to create a versatile and effective solution for remote video surveillance and control. The combination of mobility, long-range operation, and advanced camera control, coupled with our problem-solving skills, positions this system as a valuable tool for various applications, with room for further improvements and enhancements in the future.

6.2 Conclusion

In conclusion, this project represents a significant achievement in the realm of wireless surveillance and remote control technology. Through the effective utilization of an ESP32-CAM, real-time video streaming, and a versatile mobile platform, We've not only created a seamless system for capturing and monitoring visual data but also gained a wealth of experience in system integration and problem-solving.

The foundation we've laid for future improvements and AI integration is particularly promising. The incorporation of artificial intelligence can open doors to intelligent decision-making and advanced capabilities, potentially revolutionizing the fields of surveillance, robotics, and beyond. This project not only serves as a testament(legal document) to your technical prowess(ability) but also as a launchpad for innovative developments in the realm of intelligent, real-time visual data processing and remote control systems. The skills and knowledge you've acquired during this endeavor position you well for tackling even more complex and impactful projects in the future.

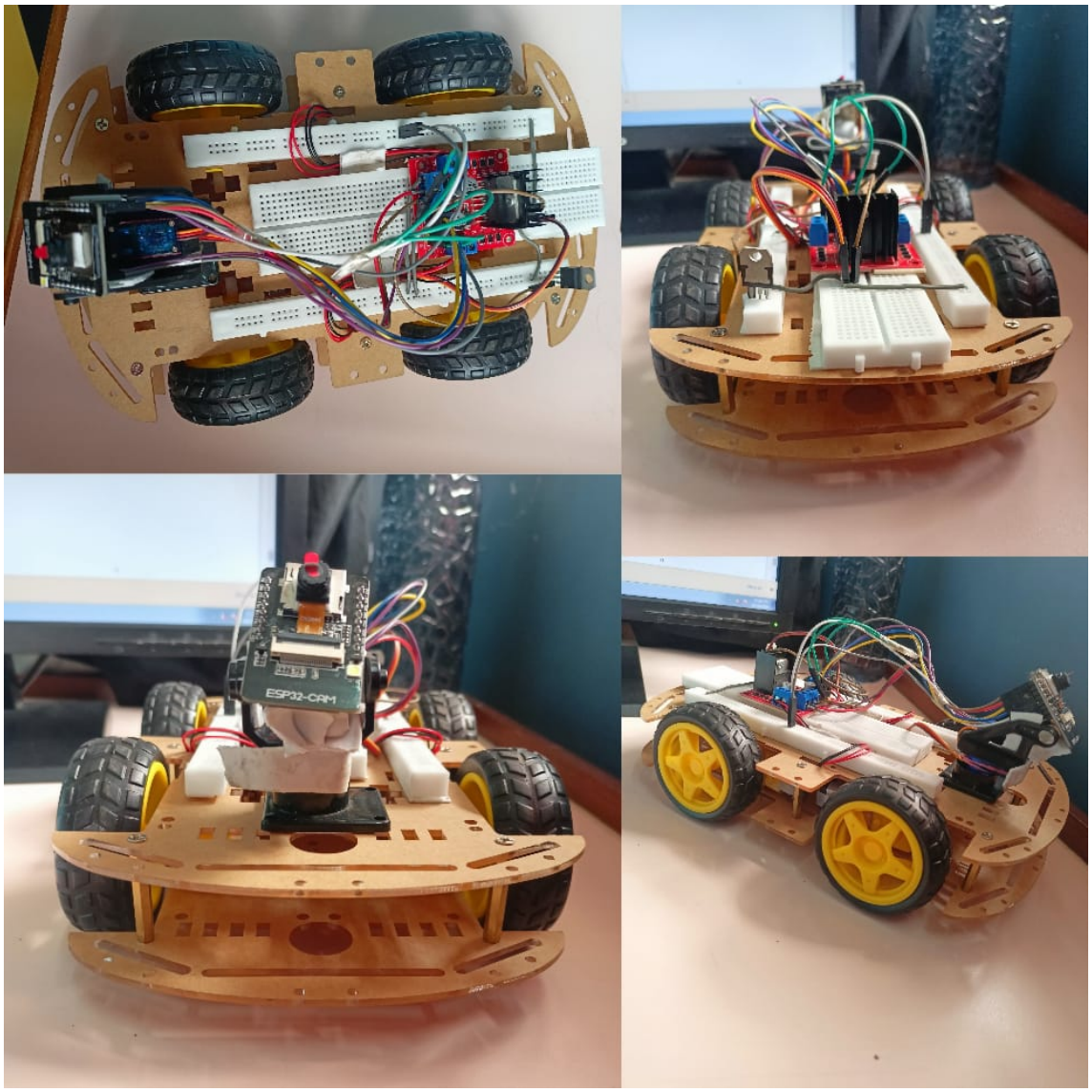

Figure 6.1: Working Model of Surveillance Robot

Bibliography

[1] Pradeeka Seneviratne , "ESP32 Deep Dive", 2018, https://www.amazon.com/ESP32-Deep-Dive-Pradeeka-Seneviratne-ebook/dp/B079H1XK8L

[2] Rui Santos, "ESP32 Camera Web Server - Surveillance Camera" , 2021, https://randomnerdtutorials.com/esp32-cam-video-streaming-web-server-camera-home-assistant/

[3] C.S.G. Lee, K. S. Fu, R.C. Gonzalez, and C.S.G. Lee, "Robotics: Control, Sensing, Vision, and Intelligence" , 1987, it provides a solid foundation in robotics principles, which can be applied to your surveillance robot project, including tilt functionality.