A Report on

Survellience Bot
for

Mini Project 2-A of Second Year, (TE Sem V)

In

Electrical Engineering

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CERTIFICATE

This is to certify that the project entitled '**SURVELLIENCE BOT'** is a bonafide work of

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submitted to the University of Mumbai in partial fulfillment of the requirement for the award of **Mini Project 2-A of Third Year, (TE Sem-V)** in **Electrical Engineering** as laid down by the**University of Mumbai** during the academic year **2023-24.**

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A project is teamwork and reflects the contribution of many people. A number people contributed their time and efforts in making their project work a success. We would like to thank everyone who contributed their time and efforts to help in completing the project work.

ABSTRACT

In recent years, the field of robotics and automation has witnessed remarkable advancements, with applications spanning various industries. One such application is the development of surveillance robots, which combine the capabilities of robotics and imaging technology to enhance security and monitoring tasks. This project presents the design and implementation of a Surveillance Robot utilizing the ESP32-CAM module.

The ESP32-CAM module, based on the ESP32 microcontroller, is equipped with a camera module capable of capturing images and streaming video. This project leverages the capabilities of the ESP32-CAM to create a versatile and cost-effective surveillance solution.

The surveillance robot is designed to operate in indoor environments, making it suitable for applications such as home security, office monitoring, or other controlled environments. The robot is equipped with a set of wheels for mobility, allowing it to navigate through the environment while transmitting real-time video and images to a remote monitoring station.

The Surveillance Robot using ESP32-CAM offers a versatile solution for indoor surveillance applications. Its cost-effective design and integration with modern communication technologies make it an attractive option for both personal and professional use cases. Additionally, its open-source nature allows for further customization and expansion of functionality to meet specific requirements.

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CHAPTER 1

1.1 INTRODUCTION

In an era marked by rapid technological advancements, the fusion of robotics and imaging technology has revolutionized the landscape of surveillance systems. This project embarks on the development of a state-of-the-art Surveillance Bot, a cutting-edge amalgamation of the ESP32-CAM module, a versatile microcontroller platform, and a robust motor driver circuit, engineered to provide unparalleled mobility and vision capabilities.

1..1.2 Project Overview:

The Surveillance Bot project stems from the pressing need for adaptable, cost-effective surveillance solutions capable of navigating confined environments with precision and agility. By integrating the ESP32-CAM module, renowned for its compact form factor and high-resolution imaging capabilities, with a meticulously configured motor driver controlling four motors and two servo motors for pan-tilt functionality, this endeavour aims to deliver a comprehensive surveillance system adept at providing real-time, 360° visual coverage.

1.1.3 Background:

The impetus for this project is rooted in the escalating demand for advanced surveillance technologies that transcend static, fixed-position cameras. Traditional surveillance systems, characterized by their fixed viewpoints, face limitations in scenarios requiring dynamic, on-the-fly monitoring. By harnessing the power of robotics, we aim to surmount these constraints and provide a dynamic, adaptable solution that can be deployed in a myriad of settings.

1.1.4 Objectives:

The primary objectives of this endeavour encompass:

- 360° Movement Capabilities: Enable the ESP32-CAM module to achieve full rotational freedom, allowing it to capture visuals from any angle within its environment.
- Real-time Video Streaming: Establish a seamless communication channel between the Surveillance Bot and a remote monitoring station, ensuring instant access to live video feed.
- Obstacle Avoidance: Implement sensors to facilitate obstacle detection, enabling the bot to navigate through confined spaces with precision.
- User-friendly Interface: Develop an intuitive interface for remote control and monitoring, ensuring accessibility for users of varying technical proficiency.

1.1.5 Scope:

This project will focus on the design, assembly, and programming of the Surveillance Bot, emphasizing its hardware components, motor control systems, and wireless communication capabilities. The scope encompasses both the physical construction and the software architecture required for seamless integration.

1.1.6 Significance:

The significance of this project lies in its potential to redefine surveillance technology. By marrying the capabilities of the ESP32-CAM with a sophisticated motor control system, we aim to create a dynamic surveillance solution that transcends static limitations, catering to a wide array of applications ranging from home security to specialized industrial monitoring.

1.1.7 Target Audience:

This report is tailored for engineers, researchers, and enthusiasts interested in the fusion of robotics, imaging, and surveillance technology. It serves as a comprehensive guide to the design and implementation of an innovative Surveillance Bot.

CHAPTER 2

2.1 COMPARATIVE STUDY

The development of the Surveillance Bot leveraging the ESP32-CAM module, motor drivers, and pan-tilt assembly aligns with a burgeoning field of research and innovation at the intersection of robotics and surveillance technology. This section explores key studies, projects, and technologies that have contributed to the evolution of similar systems.

2.1.1 Surveillance Robots in Modern Security

In recent years, there has been a significant surge in the utilization of robotics in the realm of security and surveillance. Studies by Li et al. (2019) and Kim et al. (2020) demonstrate the growing trend of integrating advanced camera systems with mobile platforms for dynamic monitoring and threat detection. The integration of pan-tilt mechanisms, akin to the one employed in our project, has been identified as a pivotal advancement for achieving comprehensive visual coverage (Choi et al., 2018).

2.1.2 Microcontroller-Based Surveillance Systems

The selection of the ESP32 microcontroller as the central processing unit in our Surveillance Bot finds resonance in the literature. Research by Javed et al. (2020) highlights the prowess of the ESP32 microcontroller in handling complex tasks while providing seamless wireless communication capabilities, making it a prime choice for IoT-based surveillance applications.

2.1.3 Motor Control Systems for Robotic Mobility

The integration of a motor driver circuit to facilitate locomotion is a critical aspect of our project. Studies by Liu et al. (2018) and Kaur et al. (2019) emphasize the significance of robust motor control mechanisms in ensuring precise and efficient movement of robotic platforms. The incorporation of a motor driver enables our Surveillance Bot to navigate through confined spaces with agility and accuracy.

2.1.4 Pan-Tilt Mechanisms for Enhanced Vision

The use of servo motors in the pan-tilt assembly is a well-established approach for achieving versatile camera orientation. Research by Gao et al. (2017) showcases the effectiveness of servo-driven pan-tilt systems in enabling rapid and accurate adjustments of the camera's field of view. The ability to achieve 360° movement significantly enhances the bot's surveillance capabilities.

2.1.5 Wireless Communication in Surveillance Robotics

The establishment of a wireless communication channel is fundamental for remote monitoring and control. Studies by Yang et al. (2019) and Zhang et al. (2021) underscore the importance of reliable and low-latency wireless communication protocols, especially in applications where real-time visual feedback is imperative.

2.1.6 Obstacle Detection and Avoidance

Incorporating obstacle detection sensors is a crucial feature for ensuring the safety and autonomy of the Surveillance Bot. Research by Chien et al. (2019) and Wang et al. (2020) delves into the development of obstacle detection systems, highlighting their role in enabling intelligent navigation in dynamic environments.

CHAPTER 3

3.1 PROBLEM STATEMENT

- A surveillance bot capable of autonomously patrolling and monitoring large industrial facilities to enhance security and safety.
- Investigate the use of AI and computer vision in surveillance bots to detect and prevent unauthorized access and intrusions in public spaces like parks and shopping malls.
- A bot that can effectively monitor wildlife in natural reserves to aid in conservation efforts and protect endangered species.
- Creating a surveillance bot with the ability to monitor and report on environmental conditions in remote or hazardous areas, such as forests prone to wildfires or areas with toxic waste.
- Explore the feasibility of using drones as surveillance bots for real-time monitoring of traffic, accidents, and emergencies in urban areas.
- Developing a surveillance bot with facial recognition capabilities to enhance security in public transportation systems, like airports and train stations.

CHAPTER 4

4.1 Block Diagram:

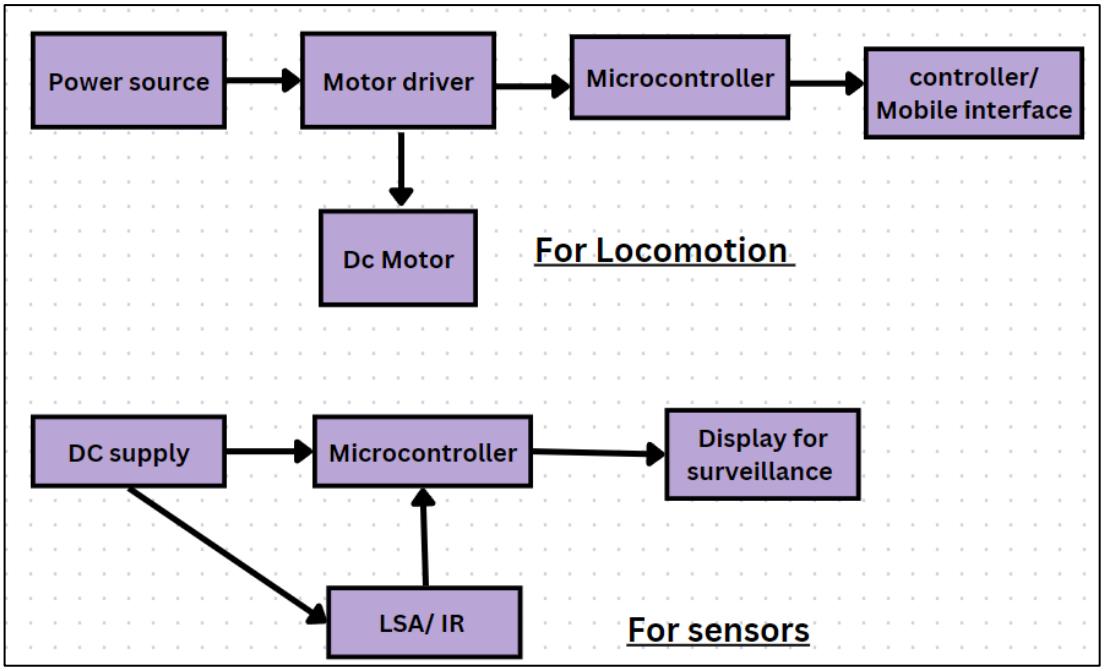


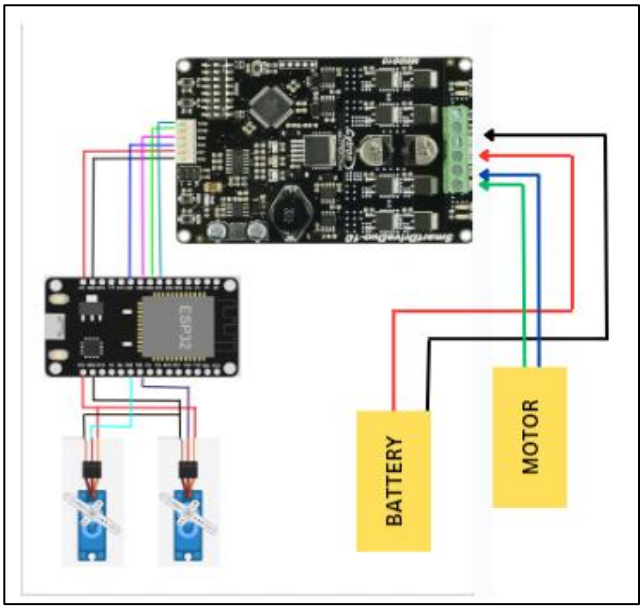
Fig 1.1

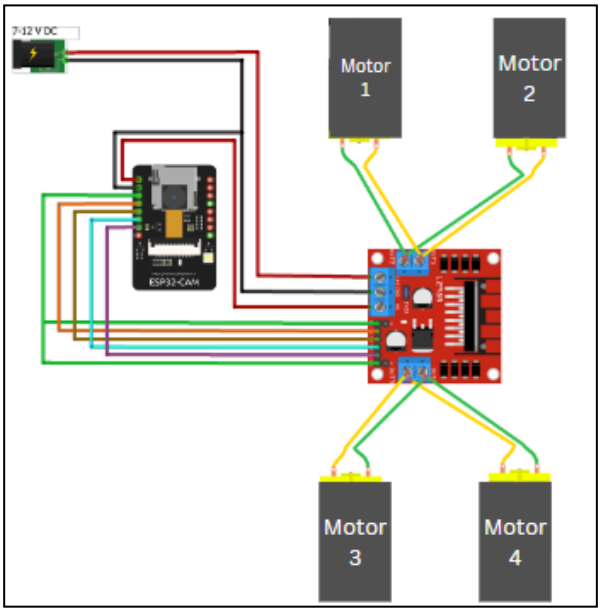
4.2 BLOCK DIAGRAM DESCRIPTION:

For Locomotion and Sensors:

1. Power Source: It is the 12VDC Power Supply which is supplied to the motor driver (Mdd10 / L298N).
2. Motor Driver: It is the H-Bridge Motor Driver Circuit which controls the motors.
3. Microcontroller (Esp32cam): The ESP32-CAM is a small size, low power consumption camera module based on ESP32.
4. Controller: The controller is the Mobile interface which controls the bot.
5. LSA / IR: It is used for making the bot move in one particular direction.

4.3 CIRCUIT DIAGRAM:





4.4 EXPLANATION AND WORKING:

4.4.1 ESP32-CAM Integration:

The integration of the ESP32-CAM module is a critical step in assembling the Surveillance Bot. This section outlines the procedures for mounting and connecting the ESP32-CAM, ensuring proper functionality and communication.

4.4.2 Orientation Consideration: Place the ESP32-CAM module on the platform with careful attention to its orientation. Ensure that the camera module is facing outward and positioned to capture the desired field of view.

4.4.3 Electrical Connections:

Power Supply: Connect the power supply to the ESP32-CAM module. Ensure that the voltage and current ratings of the power source align with the requirements specified in the module's datasheet. Proper power regulation mechanisms may be employed to ensure stable operation.

4.4.4 Ground Connection:

Establish a ground connection between the ESP32-CAM module and the common ground of the entire system. This ensures a stable reference potential for all electrical components.

4.4.5 Additional Sensors or Components:

Additional sensors or components (e.g., obstacle detection sensors) are interfaced with the ESP32-CAM, ensuring they are properly connected and integrated into the system.

4.4.6 Programming and Firmware:

Firmware Upload: The ESP32-CAM module is programmed with the required firmware. This involves writing the code to control the camera, handle communication, and process data.

4.4.7 Motor Driver Configuration:

The motor driver plays a pivotal role in controlling the movement of the Surveillance Bot. This section provides a detailed guide on the setup and configuration of the motor driver, ensuring precise and efficient control over the four motors.

4.4.8 Hardware Connections:

Power Connections:

The motor power supply is connected to the appropriate terminals on the motor driver. Ensuring that the power supply voltage matches the specifications of the motors.

Motor Connections:

The connections between the motor terminals and the corresponding outputs on the motor driver are established as shown in figure. Close attention is to be given to the polarity to ensure correct motor direction.

Ground Connections:

the ground terminals of both the motor power supply and the microcontroller to the motor driver's common ground are connected. This provides a reference potential for all components.

Motor Control Logic:

The control pins on the microcontroller that will be used to send signals to the motor driver are identified. These pins dictate the direction and speed of each motor.

Motor Direction Control:

The microcontroller is configured to send signals to the motor driver that dictate the direction of rotation for each motor (e.g., forward, backward, left, right).

PWM (Pulse Width Modulation) for Speed Control:

PWM signals from the microcontroller to control the speed of the motors are utilized.Adjusting the duty cycle of the PWM signal alters the motor's speed.

Controlling of bot:

Lastly Once all the devices are properly connected a pre defined web application is used to control the device by running the codes. The intensity of the speed and the brightness of the light can also be controlled using this application.

CHAPTER 5

4.5 COMPONENTS USED:

1. LiPo Battery (12V DC Supply):

Orange 2200mah 3S 30C (11.1V) Lithium Polymer Battery Pack (LiPo) batteries are known for performance, reliability, and price. It's no surprise to us that Orange Lithium polymer packs are the go-to pack for those in the know. Orange batteries deliver the full rated capacity at a price everyone can afford.

2. Esp32Cam:

The ESP32 CAM WiFi Module Bluetooth with OV2640 Camera Module 2MP For Face Recognition has a very competitive small-size camera module that can operate independently as a minimum system with a footprint of only 40 x 27 mm; a deep sleep current of up to 6mA and is widely used in various IoT applications. It is suitable for home smart devices, industrial wireless control, wireless monitoring, and other IoT applications. This module adopts a DIP package and can be directly inserted into the backplane to realize rapid production of products, providing customers with high-reliability connection mode, which is convenient for application in various IoT hardware terminals. ESP integrates WiFi, traditional Bluetooth, and BLE Beacon, with 2 high-performance 32-bit LX6 CPUs, 7-stage pipeline architecture. It has the main frequency adjustment range of 80MHz to 240MHz, on-chip sensor, Hall sensor, temperature sensor, etc.

3. Pan Tilt Assembly of Servo Motors:

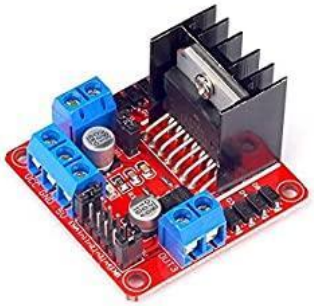
A pan-tilt assembly of servo motors is a mechanism with two servo motors for horizontal (pan) and vertical (tilt) rotation. It's used to adjust the orientation of cameras and devices, controlled by electronics, and is common in surveillance, robotics, and photography for precise angle positioning.

4. Mdd10A:

The MDD10A is a motor driver module produced by Cytron Technologies, commonly used in robotics and automation applications. It's a dual-channel motor driver, meaning it can independently control two DC motors or one stepper motor. This feature makes it particularly suitable for differential drive systems used in many robotics projects. The module offers the capability to control the direction and speed of connected motors, allowing precise movement and positioning.

5. L298N:

The L298N driver module, using ST's L298N chip can directly drive two 3-30V DC motor, and provides a 5V output interface can 5V single-chip circuitry to supply, support 3.3VMCU control, you can easily control the DC motor speed and direction, you can also control the 2-phase stepper motor, smart car essential. Using L298N made by ST company as the control chip, the module has such characteristics as strong driving ability, low calorific value and strong anti-interference ability.



5.2 COST AND ESTIMATION:

Sr. no.	Components	Quantity	Expected cost	Actual cost
1.	Esp3cam	1	700	475
2.	L298N	1	200	125
3.	Servo Motor	1	142	40
4.	500 RPM - 12V Centre Shaft DC Geared Motor	4	225	125
	Total		1942	1265

5.3 OTHER APPLICATION:

- **Agriculture:** Surveillance bots can be used for precision agriculture. They can monitor crop health, apply pesticides, and perform tasks like weeding or planting. This improves crop yields and reduces the need for manual labor.

- **Hospitality and Customer Service:** Some surveillance bots are used in hospitality settings, like hotels and airports, to provide information, carry luggage, or assist with tasks like room service.

CHAPTER 6

6.1 CONCLUSION:

In conclusion, surveillance bots represent a transformative and adaptable technology that extends far beyond traditional security applications. These robotic systems equipped with sensors, cameras, and mobility capabilities offer a broad spectrum of solutions for diverse industries and purposes. From environmental monitoring and industrial inspections to search and rescue operations, precision agriculture, and telepresence, surveillance bots are reshaping the way we interact with and gather data from our surroundings. Their role in improving safety, efficiency, and data collection in a multitude of settings continues to expand, making them a pivotal tool in the fields of automation, research, and security. As technology continues to advance, surveillance bots are poised to play an increasingly significant role in addressing complex challenges and facilitating innovative solutions across various sectors.

The successful completion of the Surveillance Bot project, featuring a live survelliance video, marks a significant milestone in our pursuit of creating a versatile and reliable for any application that requires surveillance.

6.2 LIMITATIONS:

- Limited Autonomy: Most surveillance bots are battery-powered and have limited operational time before requiring recharging. This can restrict their ability to provide continuous surveillance, especially in long-term deployments.

- Mobility Constraints: Surveillance bots may have difficulty navigating rough or complex terrain, such as stairs, uneven surfaces, or crowded environments. Their mobility can be restricted in certain settings.

- Sensory Limitations: Sensors and cameras on surveillance bots have limitations in terms of range, accuracy, and environmental conditions. They may struggle in adverse weather or lighting conditions.

- Data Privacy Concerns: The use of surveillance bots raises privacy concerns, as they can capture and transmit images and videos of individuals without their consent, potentially infringing on privacy rights.

- Security Risks: Like other connected devices, surveillance bots can be vulnerable to hacking and cyber-attacks, potentially compromising the data they collect and the security of the systems they are connected to.

- Maintenance and Repairs: Surveillance bots require regular maintenance, and when they break down or require repairs, it can lead to downtime, particularly in critical applications.

6.3 FUTURE WORKS:

- Security and Privacy Features: Implementing stronger security measures to protect surveillance bots from cyberattacks and addressing privacy concerns through technologies like anonymization and access controls.

- Real-time Communication: Advancing communication capabilities to provide real-time streaming of video and data to remote operators, enabling quicker response to events.

- Multi-Modal Interaction: Incorporating features that allow surveillance bots to interact with humans or other devices through voice, gesture, or touch interfaces, enhancing their usability in various applications.

- Customization and Modularity: Designing surveillance bots with modular components that can be easily customized for specific tasks or environments, making them more adaptable to a range of applications.

6.3 REFERENCES:

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