

A Project Report On

**“Autonomous Surveillance
Drone(case study for campus
surveillance)”**

Submitted by

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Under the Guidance of

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[2024-25]



CERTIFICATE

This is to certified that


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4. Swapnil Maruti Patil (70)
5. Anjali Pruthviraj Nagarkar (71)

has successfully completed the project phase-II entitled "Autonomous Surveillance Drone" case study on campus surveillance under my supervision, as per the academic rules and regulations laid down the institute & in the partial fulfilment of Bachelors of Technology in Electronics and Telecommunications Engineering Shivaji University, Kolhapur.

Date:


Place: Kolhapur.


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ACKNOWLEDGEMENT




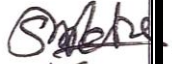

We are immensely grateful to our project guide, **Dr. S. D. Chede**, for his invaluable guidance, continuous support, and constructive feedback throughout our project. His expertise and encouragement have been instrumental in helping us navigate challenges and successfully complete this work.

We also extend our sincere thanks to **Mr. S. B. Patil**, our project document instructor, for his thorough guidance in structuring our documentation and ensuring that we adhered to high standards in presenting our work.

Our heartfelt gratitude goes to **D Y Patil College of Engineering, Kasaba Bawada**, for providing a conducive environment and necessary resources for our project. We are especially thankful to the **Garuda Club** for their encouragement and resourceful support, as well as to the dedicated faculty members of the **Electronics and Telecommunication (ENTC) Department**, whose mentorship and expertise have greatly contributed to the success of our project.

Date: 22/05/2025

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NOMENCLATURE

ESC: Electronic Speed Controller
GPS: Global Positioning System
FOV: Field of View
TVL: Television Line
AFHDS: Automatic Frequency Hopping Digital System
GCS: Ground Control System
CW: Clockwise
CCW: Counter Clockwise
SPI: Serial Peripheral Interface
BLDC: Brushless Direct Current
IOREF: Input-output voltage reference
CAN: Control Area Network
SRAM: Static Random-access memory
EEPROM: Electrically erasable programmable read-only memory
DSP: Digital signal processing
PPM: Voltage at the common collector
I2C: Inter integrated circuit
PWM: Pulse width modulation
GND: Ground

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**D. Y. PATIL COLLEGE OF ENGINEERING AND TECHNOLOGY Kasaba
Bawada, Kolhapur**



**SYNOPSIS ON
“Autonomous Surveillance Drone”
(case study for campus surveillance)**

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Department of Electronics and Telecommunication Engineering

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Academic Year-2024-25

Synopsis on proposed work-

1. Name of college: - D.Y. Patil College of Engineering and Technology, Kolhapur

(An autonomous institute)

2. Name of Course: - B. Tech (Electronics and Telecommunication Engineering)

3. Name of Student: - Mrs. Chirag Ashok Neware (Roll No-03)

Miss. Aliya Arif Bagwan (Roll No-64)

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Miss. Anjali Pruthviraj Nagarkar (Roll No-72)

4. Academic Year: - 2024-25

5. Name of Guide: -Prof. S. D. Chede

6. Proposed Title: - Autonomous Surveillance Drone

7. Place of Work: - Department of Electronics and Telecommunication
Engineering D.Y. Patil College of Engineering and Technology, Kolhapur

(An autonomous institute)

8. Introduction-

In an era where technological advancements are revolutionizing various sectors, the deployment of surveillance drones equipped with sophisticated tracking features stands at the forefront of innovation. This project explores the development of a versatile surveillance drone designed to enhance monitoring and data collection across diverse fields. The primary objective of this project is to leverage cutting-edge drone technology to facilitate comprehensive surveying and tracking capabilities.

Our drone integrates advanced features to capture high-resolution video and imagery, ensuring detailed and reliable data acquisition. Furthermore, it incorporates intelligent object identification systems, enabling the precise detection and recognition of specific targets. This multifaceted approach not only broadens the scope of surveillance applications but also improves accuracy and efficiency in data analysis.

By addressing the growing need for effective and adaptive surveillance solutions, this project aims to contribute significantly to fields such as security, environmental monitoring, and asset management. Through a combination of innovative tracking technologies and practical design, the surveillance drone will offer a robust tool for real-time observation and analysis, setting new standards for the capabilities of aerial monitoring systems.

9. Literature Review-

[1] “An Amateur Drone Surveillance System Based on Cognitive Internet of Things” Qihui Wu is with the Department of Electronics and Information Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing 210007, China (email: wuqihui2014@sina.com).

Majority of the related work have focused on how to enable various individual surveillance devices or systems to see, hear and sense the physical world for drone surveillance. Making surveillance devices or systems connected to share the observations and to accomplish information fusion represent a research trend. In this article, we argue that only connected is not enough, beyond that, surveillance devices should have the capability to learn, think, and understand both physical and social worlds by themselves. This practical need impels us to develop a new vision, named Dragnet, i.e., cognitive Internet of Things-enabled amateur drone surveillance, in order to empower the amateur drone surveillance with a “brain” for high-level intelligence

[2] “Applications and Challenges in Video Surveillance via Drone: A Brief Survey” Naqqash Dilshad, JaeYoung Hwang, JaeSeung Song* Department of Information Security Sejong University Seoul, South Korea{dilshadnaqqash, forest62590}@sju.ac.kr, jssong@sejong.ac.kr

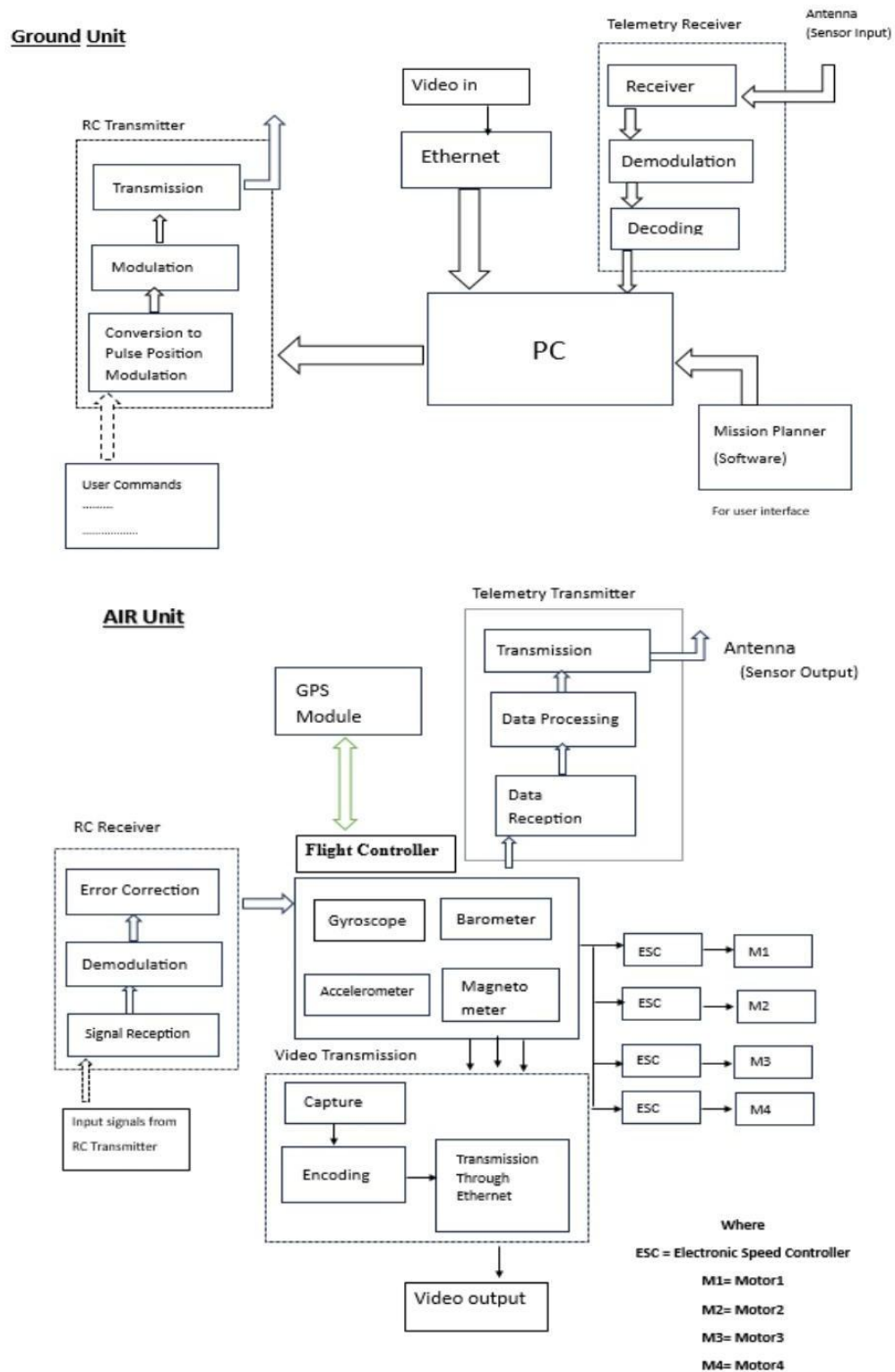
This article focuses on video surveillance using drones in object detection and tracking, video summarization, persistent monitoring of the target, search and rescue operation in a hostile environment, traffic management in smart cities, and disaster management in an apocalyptic situation. This brief survey sheds light on the research gaps and profound insights of the methods used in the mentioned articles by opening up future research tracks for the Computer Vision (CV) enthusiasts using Unmanned Aerial Vehicles (UAV).

10. Proposed work -

The proposed work is to development and implementation of a surveillance drone integrated with a camera module, GPS, and object detection capabilities. The primary tasks for this project include:

1. **Design and Assembly:** Construct the drone with a focus on integrating the camera module, GPS system, and object detection sensors. Ensure the components are compatible and optimized for performance.
 2. **Camera Module Integration:** Equip the drone with a high-resolution camera capable of capturing video and images in various lighting conditions. Implement stabilization mechanisms to ensure clear, steady footage.
 3. **GPS Integration:** Install a GPS system to provide accurate positioning and navigation data. This will enable the drone to maintain precise flight paths and location tracking during operations.
 4. **Object Detection Implementation:** Integrate advanced object detection algorithms and sensors to identify and track specific objects in real-time. Fine-tune the system to recognize and classify objects accurately.
 5. **Software Development:** Develop and test software for real-time data processing, including video streaming, GPS data visualization, and object detection results. Ensure user-friendly interfaces for operation and monitoring.
-
-

11. Block Diagram -



Air Unit

11.1 Router

A router is a networking device that forwards data packets between computer networks. It connects multiple networks, typically a local area network (LAN) to a wide area network (WAN) or the internet. Routers use IP addresses to determine the best path for forwarding data, manage traffic to avoid congestion, and ensure data packets reach their destination accurately and efficiently.

11.2 GPS Module-

A GPS module for a surveillance drone is a compact electronic device that receives and processes satellite signals from the Global Positioning System (GPS) to provide accurate location, altitude, velocity, and timing information to the drone's autopilot system, enabling precise navigation, tracking, and geo-tagging of captured data, while supporting autonomous flight operations and mission planning in various surveillance applications.

11.3 Telemetry Transmitter–

A telemetry transmitter is a device that collects and sends data from a remote or inaccessible location to a receiving system for monitoring and analysis. It typically consists of sensors, which measure various parameters (like temperature, pressure, or speed), and a transmitter, which sends the collected data to a central receiver or monitoring system.

11.4 Electronic Speed Controller (ESC)-

An Electronic Speed Controller (ESC) is a key component in various electrical systems, particularly in drones, RC vehicles, and electric vehicles. The primary role of an ESC is to regulate the speed of an electric motor by adjusting the amount of electrical power sent to it. This is achieved by interpreting signals from a control system (like a flight controller in a drone) and modulating the motor's speed accordingly.

11.5 Obstacle Avoidance Sensor

An obstacle avoidance sensor is a critical component in autonomous systems, such as drones, robots, and vehicles. Its primary function is to detect obstacles in the path of the system and prevent collisions by providing real-time information about the environment.

Ground Unit

11.6 Ground Control System –

A Ground Control System (GCS) is an essential component in managing and operating unmanned systems like drones, spacecraft, and autonomous vehicles from a remote location. The GCS provides operators with the means to control and monitor the unmanned system. It enables real-time communication, data analysis, and decision-making to ensure the system performs as intended.

11.7 Video Receiver

A video receiver is a device used to receive and decode video signals transmitted wirelessly from a video transmitter, such as those used in drones, security cameras, or live streaming applications. The primary role of a video receiver is to capture the video signals sent by a transmitter, decode them, and display or process the video feed. This allows users to view live video content from a remote source.

12. Facilities Available-

Hardware lab, Innovation lab, Computer lab with good internet facilities, Software IDE tools.

13. Objectives-

To ensure the drone is capable of capturing high-quality video and images in various environmental conditions, offering detailed and reliable surveillance data.

Advanced object detection algorithms to identify and track specific objects or targets accurately.

To develop intuitive software and interfaces for controlling the drone, viewing live feeds, and analyzing data, making it accessible and easy to use for operators.

14. Expected Outcomes-

- Ability to capture and transmit clear, high-resolution video and images, providing reliable visual data for various surveillance needs.
- To provide services in multiple fields such as security, environmental monitoring, and asset management, showcasing the drone's adaptability.

15. Expected date of completion- March 2025

16. Approximate Expenditure-Rs. /-

17. References-

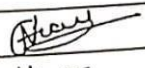

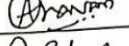
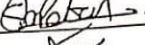

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- [2] “Applications and Challenges in Video Surveillance via Drone: A Brief Survey” Naqqash Dilshad, JaeYoung Hwang, JaeSeung Song* Department of Information Security Sejong University Seoul, South Korea{dilshadnaqqash, forest62590}@sju.ac.kr, jssong@sejong.ac.kr


Web URL-


<https://www.flytbase.com/blog/drone-surveillance-system>


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(An autonomous institute)
Academic Year-2024-25

ORGANIZATION OF PROJECT REPORT

1. Abstract

The Autonomous Surveillance Drone project introduces a smart drone-based system for real-time campus monitoring and crowd detection. It features autonomous navigation, live video streaming, and object detection to count individuals. The footage is securely streamed to an access-controlled website with real-time analytics, aiding in crowd management and safety. By combining autonomous flight, computer vision, and secure data handling, the system offers an efficient and privacy-conscious surveillance solution.

2. Introduction

This chapter covers all the basic information of project which includes,

Problem statement

Objective

Scope

Methodology

3. Literature review

This chapter covers, research papers that we have studied for our system are listed below: -

[1]. An Amateur Drone Surveillance System Based on Cognitive Internet of Things”Qihui Wu is the department of Electronics and Information engineering Nanjing University of Aeronautics and Astronautics, Nanjing 210007, China (email:wuqihui2014@sina.com).

[2]. Applications and Challenges in Video Surveillance via Drone: A Brief Survey” Naqqash Dilshad, JaeYoung Hwang, JaeSeung Song* Department of Information Security Sejong University Seoul, South Korea{dilshadnaqqash, forest62590}@sju.ac.kr, jssong@sejong.ac.kr

[3]. Web URL <https://www.flytbase.com/blog/drone-surveillance-system>

4. Analytical/Experimental/layout of Design work:

This chapter covers all the experimental and design work for our system which includes,

- A) Block Diagram
- B) Details of Design
- C) Circuit Diagram
- D) Work Flow of Project
- E) Flow Chart

5. Experimental Validations/Result

This chapter covers the hardware work that we have done.

- F) Phase I Result
- G) Phase II Result

6. Conclusion

The Autonomous Surveillance Drone project demonstrates a significant advancement in security technology by integrating autonomous drone navigation, computer vision, and real-time video streaming. With accurate people detection, secure data access, and effective use of the ESP32-CAM, the system offers an efficient, privacy-conscious solution for large-scale surveillance and real-time monitoring.

7. Future Scope

The future of the Autonomous Surveillance Drone project lies in smarter object detection, improved autonomous navigation, and higher-quality streaming. Advanced sensors like thermal imaging could extend functionality.

8. References

This chapter covers the material that we have used for our project like, research papers, YouTube videos and google websites.

9. Source code

This chapter include the source code of ESP camera that is needed for the proposed system.

10. Appendix

This chapter include the extra information of components that is needed for the proposed system.

11. Fund Sanction sheet

Our project is funded by PGCS, in this chapter we are attaching the Synopsis that we have submitted and the fund sanction sheet.

12. Research paper publication and certificate

We have published research paper for our system in IJARESM(an Approved journal).

This chapter covers the research paper that we have published and certificate for the same.

1.ABSTRACT

The Autonomous Surveillance Drone project presents a sophisticated, drone-based surveillance system designed to enhance campus safety through real-time monitoring and crowd detection. This project features a drone that autonomously navigates designated paths across the college campus, capturing live video footage and using object detection algorithms to identify and count individuals within each frame. The processed footage is securely streamed to a custom-built website accessible only to authorized personnel. Access to this website is safeguarded with user authentication, ensuring that only users with valid credentials can monitor the surveillance footage.

The website displays the live stream with an overlay that highlights detected individuals, providing an intuitive visual indication of crowd presence in various campus areas. Additionally, the platform includes live analytics such as the current count of people detected in each frame, aiding in crowd management and security oversight. Integrating autonomous flight, secure live streaming, and advanced computer vision, this project delivers a comprehensive, secure, and efficient surveillance solution. The system leverages modern technologies to enable real-time monitoring with minimal human intervention, creating a scalable model for automated campus surveillance that prioritizes security and privacy.

INTRODUCTION

2.INTRODUCTION

The growing need for effective surveillance and security in public spaces has driven interest in automated systems that can monitor environments in real-time. Traditional surveillance infrastructure, which relies on stationary cameras and manual monitoring, often falls short in large and dynamic settings such as college campuses, where wide coverage and flexibility are essential. To address these limitations, this project introduces an Autonomous Surveillance Drone designed to enhance campus safety through intelligent, real-time monitoring and data driven insights.

This project centers on an unmanned aerial vehicle (UAV) equipped with a high-resolution camera and an array of sensors, enabling it to autonomously navigate designated routes across the campus. As the drone moves, it captures video footage and processes the images using advanced object detection algorithms. These algorithms identify individuals within each frame, providing a live count of people in the observed areas. This information is invaluable for understanding crowd density and movement patterns, supporting security teams in managing large gatherings, and ensuring public safety in high-traffic zones.

One of the key components of this project is the integration of a secure, custom-built web interface that displays the live footage from the drone, enhanced with an overlay of detected individuals. This platform is accessible only to authorized users, requiring credential verification to ensure that surveillance data remains secure and confidential. The web interface provides not only a visual feed but also real-time analytics on crowd counts, giving campus authorities a comprehensive, user-friendly tool for remote monitoring.

By combining autonomous navigation, object detection, and live streaming within a secure framework, the Autonomous Surveillance Drone project demonstrates the potential of UAV technology to serve as a scalable, adaptive surveillance solution. This system minimizes the need for human intervention, freeing up resources while delivering reliable, continuous monitoring. Furthermore, the project illustrates the transformative impact of artificial intelligence and computer vision on campus security, highlighting a future where intelligent drones provide real-time situational awareness and contribute to a safer campus environment.

PROBLEM STATEMENT

Ensuring safety and effective crowd management on large college campuses is a challenging task, particularly with conventional surveillance systems that rely on fixed cameras and manual monitoring. These traditional systems are limited in scope and flexibility, often leaving blind spots and requiring significant human resources to monitor and analyze footage continuously. Additionally, the static nature of fixed surveillance cameras restricts their ability to adapt to dynamic crowd movement, reducing their effectiveness in monitoring larger, more populated areas. Given these limitations, there is a need for an innovative surveillance solution that can autonomously cover wide areas, detect individuals in real-time, and provide actionable insights on crowd density and movement.

Such a system should also ensure secure access, allowing only authorized personnel to view and analyze the footage. This project aims to address these challenges by developing an Autonomous Surveillance Drone capable of autonomously navigating the campus, capturing live footage, detecting and counting people, and streaming this data securely to a custom-built web interface. This approach offers a scalable, adaptive solution to improve campus security and situational awareness while reducing the reliance on manual surveillance efforts.

OBJECTIVE

- **Develop an Autonomous Navigation System:**

Implement autonomous flight capabilities in the drone to follow predefined routes across the campus, ensuring reliable and obstacle-free navigation for comprehensive area coverage.

- **Implement Real-Time Object Detection and Crowd Counting:**

Integrate an object detection algorithm to identify and count individuals within the drone's field of view in real-time, providing accurate and up-to-date information on crowd density and distribution.

- **Enable Secure Live Video Streaming:**

Develop a secure video streaming solution that transmits live footage from the drone to a custom-built web interface, allowing authorized users to monitor surveillance data remotely and real-time.

- **Create a Custom Web Interface with Restricted Access:**

Design a web platform that displays live drone footage with object detection overlays, allowing only authorized personnel to access the stream after verifying credentials for enhanced security.

- **Enhance Campus Safety and Surveillance Efficiency:**

Demonstrate the feasibility of UAV-based surveillance to improve campus safety by reducing blind spots, enabling dynamic monitoring, and minimizing the need for manual surveillance personnel.

- **Evaluate System Performance and Scalability:**

Assess the accuracy, reliability, and efficiency of the autonomous surveillance system, with a focus on scalability and adaptability for larger or more complex campus environments.

SCOPE

The scope of the Autonomous Surveillance Drone project encompasses the design, development, and implementation of an intelligent, UAV-based surveillance system capable of enhancing campus security through autonomous operation and real-time data processing.

Key aspects of the project include:

1. Autonomous Flight and Navigation

- o Development of autonomous navigation capabilities for the drone, including path planning, obstacle avoidance, and GPS-based routing. The drone will follow designated paths covering critical campus areas, ensuring broad coverage with minimal manual intervention.

2. Object Detection and Real-Time Analytics

- o Implementation of computer vision and object detection algorithms for identifying and counting individuals within the drone's field of view. The system will process live video streams, overlaying detection results on the footage to provide real-time analytics on crowd density.

3. Secure Live Streaming and Data Transmission

- o Creation of a secure, end-to-end video streaming solution that transmits live footage from the drone to a custom-built web interface. This interface will allow only authorized personnel to access the feed, ensuring that sensitive surveillance data is protected.

4. Web-Based User Interface with Access Control

- o Development of a secure web platform for viewing live surveillance footage. The platform will feature access control mechanisms, such as credential verification, to restrict access to authorized users. This web interface will also display real-time object detection overlays, providing insights into on-campus activity.

METHODOLOGY

The methodology for the Autonomous Surveillance Drone project involves a structured approach to integrate autonomous navigation, object detection, live streaming, and secure web-based monitoring into a cohesive system. The key stages of the methodology include:

1. Drone Selection and Setup

- o Drone Selection: Choose an appropriate drone platform based on payload capacity, flight time, and stability. Popular options include drones based on Raspberry Pi or NVIDIA Jetson platforms, as these allow for integration with sensors and cameras.

- o Hardware Setup: Install necessary hardware, including a camera module, GPS module, IMU (Inertial Measurement Unit) for navigation, and a computing unit (e.g., Raspberry Pi or Jetson Nano) for processing the video stream and running algorithms.

2. Autonomous Navigation Development

- o Flight Control System: Implement a flight control system capable of autonomous navigation. This includes path planning, waypoint navigation, and obstacle avoidance. The drone will follow predefined routes or waypoints across the campus using GPS and vision-based methods to ensure accurate positioning.

- o Obstacle Avoidance: Use sensors such as ultrasonic or LIDAR for detecting and avoiding obstacles in real-time. The drone will adjust its flight path dynamically to prevent collisions with buildings, trees, or other obstacles.

3. Object Detection and People Counting

- o Model Selection: Choose a suitable object detection algorithm, such as YOLO (You Only Look Once) or SSD (Single Shot MultiBox Detector), to detect individuals in real-time video frames. Pretrained models will be used initially, followed by fine-tuning the model if necessary to increase accuracy in a campus setting.

- o Integration: Integrate the object detection algorithm into the drone's processing pipeline, where the camera feed is continuously analyzed, and detected individuals are counted. The system will output both the detected persons and their corresponding count in real time.

- o Post-Processing: For improved accuracy, the detected objects will be refined through post-processing techniques like non-maximum suppression to filter out false positives

4. Live Video Streaming and Web Interface Development

- o Live Streaming Setup: Implement video streaming from the drone's camera to a central server. This can be done using protocols like RTSP (Real-Time Streaming Protocol) or WebRTC for low-latency streaming.

- o Web Interface Development: Build a web-based platform using HTML, CSS, and JavaScript to display the live video stream. The website will feature real-time overlays, such

as bounding boxes around detected individuals and their corresponding count. The user interface will be designed for easy access and navigation, with a focus on providing actionable insights.

o **Secure Access:** Implement authentication mechanisms such as username and password-based login to restrict access to authorized users. User credentials will be checked against a database, ensuring that only users with the appropriate permissions can view the live footage.

5. Integration and Testing

o **System Integration:** Once all components (navigation, object detection, streaming, and web interface) are developed and tested independently, they will be integrated into a single system. The drone will autonomously fly, detect people, and stream live footage to the secure web interface.

o **Testing and Calibration:** Test the system on the campus to ensure proper performance in real-world conditions. Evaluate the accuracy of people counting, the stability of the drone's flight, and the quality of live streaming. Fine-tune parameters like detection thresholds and streaming bitrate for optimal performance.

6. Security and Data Protection

o **Data Encryption:** Implement SSL/TLS encryption for secure transmission of video streams and sensitive data between the drone, server, and user devices.

o **Access Control:** Implement role-based access control to allow different levels of user access to the web interface, ensuring that only authorized personnel can view or interact with the live footage.

LITERATURE

REVIEW

3.LITURATURE REVIEW

[1] “An Amateur Drone Surveillance System Based on Cognitive Internet of Things” Qihui Wu is with the Department of Electronics and Information Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing 210007, China (email: wuqihui2014@sina.com).

Majority of the related work have focused on how to enable various individual surveillance devices or systems to see, hear and sense the physical world for drone surveillance. Making surveillance devices or systems connected to share the observations and to accomplish information fusion represent a research trend. In this article, we argue that only connected is not enough, beyond that, surveillance devices should have the capability to learn, think, and understand both physical and social worlds by themselves. This practical need impels us to develop a new vision, named Dragnet, i.e., cognitive Internet of Things-enabled amateur drone surveillance, in order to empower the amateur drone surveillance with a “brain” for high-level intelligence

[2] “Applications and Challenges in Video Surveillance via Drone: A Brief Survey” Naqqash Dilshad, JaeYoung Hwang, JaeSeung Song* Department of Information Security Sejong University Seoul, South Korea{dilshadnaqqash, forest62590}@sju.ac.kr, jssong@sejong.ac.kr

This article focuses on video surveillance using drones in object detection and tracking, video summarization, persistent monitoring of the target, search and rescue operation in a hostile environment, traffic management in smart cities, and disaster management in an apocalyptic situation. This brief survey sheds light on the research gaps and profound insights of the methods used in the mentioned articles by opening up future research tracks for the Computer Vision (CV) enthusiasts using Unmanned Aerial Vehicles (UAV).

ANALYTICAL/
EXPERIMENTAL/
LAYOUT DESIGN
WORK

4. ANALYTICAL/EXPERIMENTAL/LAYOUT DESIGN

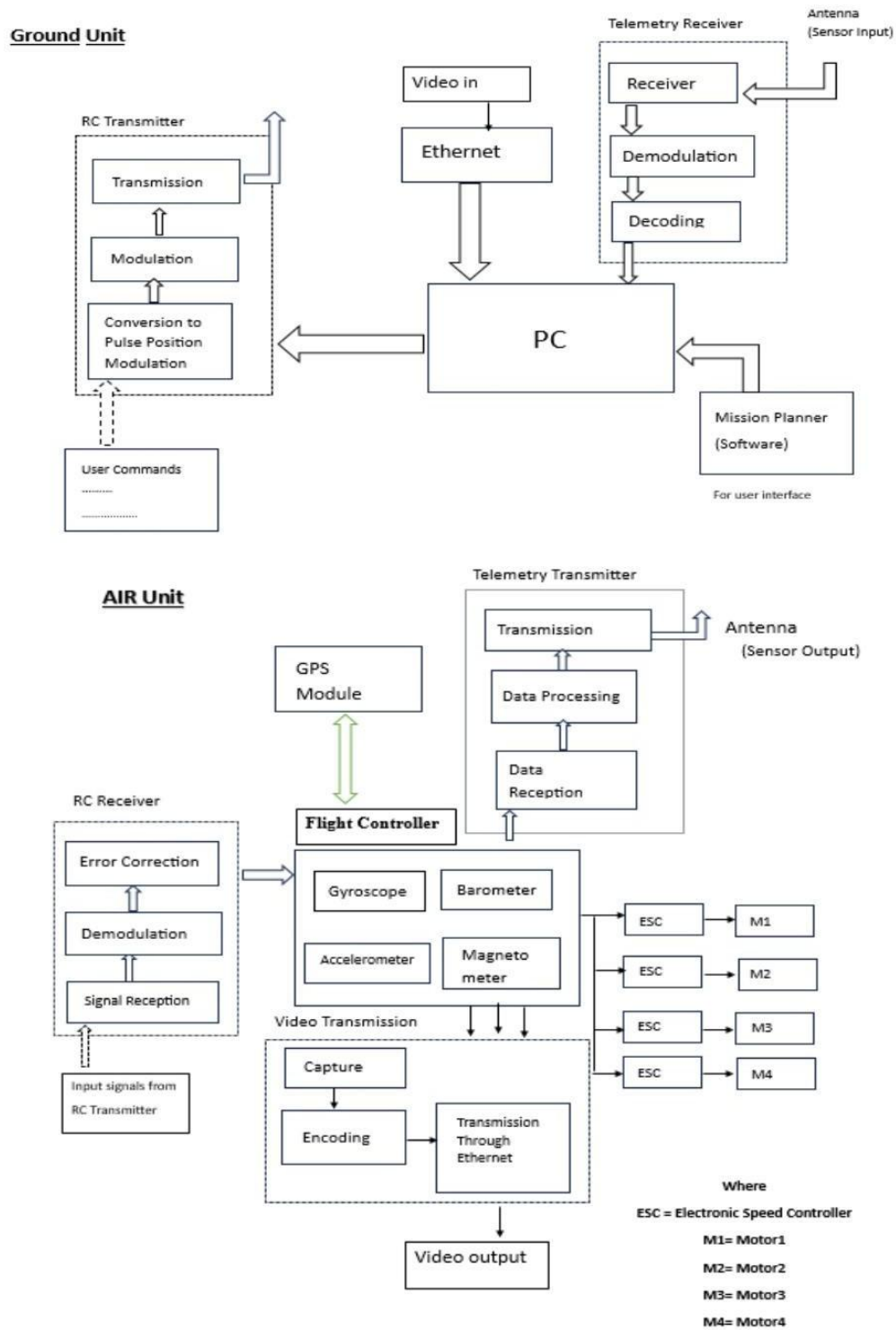
WORK

This Chapter contains:

- A. Block Diagram
- B. Details of Design
- C. Circuit Diagram
- D. Work Flow
- E. Flow Chart

A. BLOCK DIAGRAM

Fig 1. Block Diagram



Ground Unit:

The ground unit is the command center for data processing, control, and communication. It consists of the **receiver** that collects data transmitted from the air unit and processes this information using the primary **controller**. The ground unit also includes telemetry systems to monitor and log real-time data from the air unit, enabling remote control and monitoring. Additionally, it has a **transmitter** to send commands back to the air unit, guiding its actions based on the processed sensor inputs. This two-way communication ensures that the air unit's data is consistently relayed to the ground, where it can be interpreted, stored, or used for further decision-making.

Air Unit:

The air unit, represented by the drone, is equipped with a high-resolution **camera** that efficiently captures images of the environment. This camera continuously collects visual data, which is crucial for monitoring and detecting specific activities or objects within the drone's path. The drone also carries **telemetry sensors** that gather additional environmental and positional information. Using a **transmitter**, the air unit sends this data, including the captured images, back to the ground unit through an **internet-enabled communication module**. This setup allows the data to be transmitted in real time for remote monitoring and decision-making, ensuring the ground unit can assess the situation and make informed control adjustments instantly.

B. DETAILS OF DESIGN

Components Used:

1. Drone Frame (450mm)
2. Pixhawk Flight Controller
3. GPS(M8N)
4. ESC 30A
5. BLDC motors (920kv)
6. Propellers 1045
7. Camera FPV (RunCam RACERNANO3-L18-MCK)
8. Camera (RunCam Thumb 1080P Mini Action Camera)
9. Video Transmitter
10. Video Receiver
11. Telemetry Tx/Rx module
12. FSI6Sx10 channel Tx & Rx
13. 3300 mAh battery

1. Drone Frame (450mm)

The quadcopter frame is a structure that holds all the components together. It is capable of supporting motors and other electronics and prevents them from vibrations. The Quadcopter frames are arranged in a square or rectangle allow a stable and steady ascent and flying of the drone This F450 Quadcopter Frame with 4 arms is made up of high-quality Glass Fibre which makes it tough and durable. Ultra-durable Polyamide- Nylon is used for manufacturing arms that are much stronger moulded arms providing better thickness. As a result, there will be no arm breakage at the motor mounts on a hard landing. Moreover, these arms have support ridges on them, which improves stability and provides faster forward flight. In order to guide the copter in the right direction, the arm coloured as 2-red, 2-white. And this also allows the whole take-off weight to be controlled at about 800-1200 gm. Moreover, it avoids the use of extra PDB (Power Distribution Board) and makes the mounting clean and neat .The frame is constructed with a wheelbase of 450mm and weighs around 282gm.Pre-threaded brass sleeves are included in the copter for all of the frame bolts, so attaching the arms to the mainframe is done quite easily. Also, it requires one size of bolt for the overall build and thus a unique one-size hex wrench for hardware mounting. This feature of the Q450 Quadcopter Frame makes it so easy to assemble and disassemble.



Fig.2 Drone Frame (450mm)

Specifications of Drone frame (450mm)

Model	F450
Frame width	450mm
Frame height	55mm
Frame Weight	282g
Take-off Weight	800g ~ 1200g
Motor Mount Bolt Holes	16/19mm
Landing Gear Height	150mm
Landing Gear Weight	90gm

Table 1 – Specifications for Droneframe(450mm)

2. Pixhawk Flight Controller



Fig.3 Pixhawk Flight Controller

The flight controller (aka FC) is the brain of the Drone(Quadcopter). It's a circuit board with a range of sensors that detect movement of the drone, as well as user commands so Pixhawk 2.4.8 does. Using this data, it then controls the speed of the motors to make the craft move as instructed. It Supports 8 RC channel with 4 serial port. Various user interfaces are available for programming, reviewing logs, even some apps for smartphones & tablets. It detects and configures all its peripherals automatically. The benefits of the Pixhawk system include a Unix/Linux-like programming environment, completely new autopilot functions.

Specifications for Pixhawk Flight Controller

32bit STM32F427 Cortex M4 core with FPU.
Input Voltage 7V
Sensors 3-Axis Gyrometer, Accelerometer, High-performance Barometer, Magnetometer
Processor 32bit STM32F427 Cortex M4 core with FPU, The 32-bit STM32F103 failsafe Co-processor
Weight 40g
Micro SD Card Slot available

Table 2 – Pixhawk flight controller

3. GPS M8N

The M8N GPS Module is a cutting-edge navigation solution for drone enthusiasts, featuring low power consumption, high precision, and compatibility with popular flight controllers like APM 2.6, APM 2.8, and Pixhawk. With a remarkable battery life of 144 hours and Galileo readiness, this module ensures you stay connected and on course during your aerial adventures.



Fig.4 Finger print sensor R307

Specifications of GPS(M8N)

Power Supply	+3.5V to +5.5V
Supply Current	50mA
Built-in Compass	yes
Avg Temperature	40 to+80 Degree c
Response time	10s to find 6 satellite in open space
Position accuracy	2.0 m CEP

Table 3 – GPS (M8N)

4.ESC 30A

An opto ESC isolates the high-power side (battery and motor) from the signal side (connection to the receiver) by internally transmitting the receiver throttle signal from the input side to the output side of the ESC through an opto-coupler. Ready toSky 30A 2-6S ESC is specifically made for quadcopters and multi-rotors. Which provides faster and better motor speed control giving better flight performance compared to other available ESCs.



Fig.5 ESC 30A

Model	30A 2-6S ESC
Voltage	4 V-16.8V
Current	30A to 40A
Weight	30g

Table 4 – Specifications of ESC 30A

5.BLDC motor (920kv)

These motor are brushless motor. This motor provides a Motor kV of 920 and gives a thrust of 500 gm. This is CW rotating BLDC Motor, for CCW rotating BLDC motor. This 2212 920KV BLDC motor when coupled with 1045 ABS propeller and powered by an 3S Li-PO Battery through the SimonK 30A ESC, it is capable of producing around 0.5kg of thrust. These motors when used with F450 or F550 Multirotor Frames



Fig.6 BLDC motor

Motor KV (RPM/V) 920
Rating voltage 7 ~ 12
Maximum Thrust (gm)500

Table 5 - Specifications of BLDC motor

6. Propellers 1045

These propellers are light in weight and high strength propeller has a 15° angle design at the end of the propeller to avoid whirlpool while the multi-copter is flying.



Fig.7 Propellers (1045)

Prop. Diameter (inch)	10
Rotation Direction	CW, CCW
Material	ABS

Table 6 - Specifications for Propellers (1045)

7. Camera (FPV)

The **RunCam Racer Nano 3 – [MCK FPV](#) Edition** is a 1.8mm lens FPV camera with a switchable 4:3 / 16:9 resolution ratio. This camera was designed in collaboration with the world-renowned FPV pilot – Min Chan Kim!



Fig.8 Camera FPV

Power Rating	DC 5-36V
lens	1.8mm
Field of View (FOV):	160 degree
Resolution (TVL)	1000

Table 7 - Specifications for Camera FPV

8. Camera (for Video recording)



The Runcam Thumb Mini Action camera is an exciting new cam for micro FPV drones. It's super light coming in at just under 10 grams, can be powered externally, and supports a micro SD card for ultra-long recording time. This camera has an onboard gyro sensor so the footage can be stabilized with Gyroflow.

Support	Micro SD Card Capacity 128G Max
Communication Interface	Micro USB
Current Consumption (mA):	280ma@5V

Fig.9 Camera (Runcam Thumb Mini Action)

Table 8 - Specifications for Camera video recording

9. Video Transmitter

This is a high-quality TS832 48Ch 5.8G 600mw Wireless Audio/Video Transmitter for FPV RC transmitter which will give you more than a 5km range in an open, clear area. The unit is upgraded version TS832 32 channel, very easy to install with its plug & play prewired leads and also it has 48 channels in the 5.8G band. A great little feature is that it has a built-in digital display and a push-button for easy channel selection. This feature also has a memory power off so it will remember the last channel when it is switched off. This 5.8G 48ch 600mW transmitter is compatible with other makes of receivers making this an excellent choice for your FPV model



Fig.10 Video transmitter

Frequency (GHz)	5.6 to 5.9
Operating Current (A):	0.22
Voltage(V)	7 to 24
Operating Temperature (°C)	-10 to 85

Table 9- - Specifications for Video transmitter

10. Video Receiver

5.8G UVC OTG Android Phone Receiver is a new receiver that you can connect to your smartphone directly instead of a heavy monitor and is good for those who feel dizzy when wearing FPV goggles. It has low latency of around 100ms 150CH auto search allows covering all 5.8G frequency bands.



Fig.11Video Receiver

RF Range	5645~5945 GHz
Receive sensitivity	-90 dBm
Operating Voltage (VDC):	5
Current Consumption (mA):	200

Table 10 - Specifications for Video Receiver

11. Telemetry Tx/Rx module

This is 433Mhz 100mW Radio Telemetry V2 Kit is based on the 3DR Telemetry kit and is 100% compatible as it runs the same firmware onboard. This firmware used by 3D Robotics is completely open-source which is, of course, the reason we are able to use it on our own version at Unmanned Tech .The Unmanned Telemetry Kit is compatible Pixhawk-based systems and allows you to easily add a two- way telemetry connection between your drone and ground station. This is the new and improved V2 of the Unmanned Telemetry kit. The features are that both air and ground module are now interchangeable, and each is with a USB connector and a DF13 connector.



Fig.12 Telemetry Tx/Rx module

Frequency (GHz):	0.43
Rated Power (mW)	100
Range	1600 m
Receive sensitivity	-121 dBm
Operating Current (A):	1.1
Voltage(V)	3.6 to 7

Table 11 - Specifications for Telemetry Tx/Rx module

12. Battery(3300mAh)

This Pro-Range 3300mAh 4S 25C/50C Lithium polymer battery Pack (LiPo) batteries are equipped with heavy-duty discharge leads to minimize resistance and sustain high current loads. Pro-Range batteries stand up to the punishing extremes of aerobatic flight and RC vehicles. Each pack is equipped with gold-plated connectors and JST-XH style balance connectors. All Pro-Range Lithium Polymer battery packs are assembled using IR match cells. Pro-Range 14.8V 3300mAh 25C 4S Lithium Polymer Battery Pack are known for performance, reliability.



Fig.13 Battery (3300mAh)

Nominal Voltage (V):	14.8
Output Voltage (V):	14.8
Charge Rate (C)	1 ~ 3
Discharge Current:	25C

Table 12 - Specifications for Battery (3300mAh)

13. FSI6Sx10 channel Tx & Rx

Using a drone is easy but controlling a drone is a tough job that's why a transmitter is needed. You can't fly a multirotor without it because it uses radio signals to send commands wirelessly to a Radio Receiver, which is connected to an aircraft or multirotor that is being remotely controlled and Fly sky is one of the popular brands that only manufactures a Diverse Range of Transmitters and Receivers at a reasonable price. The AFHDS 2A (Automatic Frequency Hopping Digital System Second Generation) developed and presented by Fly sky is specially developed for all radio control models. Offering superior protection against interference while maintaining lower power consumption and high reliable receiver sensitivity. Fly Sky Transmitter and Receiver is gaining so much popularity due to its originality and compatibility in high-end drone projects.



Fig.14 FSI6Sx10 channel Tx & Rx

No. of Channels:	6
Frequency (GHz):	2.4
Operating Voltage (VDC):	6
Antenna Length (mm)	26
Band-Range (GHz)	2.40 ~ 2.48
Bandwidth (KHz)	500
Modulation Type:	GFSK
RF Power	< 20dBm

Table 13 - Specifications for FSI6Sx10 channel Tx & Rx

C. Circuit Diagram

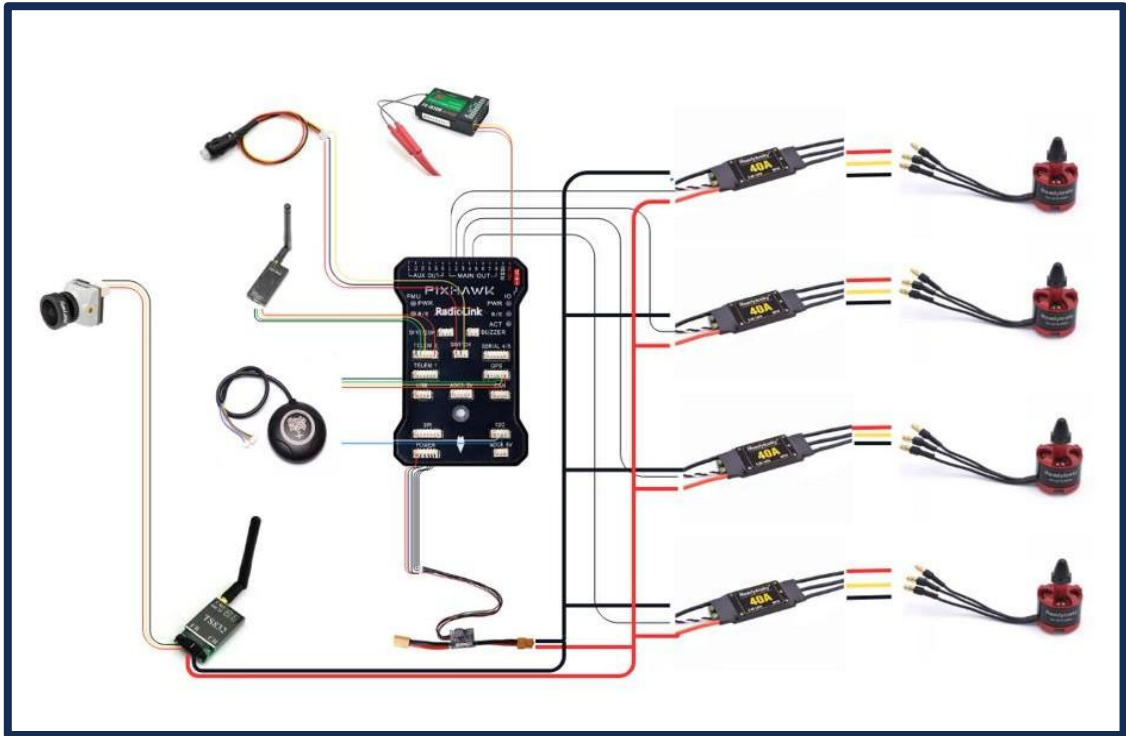
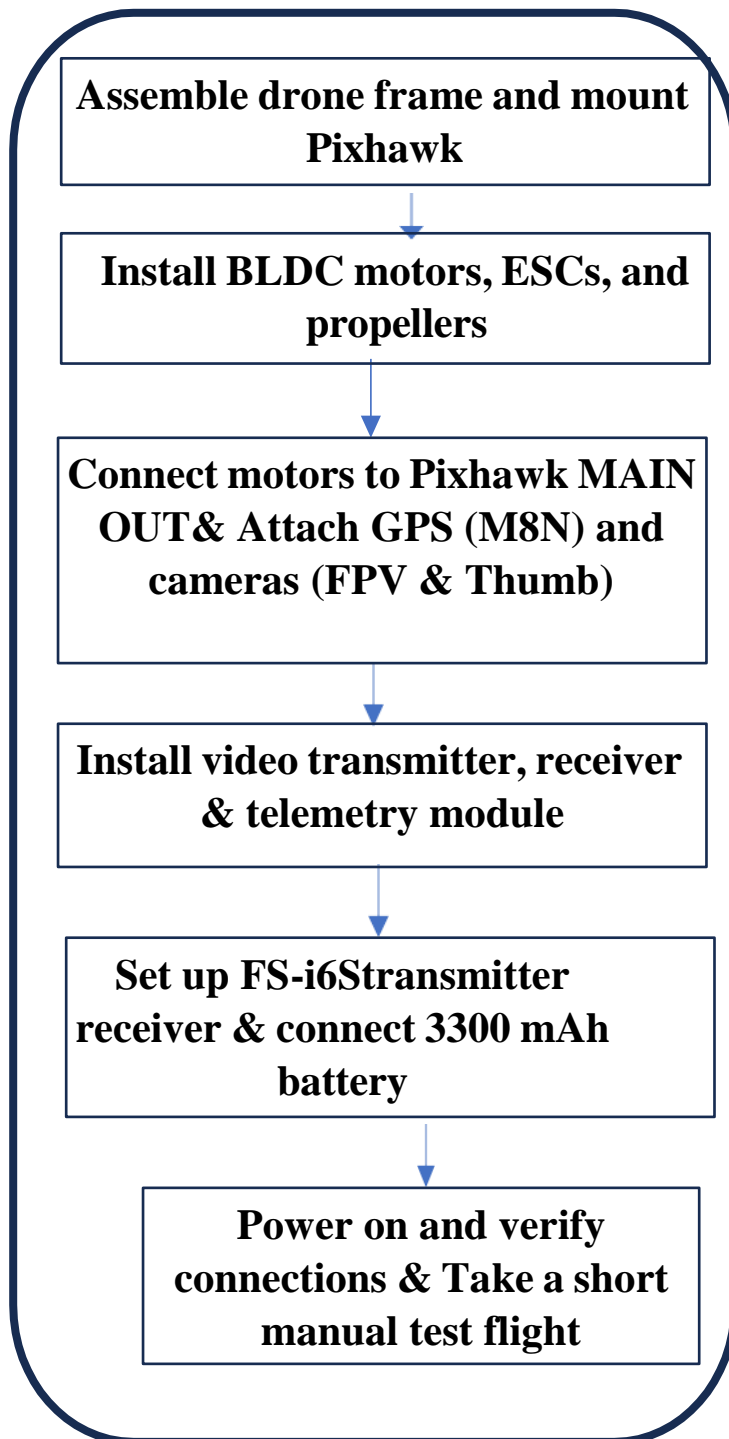


Fig.15 Circuit Diagram

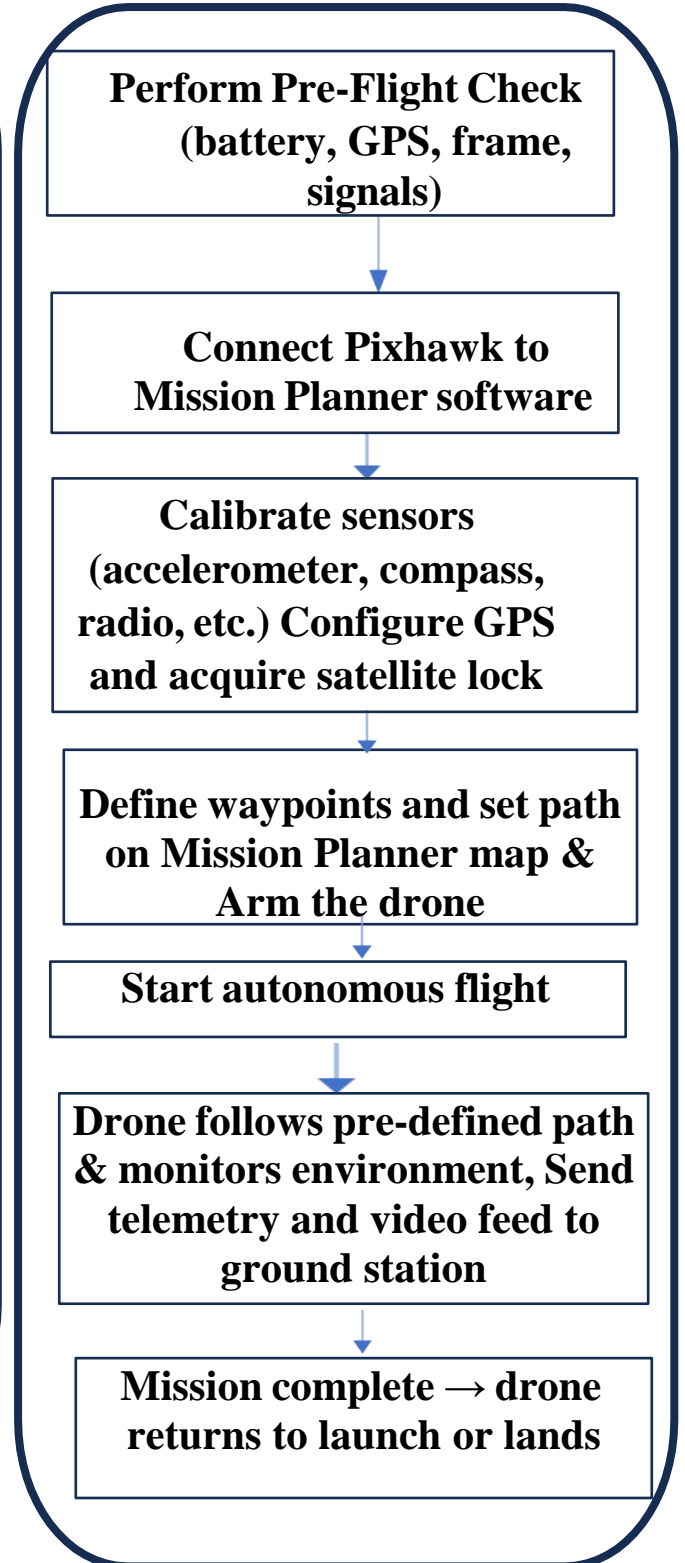
The above circuit diagram created on the **Canva** software, The battery connects to the power module, which powers the Pixhawk and feeds the ESCs; each ESC links to a brushless motor and to the Pixhawk's MAIN OUT ports for signal control. The GPS module with compass connects via the GPS/I2C port, while the radio receiver plugs into the RC IN for manual commands. A telemetry module connects to the TELEM port for ground station data, the buzzer and safety switch attach to their respective ports for alerts and arming. Lastly, an FPV camera connects to an external system for real-time video feed, completing the quadcopter's core wiring layout

D. WORK FLOW OF SYSTEM

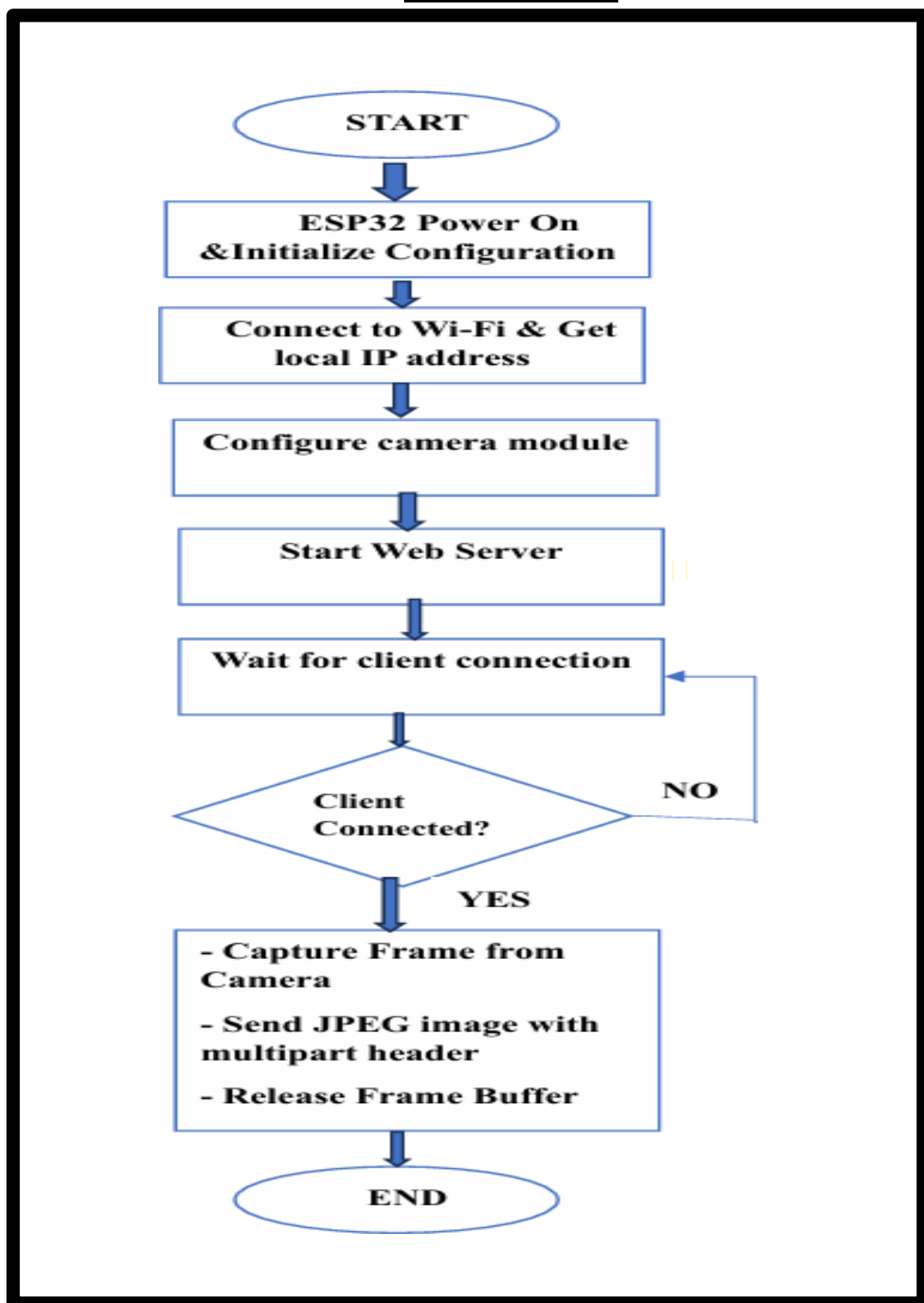
Procedure for Drone Assembly



Procedure for Autonomous Surveillance



E. FLOW CHART



Fig,16 Flow chart of System

EXPERIMENTL **VALIDATION/**

RESULT

Phase I Result



In phase I, we have done with complete hardware of the project in that, we have used V-type frame. In that we have 1400Kv BLDC motors. We have given one admin access so that only admin can access the website when alert will be given.



Fig,17 Phase I Hardware

Phase II Result



Fig,18 Working model

This is updated version of the system. In that, we have used drone frame 450mm in place of V-type frame, we have created 3D case for protecting electronic components. Additionally added the Pressure sensor and velocity sensor for speed and atmospheric Calculation.

6.CONCLUSION

The Autonomous Surveillance Drone project successfully demonstrates the integration of drone technology, computer vision, and real-time streaming for security and surveillance purposes. The drone is capable of detecting people in its field of view, counting them, and providing live footage streamed to a secure website. The use of the ESP32-CAM for video streaming has proven effective for real-time applications, while the object detection algorithms ensure accurate and efficient people identification. The system's secure access feature further enhances privacy and ensures that only authorized users can view the footage.

Overall, this project showcases the potential of autonomous drones in surveillance applications, particularly in monitoring large areas like college campuses. The combination of computer vision and live streaming provides a comprehensive solution for automated monitoring, with real-time insights into people movement and activity.

7. FUTURE SCOPE

The future scope of the Autonomous Surveillance Drone project holds immense potential for further enhancement and expansion. One key area for improvement is the advancement of object detection capabilities. Future versions could include the ability to detect a broader range of objects or behaviors, such as specific actions like loitering, or even recognize different types of individuals, enhancing the system's ability to identify specific threats or important events. Additionally, the drone's autonomy could be significantly enhanced through the integration of advanced navigation and path planning algorithms, enabling it to autonomously adjust its flight path based on detected objects or areas requiring more focus. This would reduce the need for manual control and make the system more adaptable to dynamic environments.

Furthermore, the live streaming system could be upgraded to handle higher resolution videos and incorporate cloud storage solutions for more scalable video storage and easier retrieval. Real-time alerts could also be implemented to notify security personnel when unusual activity is detected, such as large crowds or suspicious behaviors, enhancing the system's utility in proactive security monitoring. Additionally, equipping the drone with more advanced sensors, like thermal imaging, would allow it to detect people in low-light conditions or at night, extending the operational capabilities of the surveillance system.

8. REFERENCES

[1] “An Amateur Drone Surveillance System Based on Cognitive Internet of Things”
Qihui Wu is with the Department of Electronics and Information Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing 210007, China (email: wuqihui2014@sina.com).

[2] “Applications and Challenges in Video Surveillance via Drone: A Brief Survey”
Naqqash Dilshad, JaeYoung Hwang, JaeSeung Song* Department of Information Security Sejong University Seoul, South Korea{dilshadnaqqash, forest62590}@sju.ac.kr, jssong@sejong.ac.kr

[3] <https://www.flytbase.com/blog/drone-surveillance-system>

SOURCE CODE

9.SOURCE CODE

```
#include "esp_camera.h"

#include <WiFi.h>

// Replace with your network
credentials
const char* ssid = "YOUR_SSID";
const char* password =
"YOUR_PASSWORD";

// Define camera model settings (e.g.,
for AI Thinker module)
#define
CAMERA_MODEL_AI_THINKER

#include "camera_pins.h"

WiFiServer server(80);

void setup() {
  Serial.begin(115200);

  // Connect to Wi-Fi
  WiFi.begin(ssid, password);
  while (WiFi.status() !=
WL_CONNECTED) {
    delay(1000);
    Serial.println("Connecting to
WiFi...");
  }
  Serial.println("Connected to WiFi");
```

```
// Start the camera
camera_config_t config;
config.ledc_channel =
LEDC_CHANNEL_0;
config.ledc_timer =
LEDC_TIMER_0;
config.pin_d0 = 0;
config.pin_d1 = 1;
config.pin_d2 = 2;
config.pin_d3 = 3;
config.pin_d4 = 4;
config.pin_d5 = 5;
config.pin_d6 = 6;
config.pin_d7 = 7;
config.pin_xclk = 21;
config.pin_pclk = 22;
config.pin_vsync = 25;
config.pin_href = 23;
config.pin_sscb_sda = 26;
config.pin_sscb_scl = 27;
config.pin_pwdn = -1;
config.pin_reset = -1;
config.xclk_freq_hz = 20000000;
config.pixel_format =
PIXFORMAT_JPEG;

if (esp_camera_init(&config) !=
ESP_OK) {
    Serial.println("Camera
initialization failed!");
    return;
}
```

```
// Start the server
server.begin();
Serial.print("Camera Stream Ready!
IP Address: ");
Serial.println(WiFi.localIP());
}

void loop() {
  WiFiClient client =
  server.available();
  if (!client) {
    return;
  }

  Serial.println("New Client
  Connected");

  // HTTP response header
  client.println("HTTP/1.1 200 OK");
  client.println("Content-Type:
  multipart/x-mixed-replace;
  boundary=frame");
  client.println();

  // Stream video
  while (client.connected()) {
    camera_fb_t *fb =
    esp_camera_fb_get();
    if (!fb) {
      Serial.println("Frame buffer is
      NULL");
      return;
    }
  }
```

```
        client.println("--frame");
        client.println("Content-Type:
image/jpeg");
        client.println("Content-Length: " +
String(fb->len));
        client.println();
        client.write(fb->buf, fb->len);
        client.println();
        esp_camera_fb_return(fb);
    }
```

```
        client.stop();
        Serial.println("Client
Disconnected");
    }
```

APPENDIX

10. APPENDIX

Pixhawk Flight Controller

Description-

The flight controller (aka FC) is the brain of the Drone (Quadcopter). It's a circuit board with a range of sensors that detect movement of the drone, as well as user commands so Pixhawk 2.4.8 does. Using this data, it then controls the speed of the motors to make the craft move as instructed. It Supports 8 RC channel with 4 serial port. Various user interfaces are available for programming, reviewing logs, even some apps for smartphones & tablets. It detects and configures all its peripherals automatically. The benefits of the Pixhawk system include a Unix/Linux-like programming environment, completely new autopilot functions.



Fig.20 Pinout for Pixhawk Flight Controller

Pixhawk flight controller pin description-

Virtual Pin 2 and Power connector Pin 4: power management connector voltage pin, accepts up to 3.3V, usually attached to a power module with 10.1:1 scaling

Virtual Pin 3 and Power connector Pin 3: power management connector current pin, accepts up to 3.3V, usually attached to a power module with 17:1 scaling

Virtual Pin 4 and (No connector Pin): VCC 5V rail sensing. This virtual pin reads the voltage on the 5V supply rail. It is used to provide the HWSTATUS Vcc reading that ground stations use to display 5V status

Virtual Pin 13 and ADC 3.3V connector Pin 4: This takes a max of 3.3V. May be used for sonar or other analog sensors.

Virtual Pin 14 and ADC 3.3V connector Pin 2: This takes a max of 3.3V. May be used for second sonar or other analog sensor.

Virtual Pin 15 and ADC 6.6V connector Pin 2: analog airspeed sensor port. This has 2:1 scaling builtin, so can take up to 6.6v analog inputs. Usually used for analog airspeed, but may be used for analog sonar or other analog sensors.

Virtual Pin 102: Servo power rail voltage. This is an internal measurement of the servo rail voltage made by the IO board within the Pixhawk. It has 3:1 scaling, allowing it to measure up to 9.9V.

Virtual Pin 103: RSSI (Received Signal Strength Input) input pin voltage (SBus connector output pin). This is the voltage measured by the RSSI input pin on the SBUS-out connector (the bottom pin of the 2nd last servo connector on the 14 connector servo rail).

The Pixhawk has no dedicated digital output or input pins on its DF13 connectors, but you can assign up to 6 of the “AUX SERVO” connectors to be digital GPIO outputs/inputs. These are the first 6 of the 14 three-pin servo connectors on the end of the board. They are marked as AUX servo pins 1 - 6 on the silkscreen as seen above.

To set the number of these pins that are available as digital inputs/outputs, set the BRD_PWM_COUNT parameter. On Pixhawk this defaults to 4, which means the first 4 AUX connectors are for servos (PWM) and the last 2 are for digital inputs/outputs. If you set BRD_PWM_COUNT to 0 then you would have 6 virtual digital pins and still have 8 PWM outputs on the rest of the connector

The specifications of Pixhawk flight controller include the following.

Processor:

1. 32bit STM32F427 Cortex M4 core with FPU.
2. 32-bit STM32F103 failsafe co-processor.
3. 168 MHz.
4. 128 KB RAM.
5. 2 MB Flash.

Sensors:

1. ST Micro L3GD20H 16 bit gyroscope.
2. ST Micro X4HBA 303H 14-bit accelerometer/magnetometer.
3. Invensense MPU 6000 3-axis accelerometer/gyroscope.
4. MEAS MS5607 barometer.

Interfaces:

1. 5x UART (serial ports), one high-power capable, 2x with HW flow control.
2. 2x CAN (one with an internal 3.3V transceiver, one on expansion connector).
3. Spektrum DSM / DSM2 / DSM-X® Satellite compatible input.
4. Futaba S.BUS® compatible input and output.
5. PPM sum signal input.
6. RSSI (PWM or voltage) input.
7. I2C.
8. SPI.
9. 3.3 and 6.6V ADC inputs.
10. Internal micro USB port and external micro USB port extension

ESC 30A-

Features-

- High quality MOSFETs for BLDC motor drive
- High performance microcontroller for best compatibility with all types of motors at greater efficiency
- Fully programmable with any standard RC remote control
- Heat sink with high performance heat transmission membrane for better thermal management
- 3 start modes: Normal / Soft / Super-Soft, compatible with fixed wing aircrafts and helicopters
- Throttle range can be configured to be compatible with any remote control available in the market
- Smooth, Linear and Precise throttle response
- Low-Voltage cut-off protection
- Over-heat protection
- Separate voltage regulator IC for the microcontroller to provide anti-jamming capability
- Supported Motor Speed (Maximum): 210000RPM (2 poles), 70000RPM (6poles), 35000RPM (12 poles)

Connections:

BLDC ESC has three Blue wires coming out from the one end which are to be connected to the BLDC motor. On the other end, it has red and black wires which are to be connected to the battery. It also has a 3 pin servo connector which is used for receiving the throttle command and for giving out regulated 5V, 3Amp supply for the remote receiver and the servo motors.: -

Connection type	Wire Colour	Function
Power	Red	7.4 to 14.8V
	Black	Ground
BLDC Motor Connections	Three Black Wires	BLDC ESC connections
signal	White and black	Signal and ground

3300 mAh Battery-

Specifications-

- 3300mAh LiPo Battery Specifications (General)
- Capacity: 3300mAh (3.3Ah) - Cell Count: Typically 3S (11.1V) or 4S (14.8V)
- Voltage per Cell: 3.7V nominal (4.2V fully charged) - Discharge Rate (C): Usually 20C to 60C (e.g., 30C = 99A max draw)
- Max Discharge Current: 30C x 3.3Ah = 99A (depends on rating)
- Charge Rate: 1C recommended (3.3A), up to 2-5C if supported
- Connector Type: XT60, Deans T-plug, or EC3/EC5 (varies)
- Weight: ~250-350g (depends on brand & C-rating)
- Dimensions: ~135mm x 44mm x 24mm

11. FUND SANCTION SHEET

To,

Dr. S. D. Chede Sir

Project Guide

DYPCET, Kolhapur

Subject: Quotation Request – Autonomous Surveillance Drone Components

s

Respected Sir,

This letter is to request your approval for the purchase of necessary components for our autonomous surveillance drone project. Attached, please find a detailed quotation outlining the required parts, their specifications, quantities, and associated costs.

Sr. No.	Component	Price	Quantity	Total
1	Benewake TF-LUNA Micro LiDAR Distance Sensor for IoT ITS (8M)	2,000/-	3	6,000/-
2	YDLIDAR G2 360° 2D LiDAR Sensor	12,994	1	12,994
3	Miscellaneous (26 gauge wires, battery straps, delivery charges)	1,500	-	1,500
			TOTAL	20,494/-

We have carefully selected these components to ensure optimal performance and compatibility for our project's objectives. We believe this selection provides the best balance of quality and cost-effectiveness.

We would appreciate it if you could review the attached quotation and provide your feedback and approval at your earliest convenience.

Thank you for your time and consideration.

Sincerely,

Chirag Neware (Team Leader)

EN21146162

Form No. 2 & 3.

Forwarded to Hon. Executive Director

Balee
24/04/2025

OK.
Go ahead
30/04/25

RESEARCH
PAPER
PUBLICATION
AND
CERTIFICATE



Autonomous Surveillance Drone

(Case study for campus surveillance)

Mr. Chirag .A. Neware¹, Miss. Aliya A. Bagwan², Mr. Abhishek .U. Chavan³, Mr. Swapnil .M. Patil⁴, Miss. Anjali .P.Nagarkar⁵

ABSTRACT

The Autonomous Surveillance Drone project presents a sophisticated, drone- based surveillance system designed to enhance campus safety through real-time monitoring and crowd detection. This project features a drone that autonomously navigates designated paths across the college campus, capturing live video footage and using object detection algorithms to identify and count individuals within each frame. The processed footage is securely streamed to a custom-built website accessible only to authorized personnel. Access to this website is safeguarded with user authentication, ensuring that only users with valid credentials can monitor the surveillance footage.

The website displays the live stream with an overlay that highlights detected individuals, providing an intuitive visual indication of crowd presence in various campus areas. Additionally, the platform includes live analytics such as the current count of people detected in each frame, aiding in crowd management and security oversight. Integrating autonomous flight, secure live streaming, and advanced computer vision, this project delivers a comprehensive, secure, and efficient surveillance solution. The system leverages modern technologies to enable real-time monitoring with minimal human intervention, creating a scalable model for automated campus surveillance that prioritizes security and privacy.

INTRODUCTION

The growing need for effective surveillance and security in public spaces has driven interest in automated systems that can monitor environments in real-time. Traditional surveillance infrastructure, which relies on stationary cameras and manual monitoring, often falls short in large and dynamic settings such as college campuses, where wide coverage and flexibility are essential. To address these limitations, this project introduces an Autonomous Surveillance Drone designed to enhance campus safety through intelligent, real-time monitoring and data- driven insights.

This project centers on an unmanned aerial vehicle (UAV) equipped with a high- resolution camera and an array of sensors, enabling it to autonomously navigate designated routes across the campus. As the drone moves, it captures video footage and processes the images using advanced object detection algorithms. These algorithms identify individuals within each frame, providing a live count of people in the observed areas.

This information is invaluable for understanding crowd density and movement patterns, supporting security teams in managing large gatherings, and ensuring public safety in high-traffic zones. One of the key components of this project is the integration of a secure, custom- built web interface that displays the live footage from the drone, enhanced with an overlay of detected individuals. This platform is accessible only to authorized users, requiring credential verification to ensure that surveillance data remains secure and confidential.

The web interface provides not only a visual feed but also real-time analytics on crowd counts, giving campus authorities a comprehensive, user-friendly tool for remote monitoring. By combining autonomous navigation, object detection, and live streaming within a secure framework, the Autonomous Surveillance Drone project demonstrates the potential of UAV technology to serve as a scalable, adaptive surveillance solution. This system minimizes the need for human intervention, freeing up resources while delivering reliable, continuous monitoring. Furthermore, the project illustrates the transformative impact of artificial intelligence and computer vision on campus security, highlighting a future where intelligent drones provide real-time situational awareness and contribute to a safer campus environment.

2. Problem Statement:

Ensuring safety and effective crowd management on large college campuses is a challenging task, particularly with conventional surveillance systems that rely on fixed cameras and manual monitoring. These traditional systems are limited in scope and flexibility, often leaving blind spots and requiring significant human resources to monitor and analyze footage continuously. Additionally, the static nature of fixed surveillance cameras restricts their ability to adapt to dynamic crowd movement, reducing their effectiveness in monitoring larger, more populated areas. Given these limitations, there is a need for an innovative surveillance solution that can autonomously cover wide areas, detect individuals in real-time, and provide actionable insights on crowd density and movement. Such a system should also ensure secure access, allowing only authorized personnel to view and analyze the footage



This project aims to address these challenges by developing an Autonomous Surveillance Drone capable of autonomously navigating the campus, capturing live footage, detecting and counting people, and streaming this data securely to a custom-built web interface. This approach offers a scalable, adaptive solution to improve campus security and situational awareness while reducing the reliance on manual surveillance efforts.

3. Block Diagram:

3.1 Air Unit

3.1.1 Router

A router is a networking device that forwards data packets between computer networks. It connects multiple networks, typically a local area network (LAN) to a wide area network (WAN) or the internet. Routers use IP addresses to determine the best path for forwarding data, manage traffic to avoid congestion, and ensure data packets reach their destination accurately and efficiently.

3.1.2 GPS Module-

A GPS module for a surveillance drone is a compact electronic device that receives and processes satellite signals from the Global Positioning System (GPS) to provide accurate location, altitude, velocity, and timing information to the drone's autopilot system, enabling precise navigation, tracking, and geo-tagging of captured data, while supporting autonomous flight operations and mission planning in various surveillance applications.

3.1.3 Telemetry Transmitter–

A telemetry transmitter is a device that collects and sends data from a remote or inaccessible location to a receiving system for monitoring and analysis. It typically consists of sensors, which measure various parameters (like temperature, pressure, or speed), and a transmitter, which sends the collected data to a central receiver or monitoring system.

3.1.4 Electronic Speed Controller (ESC)-

An Electronic Speed Controller (ESC) is a key component in various electrical systems, particularly in drones, RC vehicles, and electric vehicles. The primary role of an ESC is to regulate the speed of an electric motor by adjusting the amount of electrical power sent to it. This is achieved by interpreting signals from a control system (like a flight controller in a drone) and modulating the motor's speed accordingly.

3.1.5 Obstacle Avoidance Sensor

An obstacle avoidance sensor is a critical component in autonomous systems, such as drones, robots, and vehicles. Its primary function is to detect obstacles in the path of the system and prevent collisions by providing real-time information about the environment.

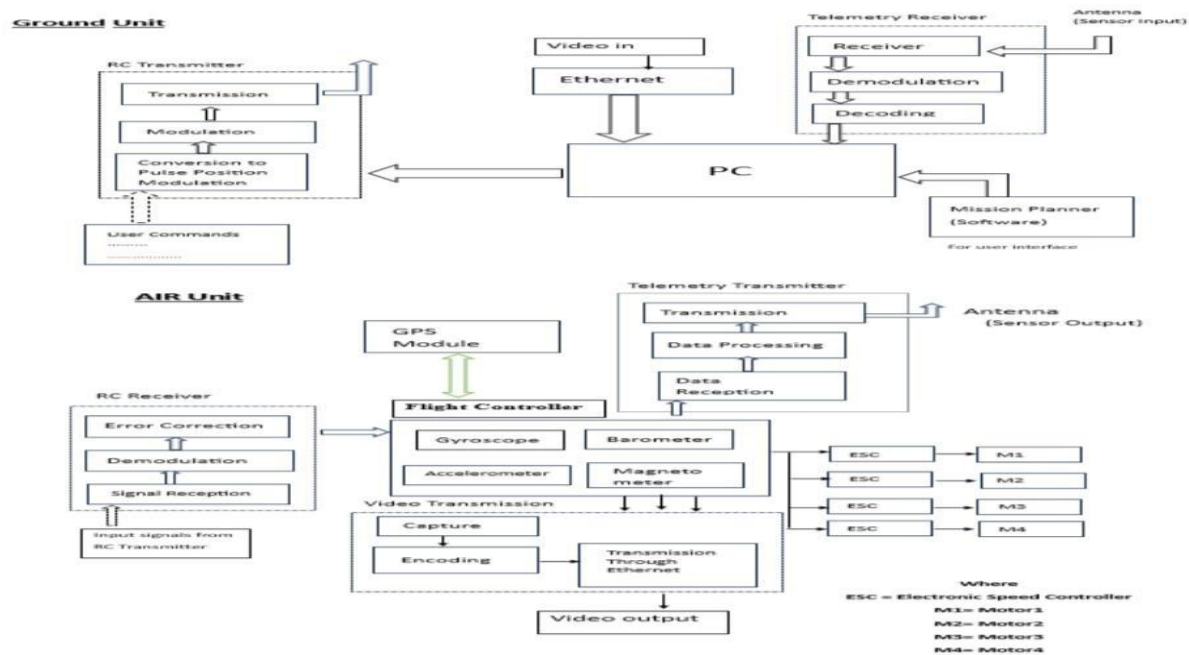
3.2 Ground Unit

3.2.1 Ground Control System –

A Ground Control System (GCS) is an essential component in managing and operating unmanned systems like drones, spacecraft, and autonomous vehicles from a remote location. The GCS provides operators with the means to control and monitor the unmanned system. It enables real-time communication, data analysis, and decision-making to ensure the system performs as intended.

3.2.2 Video Receiver

A video receiver is a device used to receive and decode video signals transmitted wirelessly from a video transmitter, such as those used in drones, security cameras, or live streaming applications. The primary role of a video receiver is to capture the video signals sent by a transmitter, decode them, and display or process the video feed. This allows users to view live video content from a remote source.



**Fig 1.0 Block Diagram
LITERATURE REVIEW**

[1] “An Amateur Drone Surveillance System Based on Cognitive Internet of Things” Qihui Wu is with the Department of Electronics and Information Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing 210007, China (email: wuqihui2014@sina.com). Majority of the related work have focused on how to enable various individual surveillance devices or systems to see, hear and sense the physical world for drone surveillance. Making surveillance devices or systems connected to share the observations and to accomplish information fusion represent a research trend. In this article, we argue that only connected is not enough, beyond that, surveillance devices should have the capability to learn, think, and understand both physical and social worlds by themselves.

This practical need impels us to develop a new vision, named Dragnet, i.e., cognitive Internet of Things-enabled amateur drone surveillance, in order to empower the amateur drone surveillance with a “brain” for high-level intelligence [2] “Applications and Challenges in Video Surveillance via Drone: A Brief Survey” Naqqash Dilshad, JaeYoung Hwang, JaeSeung Song* Department of Information Security Sejong University Seoul, South Korea {dilshadnaqqash, forest62590}@sju.ac.kr, jssong@sejong.ac.kr This article focuses on video surveillance using drones in object detection and tracking, video summarization, persistent monitoring of the target, search and rescue operation in a hostile environment, traffic management in smart cities, and disaster management in an apocalyptic situation. This brief survey sheds light on the research gaps and profound insights of the methods used in the mentioned articles by opening up future research tracks for the Computer Vision (CV) enthusiasts using Unmanned Aerial Vehicles (UAV).

CONCLUSION

The Autonomous Surveillance Drone project successfully demonstrates the integration of drone technology, computer vision, and real-time streaming for security and surveillance purposes. The drone is capable of detecting people in its field of view, counting them, and providing live footage streamed to a secure website. The use of the ESP32-CAM for video streaming has proven effective for real-time applications, while the object detection algorithms ensure accurate and efficient people identification. The system's secure access feature further enhances privacy and ensures that only authorized users can view the footage.



Overall, this project showcases the potential of autonomous drones in surveillance applications, particularly in monitoring large areas like college campuses. The combination of computer vision and live streaming provides a comprehensive solution for automated monitoring, with real-time insights into people movement and activity.

Future Scope

The future scope of the Autonomous Surveillance Drone project holds immense potential for further enhancement and expansion. One key area for improvement is the advancement of object detection capabilities. Future versions could include the ability to detect a broader range of objects or behaviors, such as specific actions like loitering, or even recognize different types of individuals, enhancing the system's ability to identify specific threats or important events. Additionally, the drone's autonomy could be significantly enhanced through the integration of advanced navigation and path planning algorithms, enabling it to autonomously adjust its flight path based on detected objects or areas requiring more focus.

This would reduce the need for manual control and make the system more adaptable to dynamic environments. Furthermore, the live streaming system could be upgraded to handle higher resolution videos and incorporate cloud storage solutions for more scalable video storage and easier retrieval. Real-time alerts could also be implemented to notify security personnel when unusual activity is detected, such as large crowds or suspicious behaviors, enhancing the system's utility in proactive security monitoring. Additionally, equipping the drone with more advanced sensors, like thermal imaging, would allow it to detect people in low-light conditions or at night, extending the operational capabilities of the surveillance system.

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IJARESM

ISSN: 2455-6211, New Delhi, India

International Journal of All Research Education & Scientific Methods

An ISO & UGC Certified Peer-Reviewed & Refereed Multi-disciplinary Journal

UGC Journal No. 7647

Certificate of Publication

Mr. Chirag .A. Neware

TITLE OF PAPER

**Autonomous Surveillance Drone
(Case study for campus surveillance)**

has been published in

IJARESM, Impact Factor: 8.536, Volume 12 Issue 12, December.-2024

Certificate Id: IJ-2812240340

Date: 28-12-2024



Website: www.ijaresm.com
Email: editor.ijaresm@gmail.com



Authorized Signatory

OPERATING

MANUAL

14.OPERATING MANUAL

BEVM FEATURES-

1. Navigation & Control

GPS-based autonomous path following
Waypoint missions using Mission Planner
Return-to-Launch (RTL) on low battery or signal loss
Geofencing to keep the drone within a safe area
Altitude hold and position hold
Auto take-off and auto landing

2. Surveillance & Monitoring

Live video feed to ground station (FPV)

3. Communication & Alerts

Telemetry video transmission (flight data to GCS)

4. Safety & Recovery

Obstacle avoidance sensors (e.g., ultrasonic, LiDAR)

5. Power & Maintenance

Battery level monitoring
Modular design for easy repairs

Mission Execution

1. Final Checks
 - Ensure propellers are removed for arming test.
 - Verify telemetry and live video streaming to ground station.
2. Arming and Takeoff
 - Arm the drone from Mission Planner or RC transmitter.
 - Switch to AUTO mode for autonomous takeoff and mission execution.
3. Autonomous Flight
 - Drone follows predefined path using GPS navigation.
 - Onboard camera captures live video.
 - Telemetry (position, altitude, battery, etc.) is sent to ground station.
4. Mission Completion
 - Upon final waypoint, drone automatically returns to launch point or lands.
 - Disarm the drone and power down safely.

SOFTWARE INTERFACE



Pre-Flight Setup

- Pre-Flight Checklist Ensure all connections (motors, GPS, telemetry, cameras) are secure.
- Verify GPS antenna has a clear view of the sky.
- Fully charge the 3300mAh battery and check voltage levels.
- Confirm radio signal strength between the Pixhawk and FS-i6S transmitter.
- Inspect frame integrity and propeller attachment.
- Connect to Mission Planner Software Plug Pixhawk flight controller into a laptop via USB.
- Launch Mission Planner software and establish a connection.
- Read and verify live sensor data (battery, orientation, GPS, RC inputs).
- Sensor Calibration Calibrate accelerometer, compass, and radio channels using Mission Planner.
- Perform ESC calibration if required.
- GPS Configuration.
- Wait for GPS to acquire at least 6–8 satellites.
- Confirm valid GPS lock (3D Fix) is visible on Mission Planner.
- Flight Path Setup.
- Use the Flight Plan tab to set waypoints for surveillance route.
- Define altitude, speed, and hold times per waypoint.
- Save and upload the mission to Pixhawk.
- Safety Configuration.
- Set Failsafe modes (RTL – Return to Launch on signal loss).
- Define flight modes (Auto, Loiter, RTL) for switchable control.

14.GROUP PHOTO WITH GUIDE



THANK YOU