QUADCOPTER WITH LONG RANGE AERIAL SURVEILLANCE AND OBJECT DETECTION SYSTEM

A MAJOR PROJECT PHASE II REPORT

Submitted in partial fulfilment of the requirement for the award of the degree Bachelor of Engineering

In

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

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Certified that the major project work titled **'Quadcopter With Long Range Aerial Surveillance and Object Detection System'** is carried out by **KIRAN KUMAR T S (1MJ21EC058), M MANOHAR NAIK (1MJ21EC065), MANJUNATHA Y E (1MJ21EC069),** and **RAHUL DIXIT(1MJ21EC107),** who are bonafied students of MVJ College of Engineering, Bengaluru, in partial fulfilment for the award of degree of **Bachelor of Engineering in Electronics & Communication Engineering** of the Visvesvaraya Technological University, Belagavi during the year 2024-2025. It is certified that all corrections/suggestions indicated for the Internal Assessment have been incorporated in the major project II report deposited in the departmental library. The major project report has been approved as it satisfies the academic requirements in respect of major project work prescribed by the institution for the said Degree.

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DECLARATION

We, Kiran Kumar T S, M Manohar Naik, Manjunatha Y E, Rahul Dixit. students of Eighth semester B.E., Department of Electronics & Communication Engineering, MVJ College of Engineering, Bengaluru, hereby declare that the major project titled ***'Quadcopter With Long Range Aerial Surveillance and Object Detection System'*** has been carried out by us and submitted in partial fulfilment for the award of Degree of **Bachelor of Engineering in Electronics & Communication Engineering** during the year 2024-2025.

Further we declare that the content of the dissertation has not been submitted previously by anybody for the award of any Degree or Diploma to any other University.

We also declare that any Intellectual Property Rights generated out of this project carried out at MVJCE will be the property of MVJ College of Engineering, Bengaluru and we will be one of the authors of the same

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ABSTRACT

The increasing demand for advanced surveillance solutions has propelled the development of drone technology integrated with IoT and real-time object detection systems. This project, **“Quadcopter with Long Range Aerial Surveillance and Object Detection System,”** aims to design and implement a robust quadcopter equipped with an ESP32-CAM module for efficient surveillance and detection.

The quadcopter system utilizes a Wi-Fi-enabled ESP32-CAM module integrated with a camera for real-time video streaming and image capture. Its structural base includes BLDC motors, an electronic speed controller, and a flight controller for stable navigation. The project emphasizes long-range communication, achieved through dual-band Wi-Fi antennas, and efficient power management using lithium-ion batteries.

Methodology involved the design of hardware and software systems, integration of components, and testing of object detection capabilities using machine learning models. Challenges such as environmental constraints, battery limitations, and computational trade-offs were addressed through iterative design and optimization.

The results demonstrate the quadcopter's capability for aerial surveillance and reliable object detection in real-time, showcasing applications in areas like disaster management, agriculture, and security. This project contributes to the growing field of drone-based solutions, highlighting opportunities for scalability and further innovation in autonomous aerial systems.

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INTRODUCTION

CHAPTER 1

INTRODUCTION

In recent years, advancements in drone technology and the integration of the Internet of Things (IoT) have revolutionized surveillance systems. These developments have enabled drones to perform tasks such as real-time monitoring, object detection, and data collection over large areas. However, existing solutions face challenges such as high costs, limited range, and energy inefficiency, which hinder their widespread adoption. Addressing these limitations, the proposed project, **"Quadcopter with Long Range Aerial Surveillance and Object Detection System,"** seeks to develop an efficient, cost-effective, and scalable solution for modern surveillance needs.

The demand for aerial surveillance systems has grown exponentially due to the increasing need for real-time monitoring in sectors like security, disaster management, and agriculture. Traditional systems, including fixed surveillance cameras and manned patrols, are often inadequate for large or inaccessible areas. Drones, or unmanned aerial vehicles (UAVs), offer a versatile and efficient alternative by combining mobility, advanced camera systems, and real-time data transmission capabilities.

The proposed quadcopter system integrates an ESP32-CAM module with a camera, enabling real-time video streaming and object detection. The ESP32-CAM, powered by Wi-Fi connectivity, facilitates long-range communication of up to 200 meters, making it suitable for diverse applications. The quadcopter is equipped with lightweight and energy-efficient components, such as BLDC motors and lithium-ion batteries, to ensure stability and extended flight time. The software leverages advanced machine learning models, including YOLOv3, for accurate and reliable object detection, even in challenging environments.

1.1 Background

The evolution of drone technology has transformed the landscape of modern surveillance systems. With advancements in hardware and software, drones are now capable of performing tasks that were once the domain of expensive, stationary, or human-operated systems. This shift is driven by the growing demand for real-time monitoring, long-range surveillance, and precise object detection in sectors like security, agriculture, and disaster management. However, despite their potential, many existing drone systems face significant challenges, such as high operational costs, limited range, and environmental sensitivity, which limit their widespread adoption.

Traditional surveillance methods, such as closed-circuit television (CCTV) systems or manned patrols, often fall short in addressing the needs of dynamic and large-scale environments. These systems are stationary, require significant infrastructure investments, and lack the mobility needed for applications like disaster relief or border security. Drones, on the other hand, offer unparalleled flexibility and coverage. They can traverse vast areas quickly, provide real-time visual feedback, and reach locations that are otherwise inaccessible. However, the complexity and cost of many commercial drones render them impractical for smaller organizations or specialized use cases.

To address these challenges, the **"Quadcopter with Long Range Aerial Surveillance and Object Detection System"** project focuses on designing an efficient, cost-effective, and scalable solution. This project leverages the ESP32CAM module, a low-cost yet powerful microcontroller with an integrated camera, to provide real-time video streaming and object detection capabilities. The integration of dual-band Wi-Fi antennas enables long-range communication of up to 200 meters, making the system suitable for a variety of applications. Additionally, the quadcopter is built using energy-efficient components such as BLDC motors and lightweight lithium-ion batteries, ensuring stability and extended operational time.

The rise of IoT has further enhanced the utility of drones in surveillance applications. By integrating IoT-enabled sensors and communication modules, drones can not only capture and transmit real-time data but also process it for actionable insights. This project adopts a similar approach, combining hardware and machine learning-based software for enhanced performance. The use of YOLOv8, a state-of-the-art object detection algorithm, ensures accurate identification of objects even in challenging environmental conditions, such as low light or partial obstructions.

As surveillance needs grow in complexity and scale, the demand for accessible and versatile drone systems has increased. Applications such as monitoring agricultural fields, tracking wildlife, assessing disaster-stricken areas, or ensuring security in large facilities require a solution that is both reliable and cost-effective. The proposed system bridges the gap between high-performance drones and affordable surveillance solutions by using open-source hardware and software, ensuring broad accessibility.

In summary, this project builds on the potential of drones to revolutionize surveillance systems. It addresses key limitations in existing systems by providing a modular, scalable, and energy-efficient quadcopter design capable of real-time monitoring and object detection over long distances. By combining affordability with advanced functionality, the proposed system has the potential to serve diverse fields, making cutting-edge surveillance technology accessible to a broader audience.

1.2 Problem Statement

Surveillance systems play a critical role in ensuring safety, security, and operational efficiency in various sectors such as defines, agriculture, disaster management, and urban monitoring. However, existing surveillance technologies, including traditional closed-circuit television (CCTV) systems, stationary cameras, and manual patrols, face several limitations. These systems are often fixed in scope, expensive to deploy, and incapable of providing real-time data over vast or inaccessible areas. Furthermore, their reliance on static infrastructure and human intervention reduces their effectiveness in dynamic environments where mobility and adaptability are essential.

Drones, or unmanned aerial vehicles (UAVs), offer a promising alternative by enabling mobile surveillance and real-time data capture over large areas. Despite their advantages, most commercially available drones are constrained by significant challenges. Key issues include:

1. **Limited Operational Range:** Many drone systems rely on line-of-sight communication or Bluetooth technology, which restricts their effective range. This limitation makes them unsuitable for large-scale applications, such as border surveillance or monitoring extensive agricultural fields.
2. **High Cost:** Advanced drones equipped with features like object detection, long-range communication, and high-resolution imaging are prohibitively expensive. This makes them inaccessible for small-scale users, organizations with limited budgets, or applications requiring multiple drones.
3. **Energy Inefficiency:** The power consumption of drone systems, especially when equipped with advanced cameras and sensors, often reduces flight time. This limits their usability for extended missions and increases downtime for battery recharging.
4. **Environmental Sensitivity:** Many drones struggle to operate in harsh environmental conditions, such as strong winds, variable lighting, or low temperatures. These factors significantly impact their stability, performance, and reliability.

5. **Object Detection Challenges:** Real-time object detection in drone systems is often hindered by processing delays, environmental noise, and the limitations of onboard hardware. Ensuring high accuracy under varying conditions remains a critical challenge.

These challenges highlight the need for a drone-based solution that addresses the limitations of existing systems while maintaining affordability and scalability. The proposed **"Quadcopter with Long Range Aerial Surveillance and Object Detection System"** aims to bridge this gap by leveraging low-cost, efficient components such as the ESP32-CAM module and BLDC motors. This system integrates real-time object detection using advanced machine learning algorithms and ensures long-range communication through dual-band Wi-Fi antennas.

The project is designed to achieve:

- An extended operational range of up to 200 meters, enabling coverage of larger areas.
- Cost-effective hardware and software integration, ensuring affordability for small-scale users.
- Energy-efficient operation for longer flight durations, reducing downtime.
- Reliable performance in diverse environmental conditions, ensuring adaptability.
- Real-time object detection with high accuracy, enhancing the system's utility for applications like disaster management and security monitoring.

By addressing these challenges, this project seeks to create a scalable, modular, and reliable drone system that caters to diverse use cases. The problem statement underscores the need for innovative solutions to overcome the barriers faced by existing drone and surveillance technologies.

1.3 Objective

The primary aim of the project **"Quadcopter with Long Range Aerial Surveillance and Object Detection System"** is to develop a cost-effective, efficient, and scalable drone system capable of addressing the limitations of existing surveillance technologies. This quadcopter is designed to provide real-time aerial monitoring, extended range, and reliable object detection capabilities for diverse applications such as security, agriculture, and disaster management. The objectives of this project are outlined as follows:

1. Develop a Long-Range Surveillance System

The project seeks to create a drone system capable of maintaining stable communication and video transmission over a range of up to 200 meters.

By integrating dual-band Wi-Fi antennas, the quadcopter ensures reliable longrange connectivity, making it suitable for monitoring large areas such as agricultural fields, industrial complexes, or disaster zones.

2. Implement Real-Time Object Detection

A critical goal of the project is to enable the quadcopter to detect and identify objects in real time. The system leverages the ESP32-CAM module for video streaming and integrates YOLOv3 (You Only Look Once) machine learning algorithms to ensure high accuracy in object detection, even under challenging environmental conditions such as low light or partial obstructions.

4. Ensure Cost-Effectiveness and Accessibility

The proposed system is designed using affordable, open-source hardware and software components to reduce overall costs. By keeping the design modular and accessible, the project ensures that the system is practical for small-scale users, educational institutions, and organizations with limited budgets.

6. Create a Modular and Scalable System

To ensure future adaptability, the quadcopter system is designed with a modular architecture. This allows for easy integration of additional sensors, advanced communication protocols (e.g., 5G), or AI-based features such as autonomous navigation and decision-making. The modularity also facilitates customization for specific use cases, such as wildlife monitoring or industrial inspections.

9. Facilitate Real-Time Data Transmission and Processing

To support immediate decision-making, the system is designed to transmit real-time data to a ground station. The integration of Wi-Fi modules and efficient video processing ensures minimal delays and reliable communication between the quadcopter and the user interface.

CHAPTER 2

LITERATURE REVIEW

CHAPTER-2

LITERATURE REVIEW

2.1 Existing Drone Systems

M. Demirhan and C. Premachandra, in their paper titled “Development of an Automated Camera-Based Drone Landing System,” published in **IEEE Access, vol. 8, pp. 202112-202121, Oct. 2020** (doi: 10.1109/ACCESS.2020.3034948), present a sophisticated approach to automating drone landings using camera-based technologies. Their methodology involved preprocessing captured images to correct lens distortions and enhance critical features, followed by employing a multichannel Convolutional Neural Network (CNN) to classify and detect browning or dead trees. To further improve accuracy, the system integrated multispectral data with vegetation indices such as the Normalized Difference Vegetation Index (NDVI). While highly innovative, the system faced several drawbacks, including high cost and complexity due to the advanced hardware and software requirements, sensitivity to environmental factors like lighting and weather conditions, substantial data processing demands, and limitations in detection precision caused by the camera's resolution.

H. G. Park, J. P. Yun, M. Y. Kim, and S. H. Jeong, in their paper titled “Multichannel Object Detection for Detecting Suspected Trees With Pine Wilt Disease Using Multispectral Drone Imagery,” published in **IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, Aug. 2021** proposed a method for drone-based object detection and landing system using visual markers. The methodology involved using pre-designed patterns on the landing area, which the onboard camera detects and processes using machine learning algorithms to guide the drone. The system incorporated real-time adjustments to maintain landing accuracy under environmental variations such as wind or lighting changes. However, the system had notable drawbacks, including its reliance on markers that could be obscured or damaged, challenges in adapting to complex or unpredictable environmental conditions, limited adaptability for marker-free scenarios, and significant power consumption due to the real-time processing requirements.

H. Takano, M. Nakahara, K. Suzuoki, Y. Nakayama, and D. Hisano, in their paper titled "300-Meter Long-Range Optical Camera Communication on RGB-LED-Equipped Drone and Object-Detecting Camera," published in **IEEE Access, vol. 10, May 2022** introduced a method for long-range optical communication using RGB LEDs mounted on drones. The system involved transmitting light signals from the drone, which were captured by a high-speed camera on the ground. Machine learning algorithms, specifically YOLOv3, were employed to detect the drone based on these light signals. Signal processing techniques were utilized to minimize interference, such as RGB light mixing, and to enhance the clarity of the communication. Despite its innovative approach, the system faced several drawbacks, including the need for a clear line of sight, sensitivity to environmental factors like weather or lighting conditions, low data transmission rates, the complexity of camera setup, and high energy consumption due to the continuous signal processing.

Sutthiphong Srigrarom, Niven Jun Liang Sie, Huimin Cheng, and Kim Hoe Chew, in their paper titled "Multi-camera Multi-drone Detection, Tracking and Localization with Trajectory-based Re-identification," presented at the **2021 Second International Symposium on Instrumentation, Control, Artificial Intelligence, and Robotics (ICA-SYMP), 2021**, proposed a hybrid detection approach for multidrone systems. The methodology involved the use of multiple cameras for 2D localization, and 3D global position estimation for accurate drone tracking. They implemented a trajectory-based identification and re-identification technique to track and locate drones effectively over time. Despite its advanced capabilities, the system had notable drawbacks, including positional errors that can arise during tracking, a high dependency on camera coverage for detection, the complexity of setup and calibration for multi-camera systems, limited detection in complex environments, high computational demand for processing the data, and sensitivity to environmental factors like lighting or obstacles.

Suet-Peng Yong and Yoon-Chow Yeong, in their paper titled "Human Object

Detection in Forest with Deep Learning based on Drone's Vision," presented at the **2018 4th International Conference on Computer and Information Sciences (ICCOINS), 2018, Perak Darul Ridzuan, Malaysia**, introduced a deep learningbased framework for detecting human objects in forest environments using drone vision. The methodology involved collecting and preprocessing data from drone imagery, followed by training a deep learning model to perform real-time object detection. The system aimed to enhance detection accuracy in challenging forested environments. However, it faced several drawbacks, including the potential for false detections due to environmental noise, scalability issues when applied to large areas, energy efficiency concerns due to the computational load of deep learning models, and sensitivity to weather and environmental factors that could affect detection accuracy.

Chen, H., Wang, J., Li, J., Qiu, Y., and Zhang, D., in their paper titled "Small Object Detection for Drone Image Based on Advanced YOLOv7," presented at the **IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS), 2024**, proposed an advanced method for small object detection in drone imagery using the YOLOv7 model. The methodology incorporated a large kernel backbone, a BiFPN (Bidirectional Feature Pyramid Network) structure, and structural reparameterization to enhance detection accuracy, particularly for small objects that are typically difficult to detect in aerial imagery. Despite its advancements, the system had several drawbacks, including increased computational cost due to the complexity of the model, the introduction of extra parameters that could complicate the model, limited generalization across diverse datasets or environments, and high dependency on computational resources, which could limit its practical deployment in resource-constrained environments.

Yong, S.-P., and Yeong, Y.-C., in their paper titled "Human Object Detection in

Forest with Deep Learning based on Drone's Vision," presented at the **4th International Conference on Computer and Information Sciences (ICCOINS), 2018, IEEE**, introduced a deep learning-based approach for detecting humans and vehicles in forest environments using drone vision. The methodology involved the use of Mobile Net (a Convolutional Neural Network, CNN) and SSD (Single Shot Multibox Detector) for real-time object detection. The model was trained using TensorFlow and Caffe with pre-processed image data, and its performance was evaluated using metrics such as Precision, Recall, and F-Score. Despite the innovative approach, the system faced several drawbacks, including the limited size of the dataset, which could affect generalization, slower detection speed, sensitivity to environmental factors like weather or lighting changes, and heavy reliance on camera quality for accurate detection.

M. M. Barhoush, A. S. Jaradat, N. S. Saleh, and I. S. Saleh, in their paper titled "Mobile Object Detection and Tracking Using DRONES," presented at the **2023 International Conference on Information Technology (ICIT), pp. 125–129, 2023** (DOI: 10.1109/ICIT58056.2023.10226037), discussed a drone-based system for mobile object detection and tracking. The methodology involved controlling the drone using Python-based programming, implementing the HAAR cascade algorithm for face detection, and incorporating mobile object tracking for surveillance and UAV control. While the system demonstrated significant potential for real-time object tracking, it faced several drawbacks, including complexities in obtaining import permissions for the required software and hardware, technical constraints in processing and controlling drone movements, and challenges posed by environmental factors such as weather conditions, which could affect the system's performance and tracking accuracy.

Seno Darmawan Panjaitan, Yohana Sutiknyawati Kusuma Dewi, Muhammad Irfani Hendri, and Romario Aldrian Wicaksono, in their paper titled "A Drone Technology Implementation Approach to Conventional Paddy Fields Applications," presented in **2022**, explored the use of agricultural drones in modern farming, particularly in paddy fields. The methodology involved integrating drone technology into conventional farming practices, which required addressing challenges such as prolonged exposure to toxic chemicals, and monitoring critical agricultural metrics like leaf length and tiller number for crop health assessment. Despite the advantages of precision agriculture, the system faced several drawbacks, including high initial costs for drone setup, limited flight time due to battery constraints, dependence on favourable weather conditions for effective operation, restricted payload capacity that limited the scope of applications, challenges with data accuracy and processing, and accessibility issues in rural or difficult-to-reach farming areas.

Singh, P., and Krishnamurthi, R., in their paper titled “IoT-based real-time object detection system for crop protection and agriculture field security,” published in the **Journal of Real-Time Image Processing, 21, 106, 2024**, proposed an IoT-based system designed to enhance crop protection and security in agricultural fields. The methodology employed ultrasonic sensors to detect movement, triggering image capture through devices like Raspberry Pi or ESP32-CAM. An optimized YOLOv8 object detection model processed these images on a Linux server, and the results were sent to farmers via Firebase Cloud Messaging (FCM) for real-time alerts through a mobile app. The system was implemented in two configurations: a Raspberry Pi-based system, which offers higher processing power but consumes more energy, and a LoRa-based ESP32 system, which is more energy-efficient and ideal for remote areas with limited power sources. However, the system had several drawbacks, including environmental sensitivity, requiring careful consideration of weather and lighting conditions. It also faced computational and energy trade-offs, especially in the Raspberry Pi configuration, and encountered challenges in cost, infrastructure, scalability, and power consumption, particularly in remote areas with limited access to energy.

2.2 Identified Challenges

The problem statement we are addressing focuses on testing the feasibility of implementing the **ESP32-CAM** module for **long-range aerial surveillance** and **object detection** in a **drone system**. The primary goal is to evaluate whether the ESP32-CAM, a compact and cost-effective camera module, can function effectively in the context of drone operations that require monitoring large areas and detecting objects from a distance. Long-range aerial surveillance is essential for applications such as agriculture, security, and wildlife monitoring, where drones need to capture video or images over extended areas while maintaining stable communication with the ground station. The ESP32-CAM’s ability to sustain a reliable connection and transmit data over long distances is a key consideration in this project. Additionally, object detection is critical for identifying and tracking items of interest, like vehicles or people, within the drone's field of view. Given the ESP32-CAM's relatively limited computational power, it is crucial to test whether it can handle real-time object detection using optimized algorithms such as **YOLO** (You Only Look Once) while maintaining efficiency. The challenge is to ensure the ESP32-CAM can deliver accurate surveillance data and object detection performance within the constraints of limited processing power, range, and environmental factors such as lighting and weather conditions.

CHAPTER-3

PROPOSED SYSTEM

CHAPTER 3

PROPOSED SYSTEM

The **"Quadcopter with Long Range Aerial Surveillance and Object Detection System"** is designed as a robust, cost-effective solution to address the limitations of existing drone systems. The proposed system integrates advanced hardware and software components to achieve long-range aerial surveillance, real-time object detection, and efficient energy management. This modular and scalable quadcopter aims to meet the diverse demands of sectors such as security, agriculture, and disaster management.

3.1 System Overview

The proposed system consists of a quadcopter platform equipped with an ESP32CAM module for real-time video streaming and object detection. Key features include long-range communication using dual-band Wi-Fi antennas, optimized power efficiency through lithium-ion batteries, and enhanced stability via BLDC motors. The quadcopter also employs a robust flight control system to ensure precise navigation and reliability.

The system architecture is designed to be modular, enabling easy integration of additional components, such as advanced sensors or AI-based navigation systems, for future scalability. The combination of lightweight materials and energy-efficient hardware ensures extended flight duration without compromising performance.

3.2 Key Components of the System

3.2.1 ESP32-CAM Module

The ESP32-CAM module serves as the core of the system, providing high-quality video streaming and real-time object detection. It is a low-cost microcontroller with an integrated camera, making it ideal for applications requiring affordability and efficiency. The module supports machine learning algorithms, such as YOLOv8, for accurate object detection and classification.

Input Voltage (Volt)	5V
Operating Temperature (°C)	-20 ~ 85
SPI Flash	Default 32Mbit
Bluetooth	Bluetooth 4.2 BR/EDR and BLE standards
RAM	520KB SRAM + 4MB PSRAM
Wi-Fi	802.11 b/g/n/
Package Dimensions	11 x 9 x 5cms
Weight	50 grams

Table 3.2.1 Specification of the ESP32-CAM Used

3.2.2 BLDC Motors and Electronic Speed Controllers (ESCs)

The quadcopter is powered by four Brushless Direct Current (BLDC) motors, which ensure smooth and efficient propulsion. These motors are controlled by ESCs, enabling precise speed adjustments and improved flight stability.

3.2.3 Lithium-Ion Batteries

Lightweight lithium-ion batteries are used to power the system. These batteries are chosen for their high energy density, which extends flight duration and reduces overall weight, enhancing the quadcopter's manoeuvrability and operational efficiency.

Brand	Witty Fox
Voltage	3.7V
Battery Capacity	800 mAh
Self–Discharge	< 2% per month
Charging	Regulated DC
Battery Type	Lithium-Ion
Battery Dimension (L x W x H)	54 x 34 x 6 mm
Connector Dimension (L x W x H)	9 x 7 x 5 mm
Weight	23 g

Table 3.2.3 Specifications of the Battery Used

3.2.4 Dual-Band Wi-Fi Antennas

The system employs dual-band Wi-Fi antennas to facilitate long-range communication of up to 200 meters. These antennas ensure reliable data transmission between the quadcopter and the ground control station, even in challenging environments.

Connector Type	Male Antenna and Female IPX connector (SMA type)
Frequency(Hz)	900/1800
Gain	<3 dB
VSWR	<1.5

Table 3.2.4 Specifications of the Antenna Used

3.2.5 Flight Controller

The flight controller is responsible for stabilizing the quadcopter and managing its flight dynamics. It processes inputs from the remote controller and onboard sensors, ensuring precise navigation and control

3.2.6 Frame and Structure

The quadcopter frame is built using lightweight yet durable materials such as carbon fiber. This ensures that the system remains stable during flight while being able to withstand minor impacts or environmental stress.

Motor	1000Kv BLDC Motor
Frame Model	F450 (Red-White)
Flight Controller	KK2.1.5 Flight Controller
Battery	2200 mAh Lipo Battery
Transmitter	Fly Sky FS-CT6B 6ch 2.4GHz Transmitter & Receiver

Table 3.2.6 Frame, Motor, Flight Controller, Transmitter Used

3.3 Features of the Proposed System

3.3.1 Real-Time Video Streaming and Object Detection

The quadcopter streams live video to a ground control station, allowing users to monitor the environment in real time. Object detection is implemented using YOLOv3, a state-of-the-art machine learning algorithm, which ensures accurate identification of objects under varying conditions, such as low light or partial occlusion.

3.3.2 Long-Range Communication

The dual-band Wi-Fi antennas enable stable communication over a range of up to 200 meters, making the system suitable for large-scale applications. This feature is crucial for monitoring areas like agricultural fields, industrial complexes, or disaster zones.

3.3.3 Energy Efficiency

Optimized power management is achieved through the use of lithium-ion batteries and energy-efficient components, such as the ESP32-CAM and BLDC motors. This ensures extended flight duration, reducing downtime for battery recharging.

3.3.4 Modularity and Scalability

The system's modular architecture allows for easy integration of additional sensors or components. This scalability makes the quadcopter adaptable to various applications, such as adding thermal cameras for night surveillance or advanced sensors for precision agriculture.

3.3.5 Lightweight and Durable Design

The quadcopter's lightweight design improves its flight efficiency and manoeuvrability, while the durable carbon-fibre frame ensures longevity and resilience against environmental stress.

3.4 Innovations in the Proposed System

1. **Cost-Effective Design:** The use of open-source hardware and software reduces overall costs while maintaining high performance.
2. **Advanced Object Detection:** Integration of YOLOv3 ensures accurate and efficient real-time object detection.
3. **Improved Stability:** The combination of BLDC motors, ESCs, and a robust flight controller enhances the quadcopter's stability, even in moderate wind conditions.
4. **Scalability:** The modular design allows for easy upgrades and customization, ensuring compatibility with future technologies such as 5G and AI-based navigation.

3.5 Benefits of the Proposed System

- **Affordability:** Designed with cost-effective components to make advanced drone technology accessible to smaller organizations and users.

- **Versatility:** Suitable for a wide range of applications, including security surveillance, agricultural monitoring, and disaster response.
- **Ease of Use:** The system is user-friendly, with intuitive controls and simple integration processes.
- **Environmental Adaptability:** The system is tested to perform reliably under diverse environmental conditions, such as variable lighting and moderate wind speeds.

CHAPTER 4

METHODOLOGY

CHAPTER 4

METHODOLOGY

4.1 Working Principle

The methodology for designing and implementing a high landing gear kit for quadcopter drones involves several key steps. First, the design process focuses on creating a lightweight and durable structure that provides sufficient ground clearance to protect sensitive components like cameras and sensors during take-off and landing. Materials such as ABS plastic or carbon fibre are carefully selected for their strength to-weight ratio, ensuring the landing gear adds minimal weight to the drone while maintaining structural integrity.

Next, the landing gear is engineered for compatibility with a wide range of quadcopter models. The mounting system is designed to be adjustable, allowing for easy installation and ensuring a secure fit across different drone configurations. Prototyping and testing are conducted to evaluate the stability and durability of the landing gear under various operating conditions, including uneven terrain and rough landings.

Finally, the gear undergoes refinements based on real-world testing to improve its performance and user experience. Features like anti-slip pads or shock-absorbing mechanisms may be incorporated to enhance functionality. The end result is a reliable, easy-to-install landing gear kit that ensures the safety of the drone and its components while expanding its operational versatility.

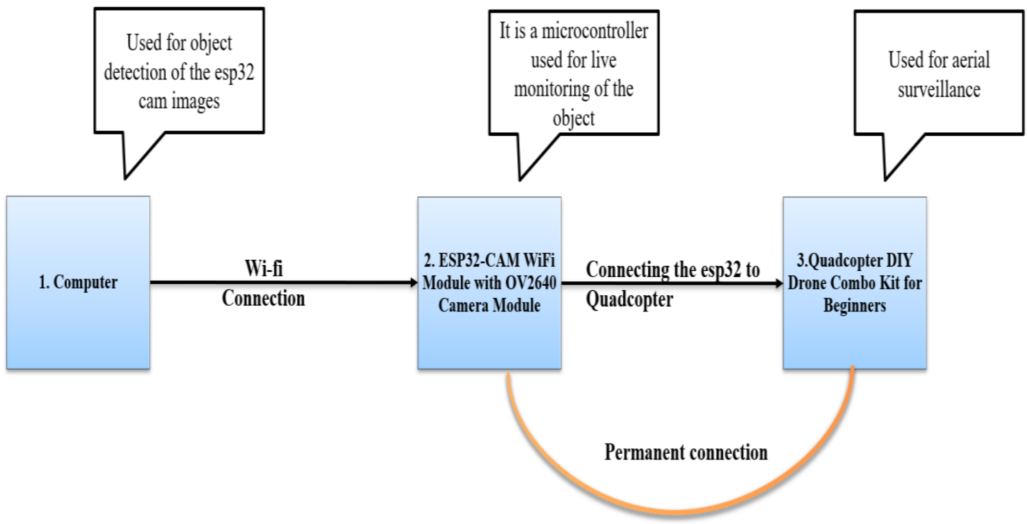

Fig.4.2.1 Overall Connection Design Of The Project

The block diagram of the proposed quadcopter system illustrates its functional architecture for long-range aerial surveillance and real-time object detection. At the core of the system is the ESP32-CAM module, equipped with an OV2640 camera for capturing real-time images and videos. This module also facilitates Wi-Fineable data transmission to the ground station. The quadcopter framework, which includes motors, ESCs (Electronic Speed Controllers), and a Apm2.8 flight controller, provides the necessary structural base and ensures stability and manoeuvrability for aerial operations. To enhance communication range, a dual-band Wi-Fi SMA antenna is integrated, allowing seamless data transfer over long distances. The high landing gear adds stability during take-off and landing while safeguarding sensitive components like the camera and sensors.

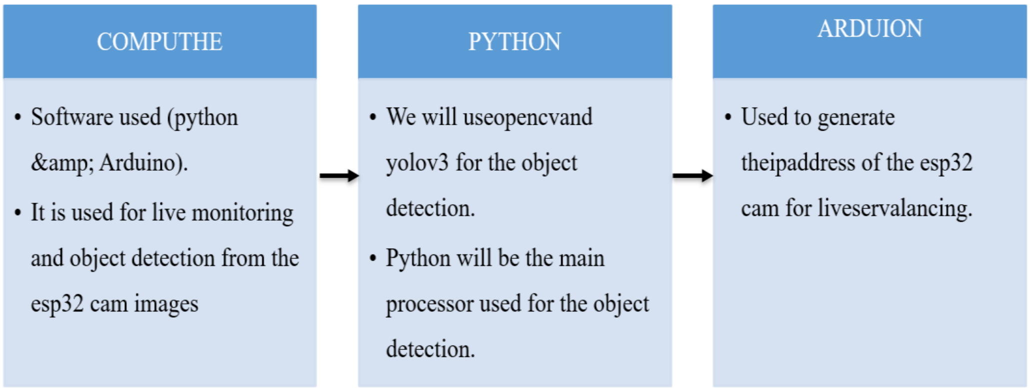

Fig.4.2.2 Components Involved in the 1st Block

This block diagram visually represents the structural and functional components of an ESP32-CAM WiFi Module, designed for wireless image processing and surveillance applications. At the core of the system is the ESP32-CAM WiFi Module, which is integrated with an OV2640 Camera Module to enable real-time image capture.

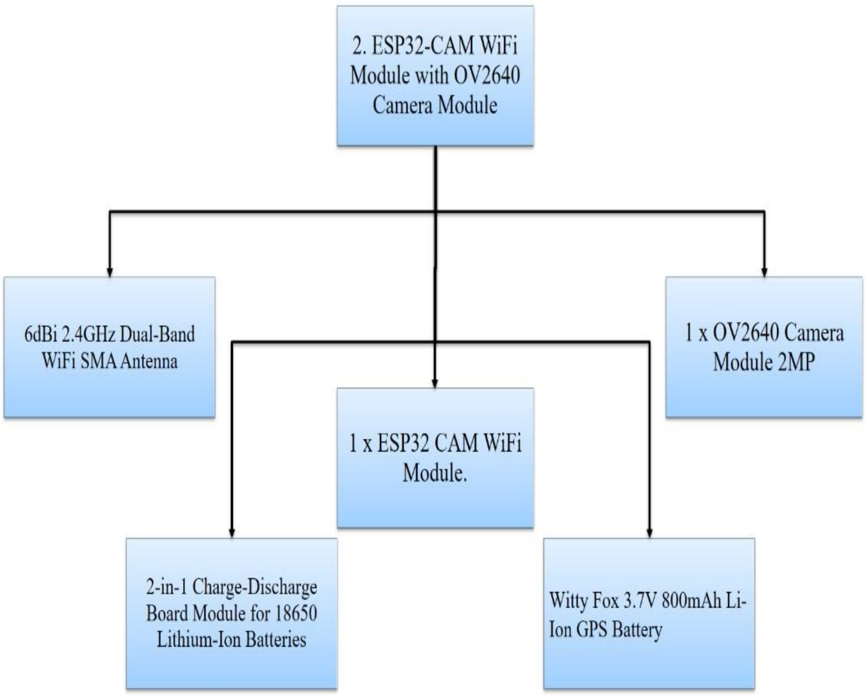

Fig.4.2.3 Components Involved in the 2nd Block

The system's power management is supported by a charge-discharge module and Liion batteries, ensuring stable energy delivery and prolonged flight times. Additionally, a USB interface facilitates the programming and configuration of the ESP32-CAM module, acting as a temporary connection during the development phase. During operation, the ESP32-CAM processes captured visual data for object detection and transmits it to the ground station for real-time analysis.

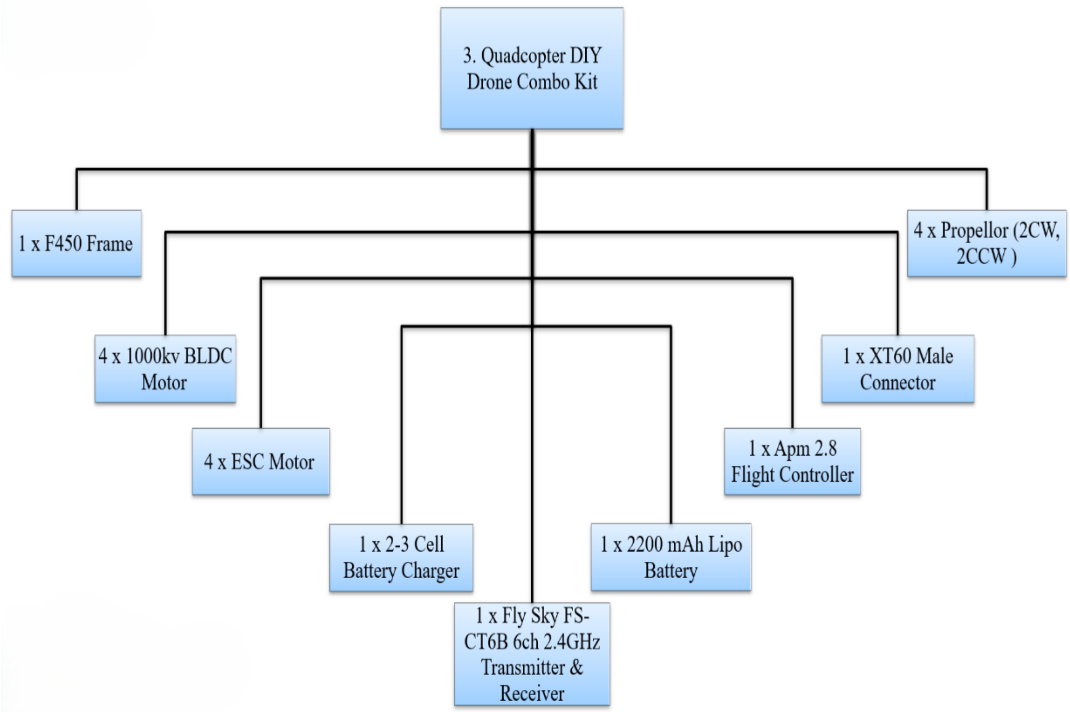

Fig. 4.2.4 Components Involved in the 3rd Block

This integrated system, with its robust hardware and software components, ensures efficient long-range surveillance and monitoring, making it suitable for diverse applications such as remote surveillance, terrain exploration, and real-time data acquisition

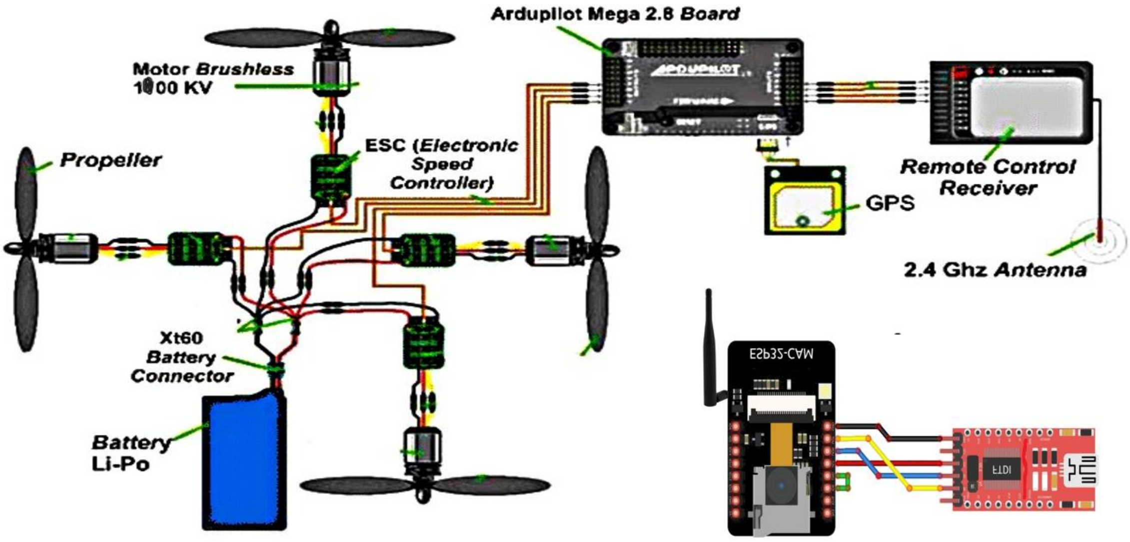

Fig. 4.2.5 Circuit Diagram

This module acts as the central processing unit, handling video streaming and wireless communication. To enhance connectivity, a 6dBi 2.4GHz Dual-Band WiFi SMA Antenna is attached, ensuring strong and stable network signals for seamless data transmission. Power management is crucial for maintaining efficiency, and this is achieved through a 2-in-1 Charge-Discharge Board Module, which is designed for 18650 Lithium-Ion Batteries. This module facilitates battery charging and regulated power output, ensuring continuous operation without power interruptions. Additionally, the system is powered by a Witty Fox 3.7V 800mAh Li-Ion GPS Battery, which provides portable and long-lasting energy, making the setup suitable for IoT-based mobile surveillance. The OV2640 Camera Module (2MP) plays a significant role in image acquisition, capturing high-resolution visuals that can be transmitted over a network for monitoring or analysis. The entire setup is structured for wireless video streaming, IoT-based applications, and real-time embedded systems, making it highly relevant for projects involving remote surveillance, automated image recognition, and smart security solutions.

CHAPTER-5

RESULTS & ANALYSIS

CHAPTER-5

RESULTS & ANALYSIS

5.1 Result

The Complete Setup was built by integrating all the necessary equipments which ware needed based on our assumption and then started testing the setup and finally concluded on the outputs based on the results.

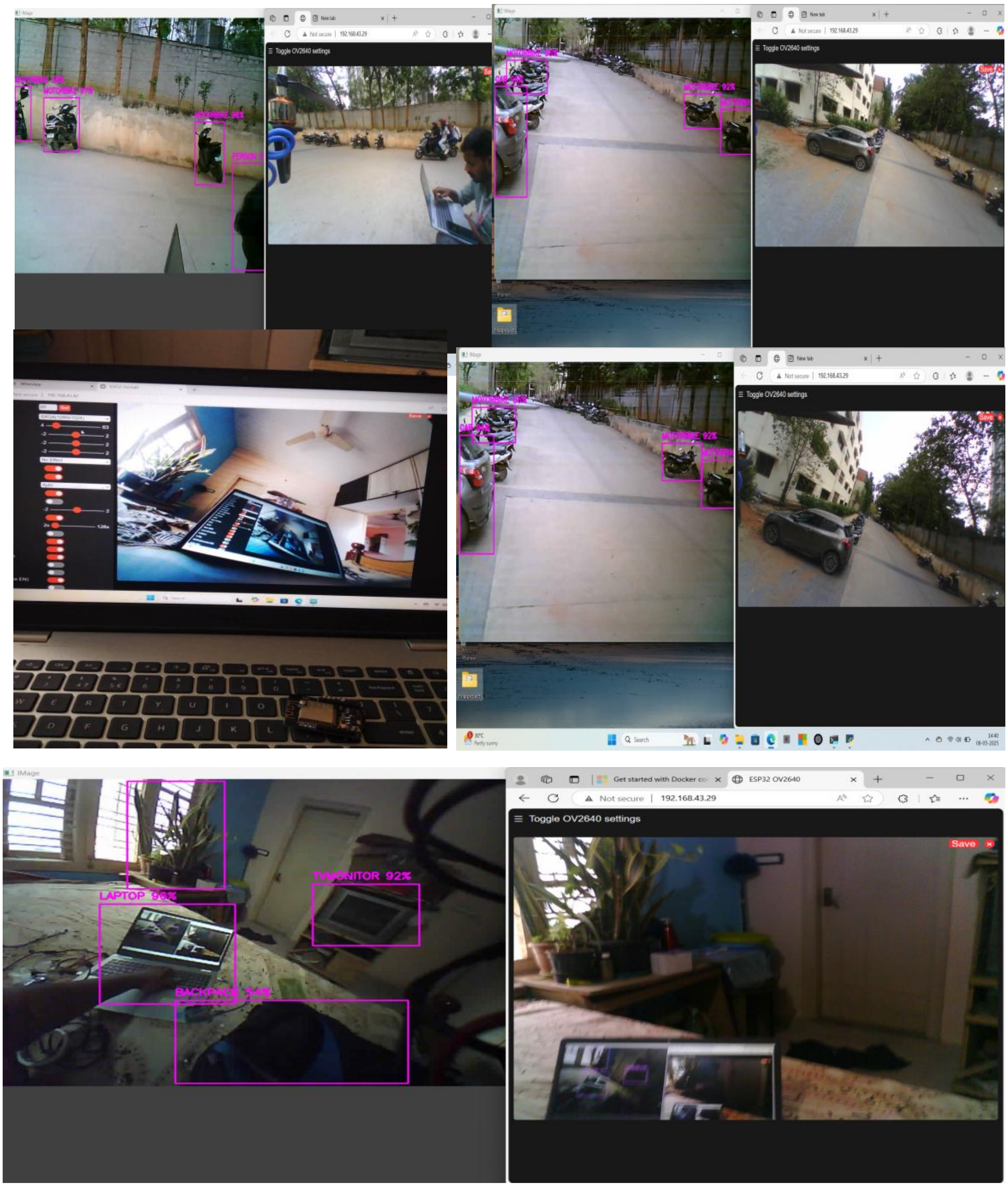

Fig 5.1 Camera Setup with left side object detection and right side surveillance

Fig 5.2 Drone flight testing

5.2 Analysis

While testing the output of our project we have come across several flaws that needs to be addressed for the this project to give even better results and improve its capabilities. The addressing Matters are as follows:

- After the drone takes flight it is hard for the person controlling the drone to identify the direction at which the drone is flying and then to control it.
- The frame rate of the object detection and surveillance will show delay if we don’t use a high processing laptop and a high quality Wi-Fi network.
- The vibration of the drone will affect the performance esp32 camara setup which can be seen in the monitor while live streaming.

Environment	Estimated Range (Line-of-Sight)
Indoors (walls present)	20–40 meters (~65–130 feet)
Outdoors (clear view)	80–150 meters (~260–490 feet)

Table 5.2 Wi-Fi range estimation

CHAPTER-6

CONCLUSION

CHAPTER-6

CONCLUSION

In conclusion, this project successfully combines advanced hardware and IoT technologies to develop an efficient drone system capable of long-range aerial surveillance and object detection for 200meters. By utilizing components such as the ESP32-CAM module, optimized power systems, and lightweight materials, the drone achieves an effective balance between performance, scalability, and cost-efficiency. The integration of real-time image processing, stable flight mechanisms, and robust communication systems ensures reliable functionality. This project not only addresses the growing demand for innovative surveillance solutions but also highlights the potential of IoT and drone technology in enhancing monitoring, security, and operational efficiency. Furthermore, it lays a strong foundation for future research and development, enabling improvements in range, precision, energy optimization, and adaptability for a variety of real-world applications.

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