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Design and Fabrication of Surveillance Drone

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Abstract: The growing demand for real-time monitoring and security has driven the innovation of advanced aerial surveillance systems. This project focuses on the design and fabrication of a compact and cost-effective surveillance drone capable of remote-controlled operations. The drone integrates a lightweight quadcopter frame with high-efficiency brushless motors, GPS for navigation, and a real-time video transmission system utilizing a high-resolution camera and wireless communication module. Powered by rechargeable lithium polymer batteries, the drone is equipped to perform surveillance tasks in both urban and rural environments. The onboard microcontroller, coupled with stabilization sensors such as gyroscopes and accelerometers, ensures flight stability and manoeuvrability. This project aims to enhance situational awareness in defense, disaster management, and public safety applications the fabricated drone is tested for flight endurance, camera clarity, and transmission range to validate its suitability and practical surveillance missions.

Keywords: Real-Time, Activity Monitoring, Surveillance Security, Unmanned Aerial Vehicle, First person view.

I. INTRODUCTION

Drones also known as UAVs have changed how we handle jobs in fields like security, farming, shipping, and watching the environment. They can reach far-off places, gather live info, and work on their own making them key to solving today's problems. This project focuses on creating a new kind of drone to meet specific job needs using advanced tech like super-efficient engines exact navigation, and smart data handling. The drone combines light materials strong control systems, and state-of-the-art sensors to work well in many different settings. Its goals include keeping an eye on important structures helping during disasters, or making resource use better. This project aims to push aerial tech forward while following safety rules and laws. This intro lays out what the project wants to do, its tech basics, and how it could change the game for its target uses.

II. LITERATURE REVIEW

Muktar Yahuza et al. [1], the proliferation of Internet of Things (IoT) technology in the realm of unmanned aerial vehicles, commonly known as drones, has ushered in a new era of connectivity and efficiency. The Internet of Drones (IoD) promises groundbreaking applications in various domains, including surveillance, agriculture, logistics, and disaster management. However, the seamless integration of drones into the IoT ecosystem introduces a myriad of security and privacy concerns. This paper provides a comprehensive taxonomy of security and privacy issues associated with the Internet of Drones and outlines open challenges that demand attention from researchers, policymakers, and industry stakeholders.

H Ali et al. [2], with the increasing emphasis on industrial security, the integration of Internet of Things (IoT) technology into surveillance drones has become a pivotal solution. This project outlines the design and development of a sophisticated surveillance drone system that leverages IoT for real-time monitoring and data analytics. Targeted specifically for industrial security applications, the IoT-enabled drone provides a comprehensive approach to safeguarding critical infrastructure, ensuring timely threat detection, and enhancing overall security measures.

M. F. T. Babierra et al. [3], this project introduces AQMoD, a pioneering Air Quality Monitoring and Warning System implemented through the Internet of Things (IoT) and drone technology. AQMoD aims to address the growing concerns surrounding air quality by providing a comprehensive solution for real time monitoring, spatial mapping, and timely warnings in areas prone to air pollution. The integration of IoT sensors with drone technology offers a dynamic and adaptable approach to enhance environmental monitoring capabilities.

P. M. S, S. Kuzhalivaimozhi et al. [4], this project presents a practical implementation of a gesture controlled autonomous drone system, revolutionizing human-drone interaction. Leveraging computer vision and gesture recognition technologies, the proposed system enables users to intuitively control the drone's movements through hand gestures. This innovative approach to drone control not only enhances user experience but also holds significant potential for diverse applications, including entertainment, surveillance, and search and rescue operation

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S. H. Alsamhi et al. [5], this paper provides a survey of the potential techniques and the applications of collaborative drones with IoT that have recently proposed to increment the astuteness of perspicacious cities. It gives a comprehensive overview of the recent and perpetual research on collaborative drone and IoT in amending the authentic-time application of keenly intellective cities.
Muhammad Asif Khan et al. [6], this paper provides an original overview of the subsisting drone detection ideas and a critical review of the state-of-the-art. Predicated on the review, the authors provide key insights on future drone detection systems. They believe these insights will provide researchers and practicing engineers with a holistic view to understand the broader context of the drone detection quandary.

III. WORKING PRINCIPLE

A surveillance drone also called an unmanned aerial vehicle (UAV), comes with high-tech cameras and sensors to keep an eye on areas from above. It can take off when someone starts it or on its own using GPS to find its way. Once it's up in the air, the drone follows a set path or someone on the ground can control it. As it flies, its sharp cameras take videos and pictures in real time giving a clear look at what's happening below. A surveillance drone monitors areas from above during daylight hours. It has an FPV camera to take clear videos and photos from the sky. You can launch the drone by hand or let it take off on its own using GPS to find its way. Once it's up, the drone follows a set path or you can control it from the ground. The camera on board records what it sees in real time, but this works well when it's bright out and easy to see. The drone sends this video back to a station on the ground right away. This lets the team watching keep an eye on things as they happen and change plans if needed. The drone saves the videos and photos it takes, or sends them somewhere else to look at later. When it's done flying around, the drone comes back to where it started. There, you can get the data it collected and charge its battery so it's ready to go again.

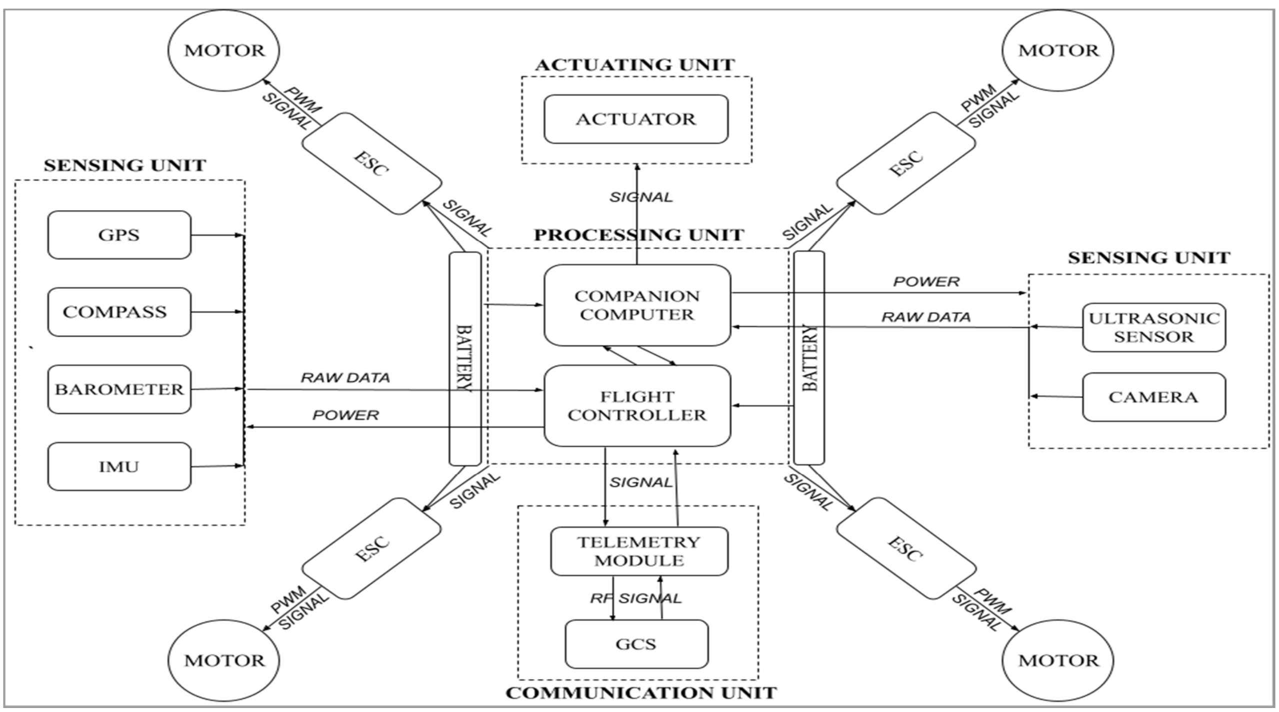

Fig: Block Design

IV. DESIGN CALCUATION

A. Key Design Parameters

These are general values for a surveillance drone (e.g., quadcopter or fixed-wing) used for monitoring or reconnaissance.
Weight:
Empty weight: 2 kg (frame, motors, electronics)
Payload: 0.5–1 kg (camera, sensors, gimbal)
Total take-off weight: 2.5–3 kg

Battery:
Capacity: 5000 mAh (LiPo, 4S, 14.8V)
Energy: 5000 mAh × 14.8V = 74 Wh

Propulsion:
Motors: 4 brushless DC motors (for quadcopter), 300 W each
Propellers: 10-inch diameter, 4.5-inch pitch
Camera/Sensors: Resolution: 1080p or 4K camera with 30–60 FPS
Additional sensors: Thermal imaging, GPS, ultrasonic for obstacle avoidance

Communication:
Range: 5–10 km (line-of-sight, 2.4 GHz or 5.8 GHz)
Data rate: 10–50 Mbps for video streaming

Flight Time:
Target: 20–30 minutes (quadcopter) or 60–90 minutes (fixed-wing)

B. Performance Calculations

1) Power Consumption

Hovering Power (Quadcopter):
Thrust required ≈ Total weight × 9.81 m/s² = 3 kg × 9.81 = 29.43 N
Assume thrust-to-weight ratio of 2:1 for maneuverability, so max thrust = 58.86 N
Power per motor ≈ 150–200 W (depends on efficiency, ~80% for typical motors)
Total hovering power = 4 motors × 175 W = 700 W
Cruising Power (Fixed-Wing): Lower power due to aerodynamic lift: ~300–400 W for 3 kg drone at 15 m/s

Payload Power:
Camera + sensors: 20–50 W

Total Power:
Quadcopter: 700 W (motors) + 50 W (payload) = 750
WFixed-wing: 400 W (motors) + 50 W = 450 W

2) Flight Time

Battery Energy: 74 Wh = 74 × 3600 Ws = 266,400 J
Quadcopter:
Power consumption: 750 W
Flight time = 266,400 J / 750 W = 355 seconds ≈ 5.9 minutes (ideal)
Real-world (80% battery efficiency, losses): ~20–25 minutes

Fixed-Wing:
Power consumption: 450 W Flight time = 266,400 J / 450 W = 592 seconds ≈ 9.9 minutes (ideal) Real-world: ~60–80 minutes due to better aerodynamics
Note: Larger batteries (e.g., 10,000 mAh) or fuel-powered drones can extend flight time.

3) Range Quadcopter

Speed: 10–15 m/s (36–54 km/h)
Flight time: 20 minutes = 1200 seconds
Range = Speed × Time = 15 m/s × 1200 s = 18 km (theoretical, out-and-back)
Real-world range: 5–7 km (limited by battery, signal, and regulations)

Fixed-Wing:
Speed: 20–25 m/s (72–90 km/h)
Flight time: 60 minutes = 3600 seconds
Range = 25 m/s × 3600 s = 90 km (theoretical)
Real-world range: 30–50 km
Communication Limit: Typically 5–10 km unless using long-range systems (e.g., LTE or satellite).

4) Lift and Payload Capacity Max Thrust:
Quadcopter: 4 motors × 1.5 kg thrust each = 6 kg total thrust
Payload capacity = Max thrust - Drone weight = 6 kg - 3 kg = 3 kg
Real-world: 0.5–1 kg to maintain stability and flight time
Fixed-Wing:
Lift depends on wing area and speed; typically supports 1–2 kg payload for 3 kg drone.

5) Data Transmission
Video Streaming:
1080p at 30 FPS: ~5–10 Mbps
4K at 30 FPS: ~20–50 Mbps
Latency: :< 200 ms for real-time surveillance
Range Impact:
Higher data rates reduce effective communication range unless using directional antennas.

V. OPERATIONAL OBSERVATIONS

A. Mission Suitability

1) Quadcopter: Ideal for short-range, hover-intensive tasks (e.g., perimeter monitoring, live video feed). Limited by battery life. Fixed-Wing: Better for long-range, wide-area surveillance (e.g., border patrol, agricultural monitoring). Requires take off / landing space. Hybrid VTOL: Combines benefits but increases complexity and cost.
2) Environmental Factors: Wind: Max wind resistance ~5–10 m/s. High winds reduce flight time and stability. Temperature: LiPo batteries lose efficiency below 0°C or above 40°C. Rain: Most drones require IP54 or higher for water resistance.
3) Regulatory Constraints: Max altitude: 120 m (400 ft) in most countries (e.g., FAA, EASA regulations). Max range: Line-of-sight unless approved for BVLOS (beyond visual line of sight). Licensing: Required for drones >250 g or commercial use in many regions

VI. RESULT

The project constitutes both different types of hardware, components and software for the aims of achieving proper successful operation. In the construction of the system hardware, more focus and examine was given for the purpose of achieving the aims. The software was use to program the basic internals component, with the basic view to achieve logical decision and to be able to control the entire system such the propellers control, ESC motors etc. of the drone. Materials cause the drone to crash or even worse losing control which can lead to a serious injury or property damage. Designing a cover to protect the circuit board is essential, the dimensions of the circuit board. If the drone lost signals from receiver to transmitter, it will automatically return to home function using GPS navigation. And also it has auto stabilization function at high wind weather conditions.
Once everything was deemed functional during the test flight, any vulnerable spots that can interfere with circuit board, electronic speed control, or the flight controller were focused on to fine tune the drone. The circuit board is wide open and that could be hazardous. Water, sand, and high winds can damage the drone circuit board when it is flying or when it is arming before take-off. This damage can four sides of 90-degree angles consist of 53mm long, thickness of 3mm to cover the circuit board with screws half an inch long to secure the cover to the circuit board

A. Observations

Scenario: Perimeter surveillance of a 5 km² industrial site.
Drone Choice: Quadcopter with 20-minute flight time, FPV camera, 5 km range.

Mission Plan:
Flight path: Pre-programmed waypoints covering site perimeter.
Altitude: 50–100 m for optimal camera coverage.
Video: Live feed to ground station, recorded for analysis.

Calculations:
Area coverage: 5 km² at 15 m/s ≈ 10–15 minutes to survey (assuming 100 m swath width).
Battery swaps: 2–3 batteries needed for continuous monitoring.
Data: 10 Mbps × 15 minutes = 6.75 GB storage.
Observation: Multiple drones or a fixed-wing drone may be needed for uninterrupted coverage.

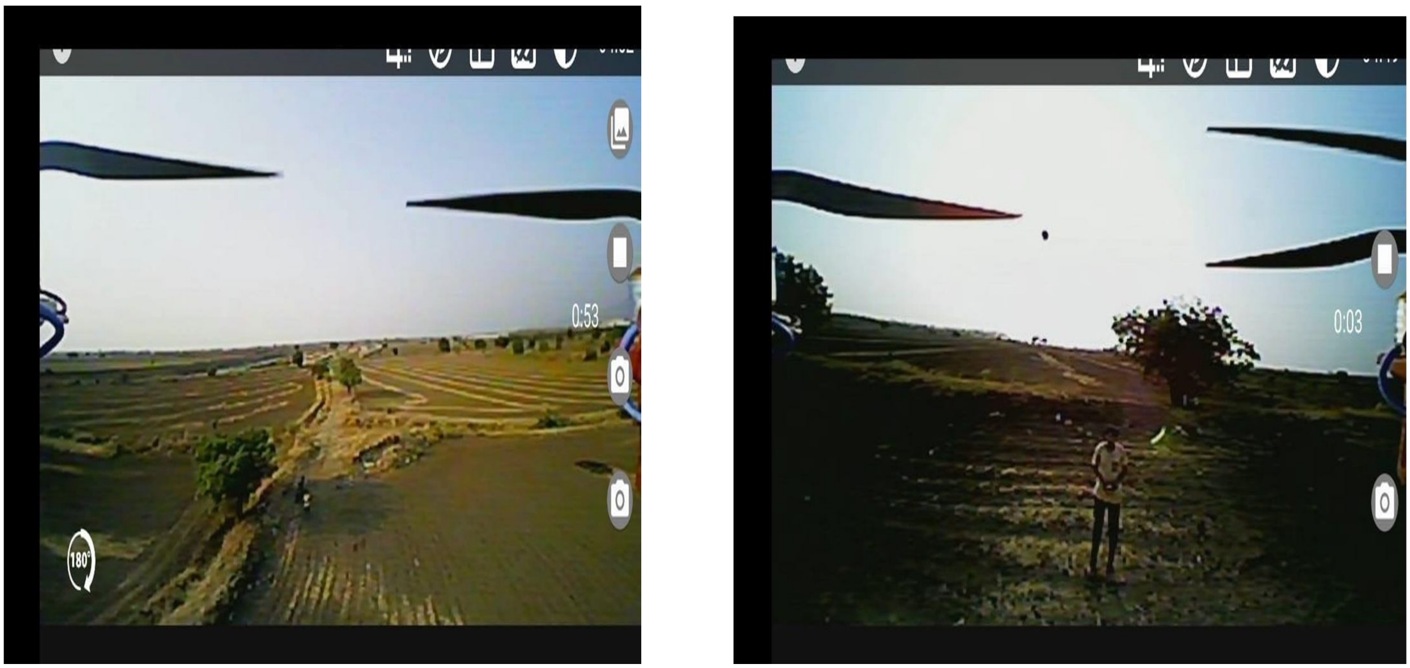

Fig: Drone Views

Fig: Mission Planner Layout

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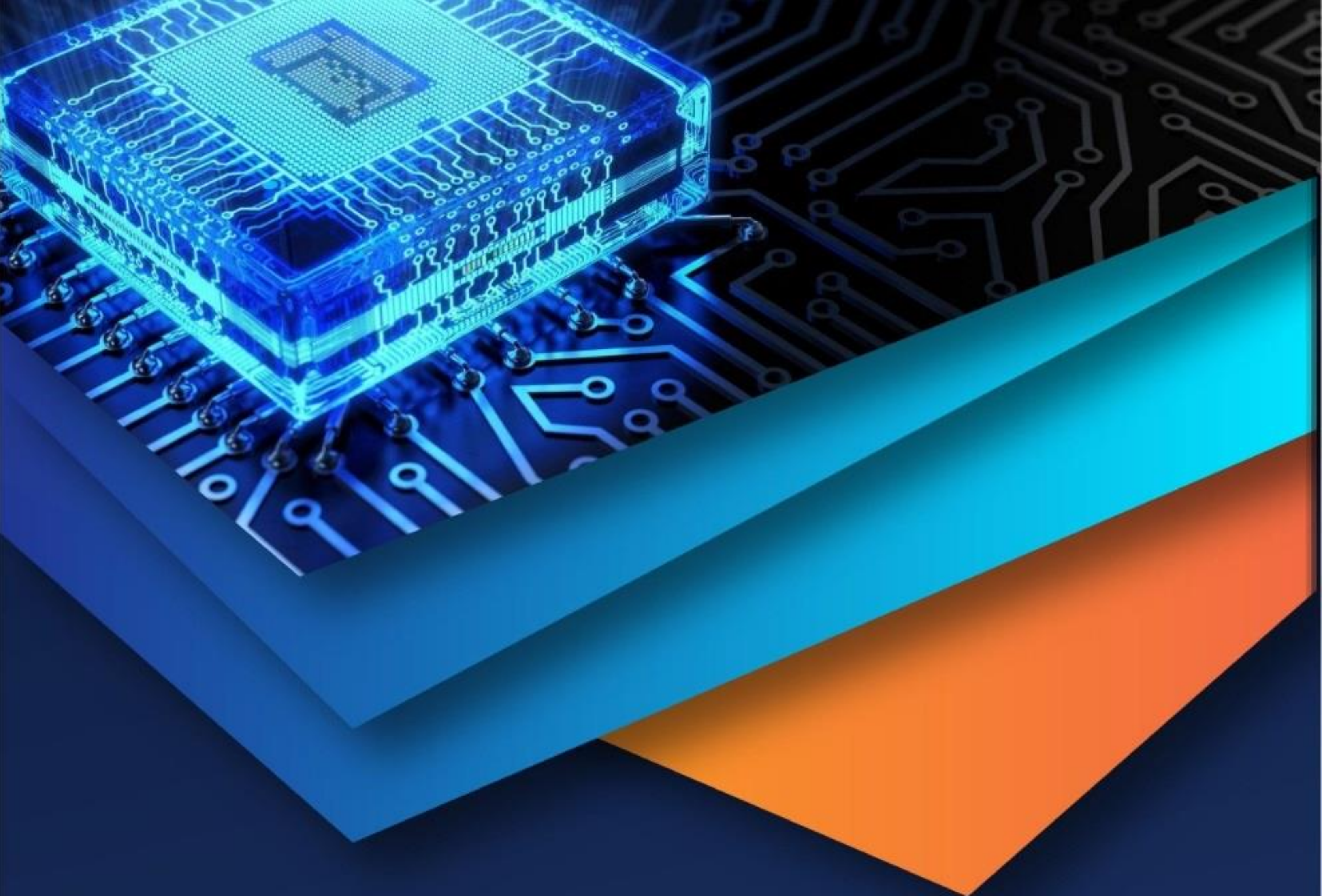

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