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DRONE-BASED EVENT MONITORING, MANAGEMENT, AND AUDIO SURVEILLANCE SYSTEM

[1]Smt. G. Divya Praneetha, [2]P. Krishna Teja, [3]S. Venkata Sairam, [4]D. Afrid,
[1]Assistant Professor, [2]Student, [3]Student,[4]Student
[1]Electronics and Communication Engineering,
[1]G Pulla Reddy Engineering College, Kurnool, India

Abstract:

This project presents a drone-based system designed for real-time event monitoring, management, and audio surveillance, aimed at enhancing situational awareness and crowd control during large-scale gatherings. At the core of the system is a drone integrated with a Wi-Fi-enabled camera and speaker, allowing for continuous live video streaming and remote audio broadcasting. The drone is powered by the Pixhawk 6C flight controller, which ensures precise navigation and stable flight, and is operated through Mission Planner software for autonomous route planning and mission execution. This combination allows the system to cover large areas quickly, providing high-quality visual feedback to event organisers and security personnel for efficient decision-making and rapid response. The audio surveillance and broadcast capability are key features, enabling real-time announcements or alerts to be delivered directly to crowds from the aerial platform. This system design is particularly well-suited for environments where human access is difficult or rapid communication is critical. The entire project has been successfully executed and completed, demonstrating that the integration of aerial visuals and audio output significantly improves overall event safety and operational efficiency. By combining surveillance, communication, and autonomous control in one compact system, this project offers a smart, scalable solution for modern event management, especially in resource-constrained environments or emergencies.

I. INTRODUCTION

In recent years, drones have emerged as a transformative technology in areas like security, monitoring, and crowd management. This project primarily focuses on using drone-based systems to ensure effective Event Monitoring, management, and audio Surveillance within college campuses. Events often demand efficient real-time communication, wide-area visual surveillance, and a fast response to unexpected incidents—areas where drones excel. This system is equipped with an SJ6 Wi-Fi camera for live video streaming and a wireless long-range speaker module capable of broadcasting audio commands up to 2 km. The drone operates on an S500 Quadcopter frame supported by Pixhawk 6C as the flight controller, integrated with Mission Planner software for full navigation control. It supports Manual, Semi-autonomous, and Fully autonomous flight modes, making it adaptable for diverse event environments. Powered by two 4S 5000mAh LiPo batteries, it ensures extended flight time. The system is designed to handle live audio, supports video/audio storage for post-event analysis, and incorporates advanced features like object detection, crowd counting, emergency detection, and GPS-based geofencing. With these capabilities, the drone acts as a mobile surveillance and communication unit, ensuring safety, control, and seamless event execution.

II. Review Of Literature

1. S. Waharte and N. Trigoni (2010) – "Supporting Search and Rescue Operations with UAVs" This study investigates the potential of Unmanned Aerial Vehicles (UAVs) to support real-time monitoring during rescue missions. It demonstrates how UAVs equipped with cameras and wireless systems can collect data in inaccessible areas. The proposed techniques resonate with our project's use of drones for live aerial monitoring and video/audio surveillance during campus events.

2. Y. Chen and Y. Huang (2017) – "Aerial Surveillance System for Public Safety Using Drones" This paper presents an integrated drone system for public safety monitoring. It uses onboard cameras and wireless transmission to deliver live video to a central monitoring station. Similar to our project, the authors utilize GPS and control software for flight navigation, supporting real-time event supervision and rapid emergency response.

3. D. Zorbas et al. (2016) – "Drone Coverage Optimization for Visual Monitoring" The research focuses on optimizing drone flight paths to ensure maximum field coverage during surveillance. Their model reduces visual blind spots and improves spatial awareness during public monitoring events. This optimization aligns with our autonomous and semi-autonomous flight plans for event-based drone operation.

III. Research methodology

First and foremost, drones change the way we see. (Rothstein, 2015, p. 125) The drone is defined as much as a technology that can see as a technology that flies, yet sight is just one part of how they sense. In this section, we conceptualize the drone as a way of flying and sensing (an epistemological tool) and as a way of knowing and experiencing differently (an ontological orientation). Alexander von Humboldt's theories about the telescope provides a useful analogue, where he suggested it was "an organ of sensuous contemplation" that forever changed our per caption of the cosmos (Von Humboldt, 1997 [1850], pp. 302–303). The telescope, writes John Pickles, "allowed us to see more and see differently, and as a result transformed our view of the universe and our place in it" (Pickles, 1997, p. 365). Drones do similar work, since they enable us to extend our perception into new places, they multiply our possible experiences, and they reshape our geographic imaginations. In both cases, the technology is more than a data delivery tool, it enables a "vision that is practiced and touched. It is not simply ocular or visual, but an assembly of practices and materials"

A. System Design Strategy

The drone platform is built using the S500 quadcopter frame with integrated power distribution, powered by dual 4S 5000mAh LiPo batteries. The Pixhawk 6C serves as the central flight controller, interfacing with GPS, telemetry, ESCs, and sensors. A Wi-Fi camera mounted on the drone captures live video feeds, which are streamed to a ground control station. An onboard wireless megaphone speaker enables voice announcements during flight

B. Component Selection

The hardware and software components were selected based on performance, availability, compatibility, and power efficiency.

- Microcontroller: **Pixhawk 6C** STM32H743 32-bit processor was chosen and ease of use.
- Communication: Telemetry Radio was selected for wireless command transmission for online devices.
- Actuation: Brushless DC motors for high efficiency thrust, Electronic Speed Controllers regulate motor speed.
- Frame & Materials: S500 PCB Quad Frame with integrated PDB, anti-vibration mount, and landing gear. Propellers"1045 (10-inch) for balanced lift and stability".
- Power: Two 4S 5000mAh LiPo (Lithium Polymer) batteries.
- For surveillance SJ6 Wi-Fi camera and for audio a wireless long-range speaker module.

C. System Integration and Prototyping

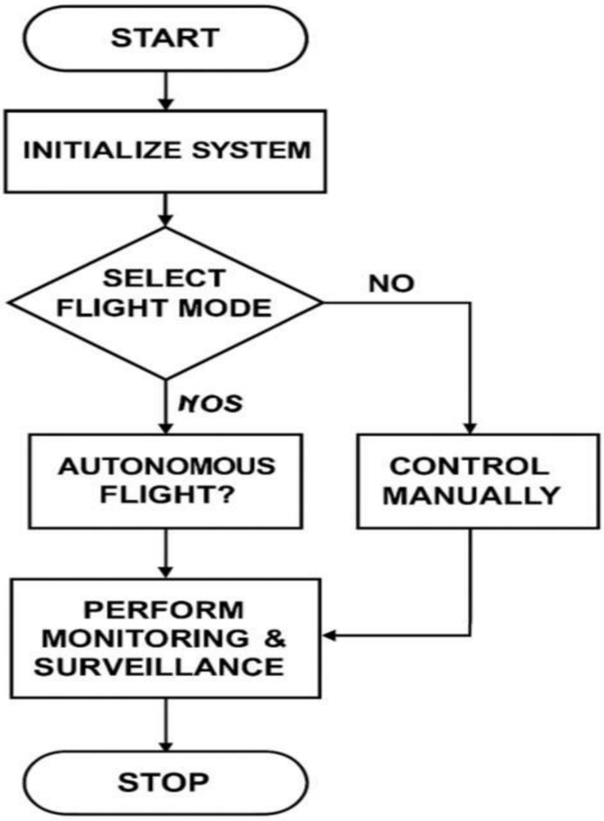
The Pixhawk 6C is the core flight controller responsible for managing drone flight, sensor data processing, communication, and safety operations.

Features

STM32H743 32-bit processor, Built-in IMU (accelerometer, gyroscope, barometer), Flexible power input with redundancy, Support for multiple autonomous flight modes, Dedicated ports for GPS, telemetry, I2C, CAN, and more

D. Control Algorithm Development

The control logic was programmed using the following logic flow:



E. Testing and Evaluation

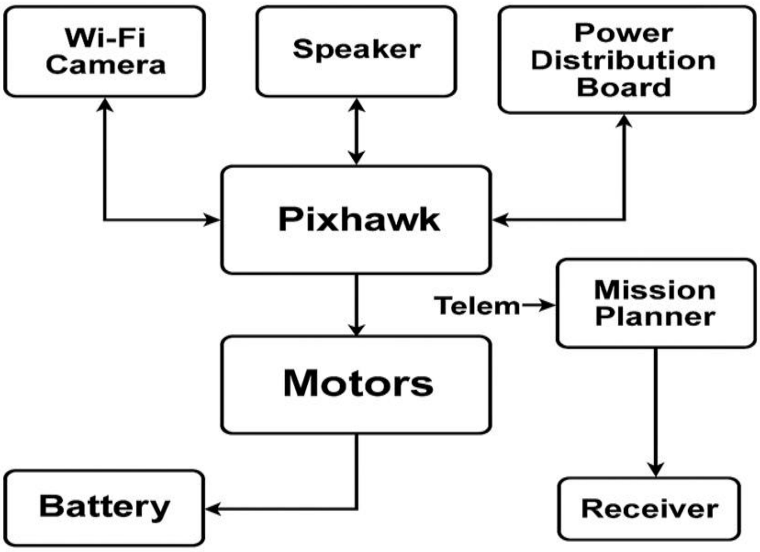
A prototype was tested in a simulated in open environment:

- Communication Range Test: Verified stable through Wi-Fi for some long distances.
- Motor Load Test: Assessed torque and performance under different air pressures.
- Power Efficiency Test: Monitored operating duration per charge and system efficiency.

Each test was repeated under varying conditions to ensure reliability and repeatability.

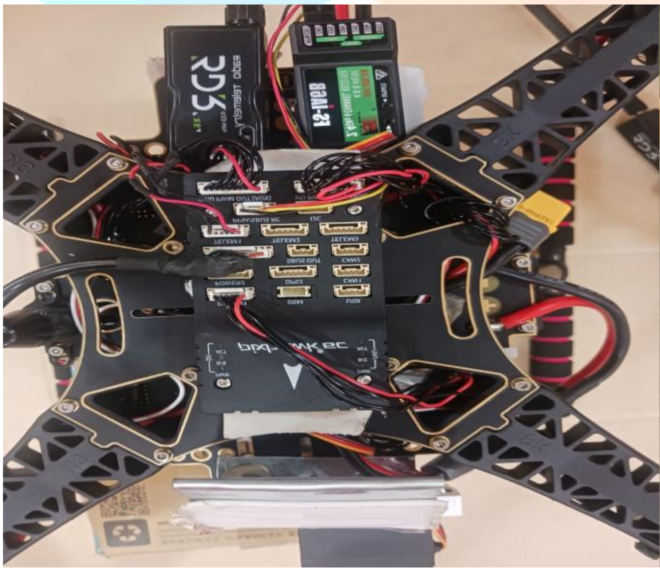
F. Block Diagram

This is the block diagram of the drone-based Event Monitoring, Management, and Audio Surveillance System." The inputs of the system include the GPS module, receiver module (2.4GHz antenna), camera (SJ6 WiFi Camera), and onboard microphone for live audio. The outputs of the system are the mini drone megaphone speaker for real-time announcements and storage modules for video/audio recordings. The entire drone flight is controlled using the Pixhawk 6C flight controller, which processes signals from the receiver and navigates using GPS data. The Electronic Speed Controllers (ESCs) manage the speed of the brushless outrunner motors, enabling stable flight. Power is supplied through dual 4S 5000mAh LiPo batteries, connected via a Power Distribution Board (PDB). The user interface and flight planning are handled through the Mission Planner software. The drone supports multiple modes of operation: manual, semiautonomous, and fully autonomous.



III. RESULTS AND DISCUSSION

The prototype system was tested during simulated event conditions. It provided stable flight, clear aerial visuals, and audible public announcements. The integration of audio and video functions helped improve real-time decision-making and crowd control efficiency. Logs recorded via Mission Planner confirmed stable telemetry, successful waypoint execution, and safe RTH operations.

IV. CHALLENGES

During large-scale college events, manual monitoring techniques often fail to provide full coverage and rapid response. Common issues include poor crowd visibility, lack of instant communication, slow response to emergencies, and inability to archive event data for analysis. Events conducted across wide and open campus areas make it difficult for staff to control the situation in real-time. Moreover, natural disruptions such as wind instability, signal interference, or video/audio lag also add complexity to real-time surveillance.

This project addresses these challenges through a multifunctional drone-based platform that delivers live aerial footage, real-time audio announcements, and intelligent automation features. The drone assists in both crowd management and communication, with advanced features like geofencing to prevent boundary violations and autonomous decision-making for emergency detection. This reduces dependency on manual supervision while improving overall safety and operational efficiency.

V.CONCLUSION

The proposed drone-based surveillance and event monitoring system demonstrates a powerful and efficient solution for enhancing safety, communication, and management during public or institutional events. By integrating a Pixhawk 6C flight controller, high-capacity power systems, GPS navigation, and wireless communication, the system offers real-time monitoring, live video streaming, and voice broadcasting capabilities. The modular design and multi-mode operation enhance flexibility and usability across different scenarios. The addition of AI-based features such as object detection, crowd analysis, and emergency detection increase the effectiveness of the system, enabling event coordinators to make timely and informed decisions. The automatic Return-to-Home (RTH) protocol and geofencing capabilities add another layer of reliability and security to the system. Overall, the project presents a robust and scalable solution for event management, with great potential to be deployed in real-world applications.

FUTURE SCOPE

In the future, the system can be further enhanced with the integration of advanced sensors such as thermal cameras for night surveillance, gas sensors for hazardous environment monitoring, and facial recognition for better security tracking. The drone can also be interfaced with cloud-based data platforms to store and analyze long-term surveillance data. Moreover, advancements in 5G and edge computing can help in reducing latency and improving data processing capabilities onboard the drone. The addition of swarm drone technology can enable coordinated multi-drone operations for larger event areas or emergency scenarios. This system also holds potential for applications in rural areas for disaster alerts, agricultural monitoring, and remote communication services. As drone technology continues to evolve, the scope and efficiency of this surveillance system will further expand.

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