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Autonomous Surveillance Drone (Case study for campus surveillance)

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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 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:

3.1Air 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.

3.1.4 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.

3.2Ground Unit

3.2.1Ground 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.

3.2.2Video 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.

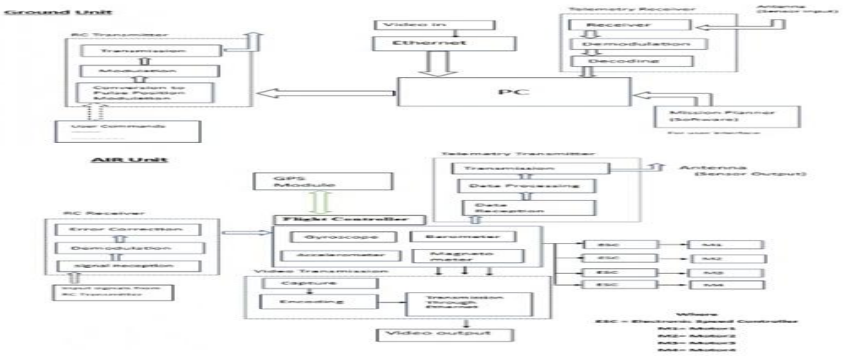

Fig 1.0 Block Diagram

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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