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Smart Drone Surveillance with Restricted Area Avoidance

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Abstract –
As everyone knows, the use of unmanned aerial vehicles, or drones, for monitoring and surveillance is growing quickly. However, a lot of drones lack the necessary safety elements, which can lead to unintentional or unauthorised entry into restricted areas including government buildings, airports, and military zones, posing a major security danger.

A clever drone surveillance system is suggested as a solution to this issue, utilising geofencing and real-time position monitoring to stop infractions of restricted areas. For efficient monitoring, the system offers live video streaming and immediately initiates safety features like return-to-launch and auto-landing. For security and surveillance applications, this system is dependable, reasonably priced, and appropriate.

Key Words: Geofencing, Unmanned Aerial Vehicle, Pixhawk, GPS Navigation, ESP32-CAM, Restricted Airspace, Autonomous Drone, Real-Time Surveillance

I. INTRODUCTION

Drones, or unmanned aerial vehicles (UAVs), are extensively utilized in various sectors like delivery, infrastructure inspection, and surveillance, owing to their ability to provide real-time data and access hard-to-reach areas. However, concerns regarding airspace safety and regulatory compliance are rising due to an increase in drone use. Restricted zones such as airports and military sites are particularly at risk of unauthorized drone operations, which can cause security breaches and safety hazards. Many current drones depend on manual piloting or basic GPS, making them vulnerable to human error and signal loss. To mitigate these risks, there is a growing need for autonomous drone systems that can avoid restricted areas independently. Geofencing technology, which sets virtual boundaries for safe flight, enhances operational safety when integrated with autonomous control and GPS. The study proposes a smart drone surveillance system combining geofencing and real-time video monitoring to ensure safety and situational awareness.

II. LITERATURE SURVEY

Geofencing, aerial surveillance, and drone safety have all been separately studied by a number of researchers. In order to reach centimeter-level precision, Smith et al. presented a GPS-based geofencing method that uses RTK-GPS. Although their technique showed great precision, its practical implementation was constrained by the cost of RTK-GPS gear.Using Mission Planner, Gupta and Patel created a Pixhawk-based quad copter with autonomous Return-to-Launch and virtual fencing capabilities. Although their efforts were successful in preventing boundary infractions, they were unable to conduct real-time monitoring. Khan and Verma used an ESP32-CAM to create a low-cost surveillance drone that transmits real-time video via Wi-Fi. Their system lacked autonomous safety measures and limited area avoidance, while being cost-effective and effective for monitoring. Other research, mostly aimed at delivery applications, has concentrated on route planning utilizing the Google Maps API for UAV navigation. Although these technologies increased route efficiency, they did not deal with the enforcement of airspace restrictions. The majority of current systems concentrate on either geofencing or surveillance separately, according to the literature. This gap is filled by the suggested system, which combines real-time video surveillance and restricted area avoidance into a single autonomous UAV platform.

III. PROBLEM DEFINITION

The increasing adoption of unmanned aerial vehicles (UAVs) for surveillance, delivery, and monitoring applications has significantly increased the risk of unauthorized entry into restricted airspaces. Sensitive areas such as airports, military installations, government buildings, and critical infrastructure require strict airspace control. However, many low-cost and commercial drones lack built-in intelligence to recognize restricted boundaries in real time. This absence of automated geofencing and safety mechanisms can lead to accidental airspace violations, security threats, legal consequences, and potential collisions. Hence, there is a strong need for an intelligent drone surveillance system that can continuously track location, identify restricted zones, and autonomously execute preventive actions to ensure safe and compliant drone operations. These restricted regions in real time. This can lead to security.

IV. PROPOSED WORKING

The proposed Smart Drone Surveillance System is an autonomous monitoring solution designed to prevent unauthorized entry into restricted airspaces while enabling real-time aerial surveillance. The system uses a Pixhawk flight controller as the central processing unit to manage navigation, flight stabilization, and safety decisions based on real-time GPS data received from the NEO-M8N module. Restricted areas are defined using polygonal geofencing through the Mission Planner software integrated with the Google Maps API and are uploaded to the controller prior to flight. The system's key features include:

1. GPS-based real-time location tracking
2. Automatic safety actions
3. Geofencing using Google Maps API
4. Restricted area detection

The system tracks the drone's location in real time, detects restricted areas, and automatically activates Return-to-Launch or auto-landing on geofence violations. Live video surveillance is provided through an ESP32-CAM, streaming footage over Wi-Fi for secure monitoring.

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V. RESULT

After executing the above proposed system, we got the following results.

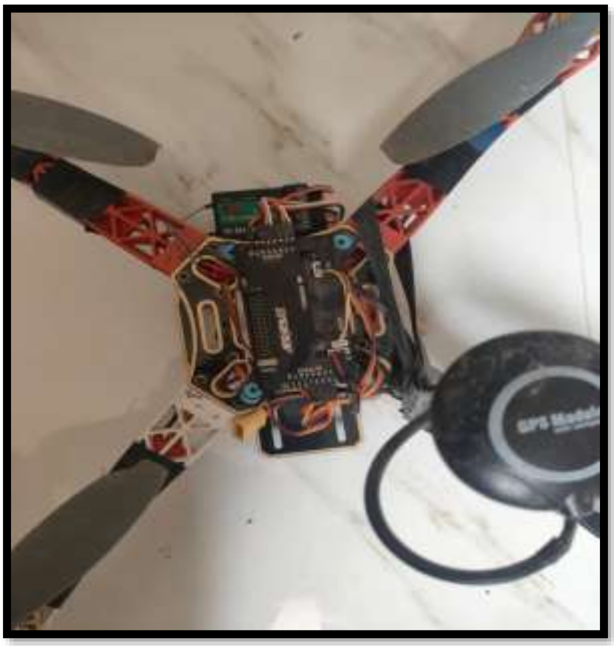

Fig 5.1 Drone Model

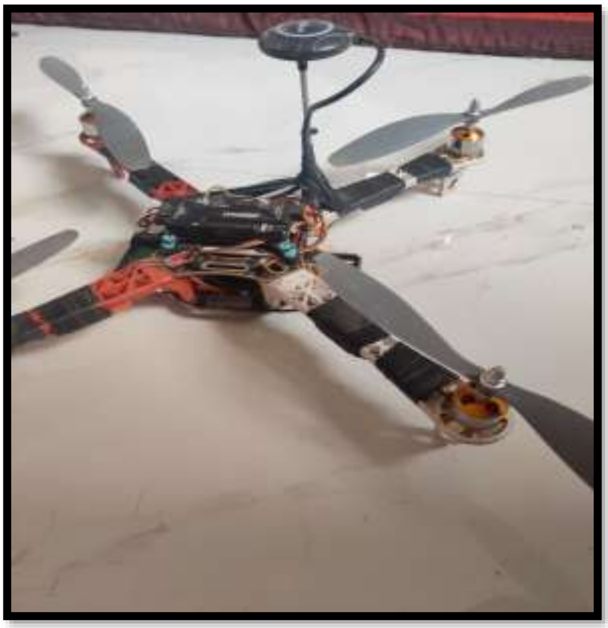

Fig 5.2 Drone Assembly

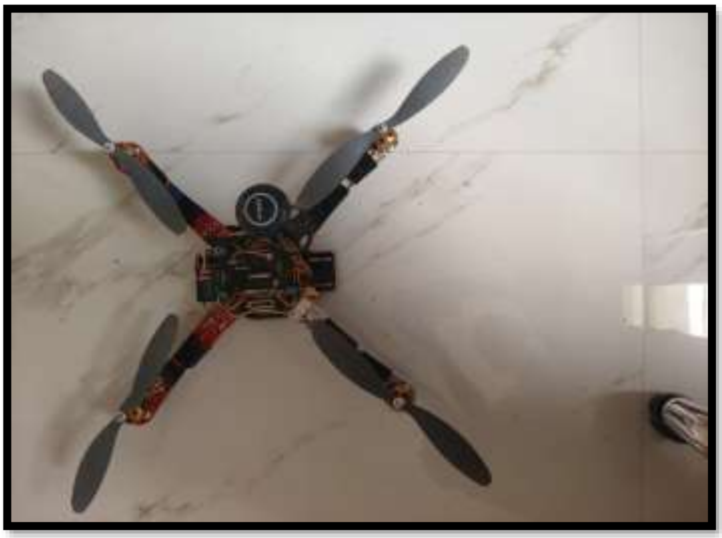

Fig 5.3 Final Drone Setup

Fig 5.4 Drone in Flying Condition

VI. CONCLUSION

This article described a smart drone surveillance system that uses geofencing, the Google Maps API, and restricted area avoidance. The suggested technology offers real-time aircraft monitoring while successfully preventing unauthorized airspace entry. It is appropriate for industrial, public safety, and defence applications due to its low-cost design, autonomous operation, and safety features.

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