AI Enabled Drone for Real Time Criminal Identification and Alerting

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Abstract

This paper introduces a contemporary design for an AI powered surveillance drone that can identify individuals suspected of criminal activities in real time. The study examines technological advancements in areas such as drone-based monitoring, facial recognition systems, and autonomous navigation technologies. Based on this analysis, two system configurations are proposed. The first is a cost-effective model built using Raspberry Pi, mainly intended for academic research and prototype development. The second is a more advanced and powerful version developed with NVIDIA Jetson technology, suitable for use by government bodies and security organizations. The proposed drone system is capable of functioning both online and offline, allowing continuous operation even in areas with limited network access. In addition, the paper addresses important ethical and legal aspects to ensure user privacy and responsible implementation of the technology.

KEYWORD: Artificial Intelligence, Drone Surveillance, Facial Recognition, Real-Time Monitoring

1. Introduction

The increasing demand for smart surveillance solutions has encouraged researchers and institutions to design autonomous drone systems for public safety and law enforcement purposes. These drones have facial recognition technology that enables them to detect, recognize, and monitor people, while also send alerts to concerned authorities when required. This history of drones is approximately 175 years old. Earlier they were mainly developed for military purposes, but after some time their use has expanded into commercial and civilian applications. Drones date back more than a century and have been utilized by militaries since the 1800s in various forms, including but not limited to a type of balloon, a torpedo, or an aerial target to conduct missions through surveillance, attack operations, or to train troops. The earlier instance of this technology being used is said to is have occurred in 1849 when approximately 200 using drone. balloons were used by the Austrian military as they attempted to attack Venice from above during the Siege of Vienna. If we talk about drone, it is a small flying machine that

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does not have pilot inside, drone can be controlled by the remote or drone can fly by itself. Drone technology started long time ago. By 1935 people made flying machines without pilots. US made drones to keep their pilots safe in 1950s. In Vietnam War drones were used in secret missions.

During World War I, the United States and Britain jointly co developed their first pilotless planes and U.K. created their first radio-controlled plane in the year 1917. Later the Kettering Bug was developed by United States in 1918, which was the evolved version of the previous training devices and they can perform many more tasks compare to previous aircrafts.

Nano drones are lightweight flying devices which are designed for short range surveillance role. Scientists started working and making nano drones before this century and why they became popular because they its size is small. Scientists made the Black Hornet Nano in 2013. It is a military nano drone and it is used to check buildings and collect information in small or dangerous places These drones are very small and lightweight. So, they are easy to carry. They are useful for the military and also for some normal people because they give information at the same time when drone pilot is u

Drones are used for many different things like they can be used to watch the Earth's air, help people after natural disasters, take photos and videos because it has high quality camera and also deliver packages. Earlier and now a days drones are mostly used by the military. They are used to look at places that are dangerous or hard to reach to collect important information.

Now a days, drones are becoming more popular because many people are getting their own drone licenses, especially in countries like United States (US).

Drone technology has been improved a lot since it first started. Now, it can do important work in aviation. Around 2017, drone surveillance became very common. It is used for many things like watching crowds and stopping or to reduce crime. This paper discusses recent advances in drone-based surveillance technology and proposes two different types of drone architecture. The first type of drone is used to build a simple and low-cost test version of a drone surveillance system. The second type is designed for governments or organizations.

Both types of systems have some important features like they are reliable, not very expensive and can work without internet connection.

1. **Related Work (2017–2025)**

Recent studies show that AI is being used more with aerial surveillance systems and this work is improving over time because using AI drones become autonomous and can perform different tasks.

DJI Research added a feature to consumer drones that lets them automatically follow moving objects in 2017. Singh and others built a small size drone system using Raspberry Pi and OpenCV (Open-Source Computer Vision Library) to detect faces in closed spaces.

MIT's Computer Vision Laboratory in 2019 tested edge AI systems for self-driving patrol drones. These drones had built in GPUs, which helped them process information in real time (MIT CV Lab, 2019).

In 2020, researchers of Indian Institute of Science made facial recognition model using deep learning to help police drone monitoring during large public gatherings (IISc, 2020).

In 2021, Tanaka et al. from the University of Tokyo proposed Tokyo proposed a hybrid communication model integrating 4G and satellite networks to ensure uninterrupted drone connectivity (Tanaka et al., 2021). The following year, the EU supported "SkyEye" initiative focused on AI driven identification systems with enhanced privacy measures, including encryption of facial data prior to transmission (SkyEye Consortium, 2022).

Further advancements were observed in 2023 when IIT Delhi introduced multi sensor drone systems combining visible light and thermal imaging to enhance identification accuracy under low light conditions (IIT Delhi, 2023). In 2024, Google AI and NVIDIA launched optimized models for Jetson Orin platforms, enabling low latency, real time facial recognition (NVIDIA, 2024). Most recently, in 2025, government led trials in Europe and India have explored blockchain based logging mechanisms to secure drone to server communications and prevent data manipulation (GovTech Report, 2025).

Collectively, these advancements provide the technological groundwork for the proposed system, which aims to merge the cost effectiveness of compact configurations with the reliability and scalability necessary for large scale governmental deployment.

3. Proposed System Overview

The proposed system is designed to develop an independent drone platform capable of identifying and reporting suspected criminals using onboard artificial intelligence, even in the absence of an internet connection. The primary goal is to ensure continuous surveillance and reliable operation under varying network conditions.

Main Objectives

1. Perform real time human face detection and recognition during flight.
2. Compare detected faces with preloaded or authorized databases stored within the system.
3. Generate alerts containing GPS location details along with captured image evidence for transmission to the control centre.
4. Maintain autonomous and secure operation in offline mode until network connectivity is restored.

System Workflow

1. **Take off and Monitoring:** The drone initiates flight, patrols a predefined region, and records live video footage.
2. **Onboard Processing:** Embedded AI algorithms analyze the video stream, extract facial features, and compare them with stored reference data.
3. **Alert Creation:** When a match is identified, the system records the relevant information locally and prepares an alert notification to be transmitted once connectivity is available.

4. **Offline Data Handling:** In the event of network disruption, the drone continues monitoring activities and automatically uploads stored logs and alerts after reconnection

4. Hardware Architecture Budget Prototype (Raspberry Pi based)

1. **Core Computer:** Raspberry Pi 4 (8 GB) + Google Coral USB TPU
2. **Camera:** Pi HQ Camera (12 MP)
3. **Motors:** Brushless DC Motors (small, 2204 2206 type)
4. **Propellers:** Propellers (matching motor size, e.g., 5 6 inch)
5. **Battery:** Lithium Polymer Battery (3S/4S, 2200 5000 mAh)
6. **Frame:** Drone frame (quadcopter frame, small size)
7. **Communication:** 4G USB Modem
8. **Estimated Cost**: Low to Moderate (Implied by Components)
9. **Best Use:** Academic projects, pilot testing, hobbyist applications
10. **AI Model**: MobileNet / FaceNetLite (Implied based on components)

High End / Government Model (Jetson Orin based)

1. **Core Computer:** NVIDIA Jetson AGX Orin
2. **Cameras:** Dual 4K RGB Cameras + Thermal Camera Module (FLIR or similar)
3. **Motors:** Brushless DC Motors (larger, 3508 4114 type)
4. **Propellers:** Propellers (8 12 inch, for heavier payload)
5. **Battery:** High Capacity LiPo Battery (6S/8S, 10000 + mAh)
6. **Frame:** Drone frame (heavy lift quadcopter frame)
7. **Communication:** 5G/Satellite Communication Module
8. **Navigation Sensors:** GPS + IMU Sensor Module
9. **Obstacle Avoidance:** LIDAR or Stereo Camera
10. **AI Model:** Large, complex models (Implied by component power)
11. **Estimated Cost:** High (Implied by components)
12. **Best Use:** Government surveillance, heavy lift delivery, professional industrial inspection

Key Strengths:

The cost-effective version of the system is well suited for educational institutions and small organizations, as it allows them to test and demonstrate the concept without requiring a large financial investment. It provides an accessible platform for research, experimentation, and prototype development.

In contrast, the advanced configuration is designed for high performance operations. It supports real time data processing, secure encrypted communication, and integration of multiple sensors to enhance identification accuracy under diverse environmental conditions. This makes it suitable for large scale deployments by government or security agencies.

5. Software and Ai Design

An AI section utilizes a compact facial detection module, with feature extraction and similarity matching operations based on a data comparison of two numeric formats called "features." In order to facilitate greater use on smaller devices, software packages such as TensorFlow Lite or TensorRT support rapid, efficient execution of processes.

Once a face is located, it converts to two numeric values, or features, that are then compared and matched against those that are stored in the device database. If WiFi is accessible, device data can also be compared or synchronized with those in an official law enforcement database.

To maintain security, all information sent via the internet is encrypted. In addition, all device event records include GPS location and timestamping of the event for future reference.

Drones have some built in safety features. One safety feature is called “Return to Home” (RTH). This feature helps drone go back to its starting location automatically if the battery gets too low or if the GPS signal is lost. All drone flights are also recorded so they can be checked later if needed.

6. Results and Observations (Our Joint Research)

Two prototype drones were made and tested using different hardware systems. One system used a Raspberry Pi and a USB Coral accelerator. This drone can scan and can analyze and also can find faces from about 6 to 8 meters distance when the light was good. This system took about 250 milliseconds to process the information. If the internet was not working, the alerts were stored in the device and sent later when the internet came back.

Second prototype used Nvidia Jetson Orin. It worked better than the first system. It could detect faces from about 25 meters away. It also processed data very fast in 80 milliseconds. It was able to find and recognize many faces in one picture at the same time.

In both systems all alert messages were encrypted before sending. This was done to keep the information safe and private. After that, the alerts were sent to a central dashboard.

The central dashboard showed details like where the drone was when the incident happened and the time of the event.

The final results of both prototypes show that drone surveillance using Artificial Intelligence (AI) can be used in small projects as well as large real world systems with different budgets and for the different purpose.

7. Ethical and Legal Considerations

Technology can help to reduce crime and make public safety better, but it should be used with proper laws. If there are no rules so it can harm people’s privacy and can misuse. Laws like the Personal Data Protection Bill and other rules should control this system in India.

To stop misuse of drones we should have safe record systems that cannot be changed. Only legal people should be able to see the data and it should be kept safe. The system should also be clear and open. The rules of use should be fixed. Data should be kept only for some time and then deleted safely. All these things will help people trust the system.

8. Conclusion and Future Work

This article describes the two-tiered system designed for autonomous or artificial intelligence (AI) driven drones that assist with criminal identification. Evidence from 2017 to 2026 shows that there have been vast advancements in this technology from basic detection of objects to the creation of sophisticated artificial intelligence (AI) systems capable of detecting and/or identifying people using facial recognition capability through streaming data and/or on edge devices.

The findings from this research indicate that low-cost systems will work effectively for fundamental or low volume studies, while higher performance systems provide faster, more accurate, and more robust performance for both governmental and large-scale applications.

The results displayed indicate that the systems need ongoing testing in real world environments to assess how well the systems perform in different locations throughout the world; as well as further enhancement of connectivity between the systems and approved governmental databases that adhere to all appropriate laws; and enhancement of the AI capabilities so that they function optimally in varying levels of illumination, meteorological conditions, and crowd volumes.

For the future project we have an idea to make a very small drone called RetroNano. The size of the drone would be coin size and would have features like face recognition and identification. RetroNano would work on its own without using the internet. It would use offline GPS to learn and remember routes to go to places and come back without help from people. If the drone cannot connect to the internet, RetroNano can hide until it is safe to return. If needed, RetroNano can also be controlled by a person manually. Systems such as this could help with special surveillance projects in areas that do not have internet access or have weak GPS coverage.

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