The Rise of Intelligent Drone Fleet Services

Abstract

Over the last few years, drones have seemingly flown out of nowhere and landed as major tools for organizations in the areas of remote asset management, logistics, and public service delivery. We have already seen ecommerce giants such as Amazon investing heavily in this technology so that, in near future, a fleet of drones is able complete last mile deliveries at a fraction of the present cost.

Today, a single drone can fly autonomously and execute beyond-visual-line-of-sight (BVLOS) operations. UAS service suppliers (USSs) are evaluating the feasibility of deploying entire drone fleets instead of lone UAVs to accelerate service turnaround and improve profitability.

This paper presents an extendable artificial intelligence (AI) framework for autonomous drone fleet services, highlighting the potential benefits through two drone-fleet-as-a-service use cases – one for the commercial retail sector (last mile delivery) and another for government services (public safety – search and rescue).

Democratizing Drone Services

Unmanned aerial vehicles (UAVs) are steadily making inroads into the commercial, consumer, and military sectors. With UAV service suppliers (USSs) gearing to meet the demand for cutting-edge logistics and safety solutions, the need for smart drones is driving semiconductor, connected devices, and UAV manufacturers to focus on developing technologies that support intelligent beyond visual line of sight (BVLOS) operations. We are already seeing a number of USSs integrating advanced UAV traffic management (UTM) solutions, such as features for flight monitoring and control, detect sense and avoid (DSAA), drone-to drone communication, and exigency procedures, into their operational frameworks. The ultimate goal for these companies is to extend their offerings' capabilities, create drone fleets, and deliver drones-as-a-service (DaaS) to different businesses.

The challenge, however, continues to be the lack of a common extendable framework that incorporates deep learning and artificial intelligence (AI) training models, and computational algorithms to optimize and automate drone fleet services.

Building an AI Framework for DaaS

The simulation test bed is set up in the hardware-in-loop (HIL) mode while equipping the drone platform with an AI-driven framework, like Google's TensorFlow, and computational algorithms are used for optimized path planning and distress detection – image-fire/audio-help. The training set uploaded is based on the options selected from a services catalog provided by the USS. Once that is done, the AI program can create flight plans or deploy drones according to the instructions detailed in the service receipt.

Once implemented, the AI framework takes over autonomous operations – from flight planning and deployment to fleet control and monitoring – completely removing the need for manual intervention in these aspects. Traffic management and regulatory guidelines are inherently in line with the UAV traffic management guidelines.

Use Case 1: Deploying Drone Fleets for Last Mile Delivery

Let us consider a retail industry scenario where last mile deliveries are completed through DaaS. A typical operational workflow for such a service would begin with processing the service requests followed by mission planning and monitoring during the course of a delivery run. This approach is feasible and only recommended for a single service task such as drop-offs or pick-ups. However, if the same workflow's scope is scaled up for completing multiple drops and picks as part of the service offering, the operational and execution costs are likely to increase significantly.

As an intermittent solution, an entire fleet of drones can offer better user experience with respect to delivery and pick-up services, although the high operational cost of planning such services would be an issue.

The proposed model leverages the USS' ground station and each drone's on-board AI framework to collectively execute intelligent fleet services. The typical operations would include:

- Running flock fleet mission from current location to final drop zone
- Computing last mile delivery for uploaded drop location
- Optimizing drone fleet operations for completing multiple tasks (e.g., milk run)
- Marking areas of interest (perimeter) within last mile drop zones
- Autonomously executing drone services
- Recalling drone fleet after completing last mile delivery

We believe that such an AI-backed drone fleet management framework will not only reduce the cost of operations for commercial segment services, but also assist in civil inspection, surveillance, and delivery tasks.

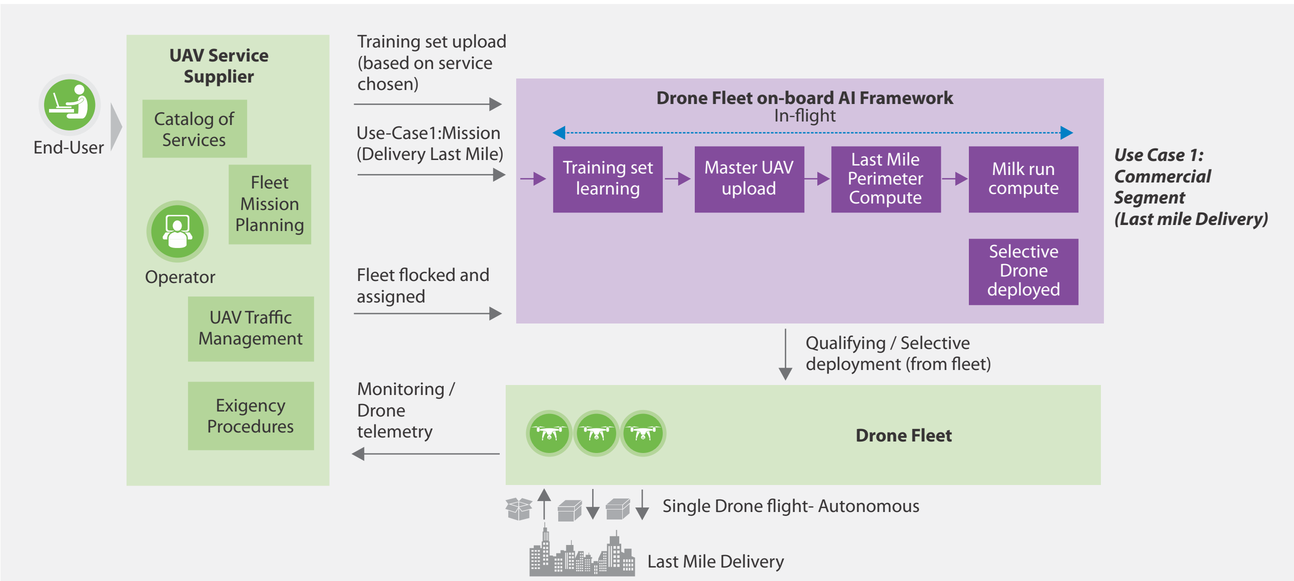

Figure1: An AI framework for optimizing drone-based last mile delivery

Use Case 2: Leveraging Drone Fleets for Search and Rescue Operations

Let us now consider the case of a search and rescue operation in the civil government sector. A typical approach would comprise a system for helping the drone navigate along with real-time video surveillance capabilities. In case the drone spots a person in distress, it signals stand-by emergency services personnel and directs them to the location. While this is the standard operating procedure, there is scope of improvement, especially for cases where the subject of a search operation needs immediate assistance.

This AI framework (see Figure 1) leverages in-flight training to quickly iterate or modify mission directives based on the situation at hand and deploys multi-purpose drones capable of:

- Dispensing a combination of emergency aids such as first-aid, phones for calling 911, water, among others
- Capturing and analyzing real-time audio and video
- Selectively deploying drones for specific services from the entire fleet that:
- Respond to calls for help (audio) – drones equipped with medical and 911 phones
- Respond to detected hazards such as fire (video) – firefighting drones armed with water jets and capable of dispensing face masks for people on the ground

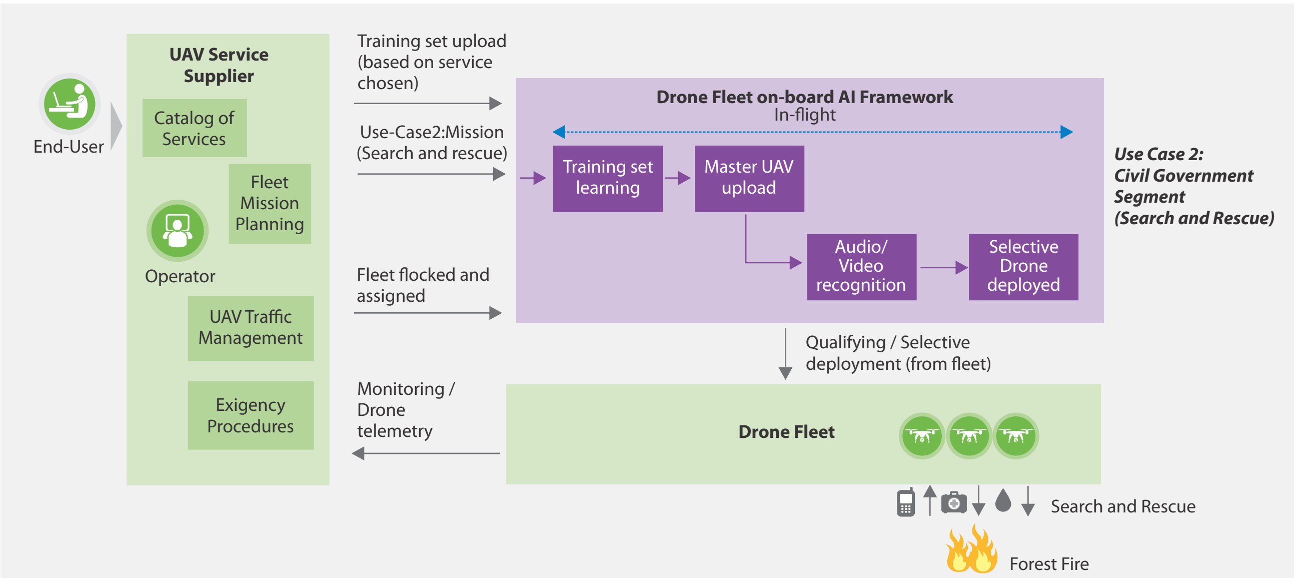

Figure 1: Modular and extendable framework to support add-on services

Primary drone (black) executes search mission. Other multi-service drone fleet on stand-by

On fire detection, Primary drone (black) autonomously directs other drone (red) to fire detect coordinates.

Figure 2: Detecting and responding to critical events

The HIL simulation test bed needs to be setup for drone fleet search and rescue operations, as highlighted in Figure 2. In the earlier scenario, the AI framework is trained to detect fire during the mission. The drone camera (gimbal) is capable of capturing and transmitting surveillance video during search operations. Once the fire or a similar hazard is detected, the right drone for the job is deployed while the primary drone carries on with the search mission.

A New Breed of Intelligent Drones

AI-enabled frameworks can be used by USS for providing DaaS to complete a wide variety of tasks in retail, manufacturing, healthcare, transportation, industrial, telecom, and civil operations. Between 2019 and 2020, we are likely to witness the US UAV traffic management and Europe's U-Space programs take off and open up the commercial market for drone services.[1,2]

While we have demonstrated the AI framework for two viable drone fleet services, the modularity and extensibility of the framework provides scope for supporting a wide range of intelligent fleet services. Once pre-trained AI engines become commercially available, the possibilities are truly endless. As a plug-and-play solution that delivers additional computing power, DaaS providers can hope to extend cost-effective, agile autonomous, drone-fleet services to an even wider audience in the form of autonomous taxi fleets and security systems to name just a few.

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