

Drone Services for Augmenting Mobile User Devices On-Demand: Concept and Prototype

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ABSTRACT

Despite¹ the increase in drone popularity, still, there are numerous issues to be solved. But there are many beneficial applications that can be derived through the use of drones combined with other available, scalable and growing technologies such as mobile devices, smartwatches, and add-on electronic sensors. In this paper, we propose and investigate an approach to using drones acting as servers (edge computing style) in order to collect data, provide Internet access, and process data for mobile users.

KEYWORDS

Drone services; drones; unmanned aerial vehicles (UAVs); Edge computing.

1 INTRODUCTION

Drones, or unmanned aerial vehicles (UAVs), have significantly attracted the attention of researchers and enterprises especially in the light of the virtually unlimited range of drone services. Amazon and DHL have established a realistic example of using drones to transport goods to their customers. And at the humanitarian level, drones have proven effective in delivering urgent medical supplies [2] and finding wounded people [1]. Facebook additionally has a method to set up satellites and drones to supply Internet access to remote areas. Other services include increasing vision via flying cameras, use a drone as a coach to accompany someone for jogging, monitoring houses on alarm triggering and the list goes on [3].

There are different types of drone services that can be implemented in different scenarios. For example, a drone can act as a security guard to protect someone walking home alone at night or a drone can act as a flying camera that can be rented simply by calling the drone to come to a given location to take photos or videos. Another scenario is a drone that can be used to

deliver computing services, e.g., connectivity and compute resources, i.e., where it acts as a server to provide edge computing services [4]. In this paper, we focus on a prototype of this particular type of services where the drone acts as a fly-in-fly-out on demand edge server. These services include transporting data from the mobile client to the station (via the drone), providing data tethering to clients and performing computational work sharing with clients.

2 CONCEPT AND DESIGN

In order to provide an understanding of how a drone serves incoming requests, Figure 1 shows an experimental area where clients are located during our experiments as well as the starting point for the drone operations (i.e., the drone station).

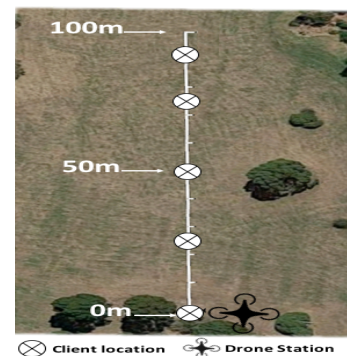


Figure 1: Study area

The proof-of-concept prototype consists of three main components:

- 1) Drone: Using Parrot Bebop drone with an attached/fixed Nexus device supplied with our custom application (*called Drone services - server*) to perform the computational services with the data received from the client's mobile device.
- 2) Controller: using an Android device supplied with a customized version of the FreeFlight Pro app to control the drone (this can be replaced with an automated custom controller).
- 3) Client: A smartphone with a custom app (*called Drone services - client*), that allows configuration of the client device to be discoverable by the drone.

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3 PROTOTYPE AND EXPERIMENTS

Our experiments comprise two Android devices; LG Nexus 5X, Lenovo TAP3 8 and one Bebop drone. We have implemented the following three drone services in one Android application called (*Drone services*):

- 1) Data Collection Service,
- 2) Data Provisioning Service
- 3) Data Processing Service.

Figure 2 illustrates the front-end component that offers mobile clients simple interactions with the system. This section discusses each service and its potential for improving data service provisioning.

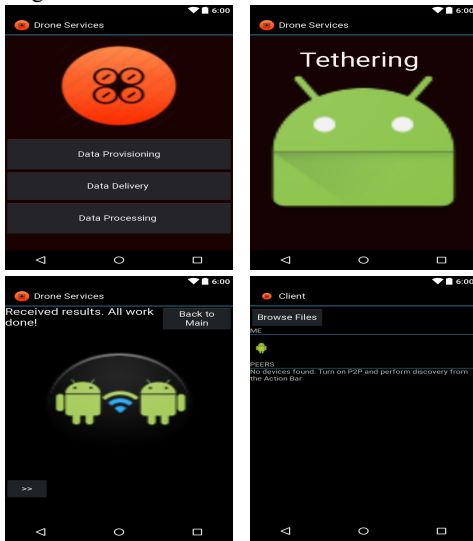


Figure 2: Screenshot of the (Drone services) app homepage and each service.

Data Collection Service. In this service, firstly, five reference points were set along the drone path as shown in Figure 1. These reference points are used as possible client locations. We then performed six experiments, and each experiment repeated five times with six different file sizes (from 5MB to 100MB) for files uploaded from the client’s smartphone to the device attached to the drone. In the first five experiments, the drone status was hovering at point 0m and the client changed the location at each test correspondingly. At the sixth experiment, the drone was flying towards the 100m point and the client’s location is fixed at 100m point. We compared the results for different drone status and different file sizes as shown in Figure 3. The simple tests indicate that as the file size increases, uploading while flying is better than uploading while hovering, so that such data services can be active during flight.

Data Provisioning Service. The drone acts as a flying access point to provide internet access to clients via tethering. No matter what status the drone is at, hovering or flying, the coverage remains as long as the drone and the client are within Wi-Fi range of each other.

Data Processing Service. Complex data processing such as image processing and natural language processing can be time-

consuming or may drain resources. In this case, the drone plays the role of a data processing partner that share its resources with other devices using the Honeybee technique [5]. Actually, a drone can also act in an opposite way, rather than offering its resources, it can also ask its surrounding devices for resources to help it do processing.

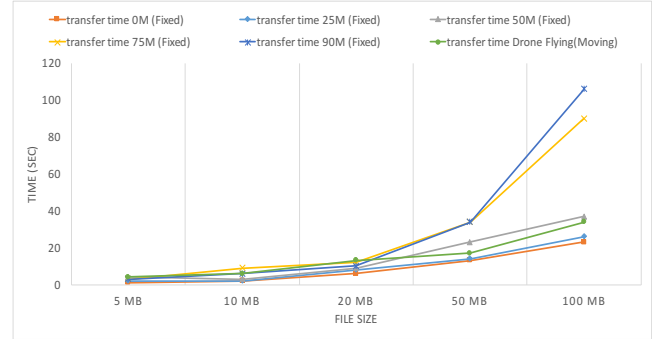


Figure 3: File Transfer time against file size with respect to the drone flying status.

4 CONCLUSIONS

The idea of a drone delivering services is not new. There have been many studies in using drones. For example, the work in [6] explores the feasibility of using a drone to accompany terrified people home at night. Also, there are interesting proposals that focus in designing drone network traffic management [7]. In the era of developing technology and cutting in its cost, firms start operating drones to deliver services (i.e., a “phone-a-drone” or drone rental services). In this paper, we have discussed and implemented three drone data services; in each service a drone plays the role of an edge server augmenting the user’s device. Further drone services, from photo-taking to drone as a mobile guard, will be developed in the future.

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