DRONE-AIDED EFFICIENT WIRELESS NETWORK COMMUNICATION FOR FAST RECOVERY AFTER DISASTERS

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This paper proposes the use of drone technology and wireless communication for fast recovery from damage caused by disasters such as hurricanes and severe flooding. Communication infrastructures are often destroyed due to such events, and causes delay in the recovery efforts as well as inconvenience to the community. To resolve this issue, we propose to use multiple drones to provide wireless connections between a center and a user or among users in the damaged areas (Figure 1). Multiple drones equipped with wireless communication relay devices are assigned to each initial wireless relay station. These assigned drones are launched and form aerial relay stations (aerial relay nodes) over operation areas following ground users. Without considering the locations of users and initial ground relay stations, surrounding environments and deployment times (launch times), multiple drones can provide users with wireless communications.

Fig. 1. A Concept of Drone Relay Stations (DRS)

The concept of drone relay stations for providing wireless communications to the destroyed areas is possible considering features of the drone that are currently developed (or developing) technologies as follows:

High-mobility. Drones can fly aerial areas so the flight path of a drone is not affected by ground conditions. The drone also needs less deploying (launching) time than the current methods (ground vehicles and aerial vehicles). The drone can quickly respond to a request for an aerial relay station.

Swarming flight. To ensure quality and coverage range of wireless links, drones must fly at a constant distance and/or a formation with other drones and ground vehicles. Drones act as a wireless linked node in aerial relay stations. Hence, swarming flight technology is needed to make a perfect drone flight distance and/or formation [1]. Recently, the US military tested a swarming flight of drones in California where the drones demonstrated advanced swarm technologies [2] (see Figure. 2 (a)).

Collision avoidance. Drones can collide with unexpected obstacles when they fly as they are following ground users. They may encounter unexpected barriers such as other drones, tall trees or tall buildings. In these cases, to ensure real-time wireless relay services for users in destroyed areas, the drones can detect the unexpected event and avoid them before colliding or hitting said obstacle. Many collision avoidance researches have been conducted for multiple drones using various approaches [3] (see Figure. 5 (b)).

Long operating time. The duration of relay flights is varied based on types of disasters. It can be less than an hour or longer than a day. Regardless of the length of operation times, drones should be aerial wireless relay stations during the required duration. Although fuel cells currently have limitations, fuel cells provide drones with longer flight durations compared to the performance of batteries. There are many works that show the use of fuel cells for smaller drones [4,5].

(a) Swarming flight [6] **(b)** Collision avoidance [3]

Fig. 2. Developed/Developing Drone Technologies

Resistance to Harsh Weather Conditions. Drone flights are likely to be affected by weather conditions. First, strong winds cause drones to consume more fuel to keep a flight stable or even making it impossible to fly through strong winds. Second, heavy rain or snow can also interfere with drone flight, and lastly, significantly cold temperatures may result in a reduction in the performance of drone's batteries [7]. Hence, resistance to the harsh weather factors is one of the features to ensure wireless communication relay in the real-time and real world. Recently, however, a test showed how well a drone could fly in 15 meters per second level wind [8].

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