A Study on the use of Integrated Mesh Network with Drones for Emergency Internet Access using Onion Omega 2+

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Abstract

One of the most important aspects of an effective disaster response is the ability to communicate effectively, either between emergency responders with each other, or between emergency responders and victims. Reliable and clear communication is necessary in order to coordinate more effectively. However, the infrastructures are often damaged due to the disaster, making it difficult to establish a communication network. As such, this paper aims to create an emergency communication network that is stable, reliable, and adaptable to the unpredictable situation. In this paper, we designed a drone mounted with an Onion Omega 2+ IoT device. The Onion Omega 2+ device will use a wireless mesh network architecture to provide a reliable internet access to the disaster affected areas. The proposed method provides a wireless communication of up to 27 Mbps with a coverage of 50 m for one drone.

Keywords: Disaster Response, Drone, Onion Omega 2+ , Telecommunication, Wireless Mesh Network

Ⅰ. Introduction

Natural disasters are a constant looming threat to human lives, especially in areas where they are more commonly occurring. These disasters often uproot the lives of people, and may even cause casualties. As such, one of the most important aspects of handling natural disasters is the disaster response. This refers to the actions taken in order to prevent any additional loss of life, reduce the likelihood of health impact, and establish a line of supplies to meet the basic needs of the people affected by the disaster. [1]

Emergency communication during a disaster is a crucial aspect as it allows for proper and accurate relaying of information and allows for the emergency responders to more efficiently work together. However, the infrastructure that is responsible for telecommunication services is often damaged during the disaster. Therefore, a rapidly deployable, reliable, efficient, and stable emergency communication network is needed. [2]

In this paper, we designed a drone mounted with an Onion Omega 2+ IoT device that can provide an internet access using a wireless mesh network architecture. The drone will be deployed in a disaster-affected areas where conventional communication infrastructure is unavailable or non-functional.

Ⅱ. Method

In this paper, we propose a design using a mesh network architecture supported by Internet of Thing (IoT) device called Onion Omega 2+ and drone to create a high resilient communication system. The system will combine mesh network and multi-hop wireless communication schemes. By using a multi-hop scheme, the network will be more reliable, resilient, and adaptable since we can easily deploy more drone on the disaster affected areas when it is needed and it will automatically make a mesh network connection and enable internet access to the areas. [3] [4]

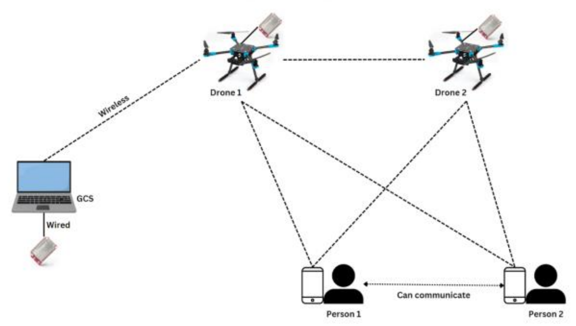

Fig. 1. Design Topology

The figure above shows the network topology that is being used in this paper. The ground control station will be connected to the internet then it will be connected to the Onion Omega 2+ by wired. The Onion Omega 2+ that is being connected to the ground control station now has an internet access. The Onion Omega 2+ on the ground control station then will emit an internet signal to the Onion Omega 2+ mounted on the drone through wireless communication. Then the Onion Omega 2+ on the drone will emitting internet signal to all of the Onion Omega 2+ on the area creating a mesh network and multi-hop connection. Through this, the responders and victims can connect to the mesh network through Wi-Fi connection.

In this paper, the Onion Omega 2+ will act as a node or access point to transmit and receive signals from the ground control station and responders. The Onion Omega 2+ was chosen mainly due to its built-in Wi-Fi antenna and its relatively cheap price compared to other similar IoT devices. The Onion Omega 2+ also has a relatively small size, making the overall weight of the drone lighter when mounted. The Onion Omega 2+ also uses a low power consumption, making it a reliable IoT device for a long range and time mission.

In this paper, a quad-copter drone was chosen because it is more stable and easier to control during flight compared to the other types of drones. The total weight of the drone is calculated to be 2.17 kg. The drone can fly around 30 minutes with an 8400 mAh battery. The flight time can be improved if we use a higher battery capacity. The drone mounted with an Onion Omega 2+ device that will make a mesh network connection.

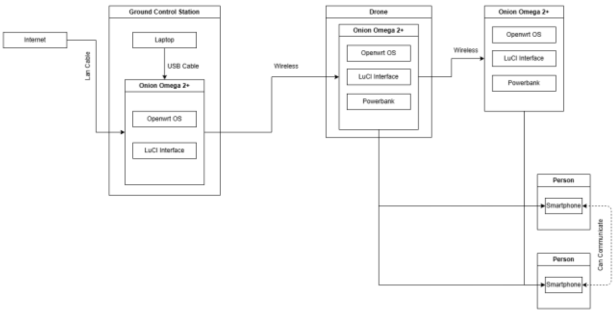

Fig. 2. Implementation Design

The figure above shows the implementation of a multi-hop communication using Onion Omega 2+, drone, and mesh networking. The system starts with a ground control station that acts as the central hub for the network. The Onion Omega 2+ that runs OpenWrt OS with a LuCI interface is connected via a LAN cable to the internet and then connected through a USB to a laptop. This Onion Omega 2+ acts as the first communication node that will transmit signals wirelessly to extend the connection.

The first Onion Omega 2+ then connected via wireless connection to both Onion Omega 2+ on the drone and Onion Omega 2+ on the ground. This connection of all of the three Onion Omega 2+ makes a mesh network which means even if one of the Onion Omega 2+ devices is down, the receiver can still connect to the ground control station. In situation where there is no direct connection, a mesh network allows for multi-hopping between the Onion Omega 2+ devices, allowing an indirect connection to be made.

We deployed a drone with an integrated mesh network in a field to simulate a disaster affected area. The following table shows the performance metrics collected during the test.

Table I.
Experimental Results of Drone Mesh Network

Metric	Value	Description
Average Latency (between devices)	19 ms	End-to-end ping between devices
Average Latency (between server)	1.621 ms	End-to-end ping between server
Packet Loss Rate	0%	Measured during file transfer
Throughput	26.54 Mbps	TCP data rate under load
Total Coverage	50 meters	Total network coverage
Flight Duration	30 Minutes	Total flight duration

As shown in Table I, the average latency between devices remained under 20ms with 0% packet loss rate and a throughput of 26.54 Mbps. These values indicate that the integrated mesh network with drone has a reliable communication

Ⅲ. Conclusion

Emergency communication network is considered as one of crucial aspects during a natural disaster. However, the communication network infrastructure is often damaged during the disaster. In this paper, we proposed a solution of using a drone mounted with Onion Omega 2+ device to provide an internet access in the natural disaster affected areas using a wireless mesh network and multi-hop schemes. Using one Onion Omega 2+ connected to laptop that will act as the ground control station, drone mounted with Onion Omega 2+ will run a mesh network and will provide an internet access to its surrounding area with a coverage of 50m of using a single drone and can be extended by just deploying another drone. The drone has a flight time around 30 minutes and can provide up to 27 Mbps transmission speed.

In the future, the integrated mesh network with drone can be improved by using a higher battery capacity to increase its flight time. Using an additional external antenna might also improve the signal coverage of the Onion Omega 2+.

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