Implementation of UAVs with SDRs to Restore Wireless Connectivity After Disaster

Omar Naffaa, Computer Engineering

Mentor: Dr. Tamer Omar

Austin Austria, Brandon Helfer, Rikki Niemi, Krystal Wang

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Abstract

In the event of a natural disaster, victims are often left without a means of communicating for aid due to cellular towers degrading or failing. A proposed solution to this issue is to utilize unmanned air vehicles (UAVs) with radio capabilities in order to relay the connection of a working cellular tower from a distant area away from the disaster. The purpose of this project is to establish a connection between two Universal Software Radio Peripherals (USRPs), with the eventual goal of integrating these devices on UAVs. During this project, I worked to implement a program using the LabView software application that would utilize Phase Shift Keying (PSK) as a means to modulate a signal that would be transmitted between two USRPs. Once the transmitter and receiver software were created, different versions of PSK were tested and compared with the goal being to determine the most effective modulation technique while also proving that a remote radio connection can be created between the devices. From this project, I gained hands-on experience working with multiple communication protocols as well as exposure to LabView as a software development platform.

Introduction

In situations in which a natural disaster such as an earthquake or intense wildfire occurs cellular towers (base stations) can become disabled, leaving victims at the scene without a way to reach out for help. Although there are specialized radios that can be used to send a distress signal, many civilians do not carry this equipment on hand.

This project proposes a solution to improve the safety of victims of a natural disaster by exploring and modeling the use of Software Defined Radios (SDRs) mounted on Unmanned Air Vehicles (UAVs) as a relay system to pass the signal generated by a cellular device located at the scene of the disaster to nearby base station, allowing the victim to receive aid.

This system is modeled using National Instrument's USRP 2920 SDR, which were programmed using the LabVIEW software development environment. For this project, I performed testing to verify QPSK is the best protocol to use for data transfer in our case.

Overview, Results, and Discussion

Figure 1: NI USRP 2920 SDR

Pictured above in figure 1 is our Software Defined Radio, which was used throughout the project. This device is configured using LabVIEW, which allows the programmer to easily configure it to be a transmitter, receiver, or transceiver.

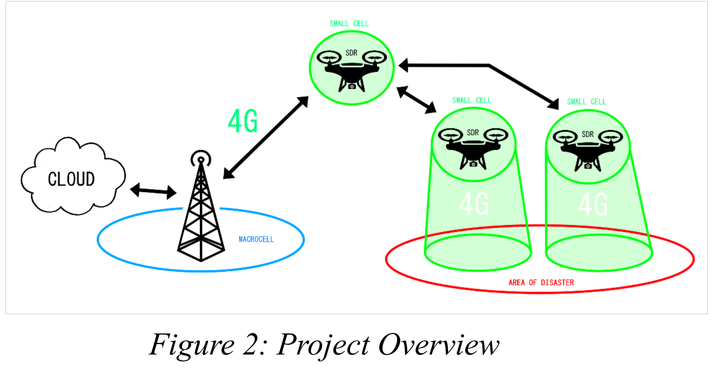

Figure 2: Project Overview

Shown in figure 2 is the architecture of the project. The macrocell on the left is represented by a USRP programmed to be a receiver while the UAV drones acting as our relay system are our transceiver USRPs. Within the area of disaster there will be a transmitter USRP that will represent a person in distress. With this model, a user can transmit a help signal, which will be passed along a relay system until being received by a base station.

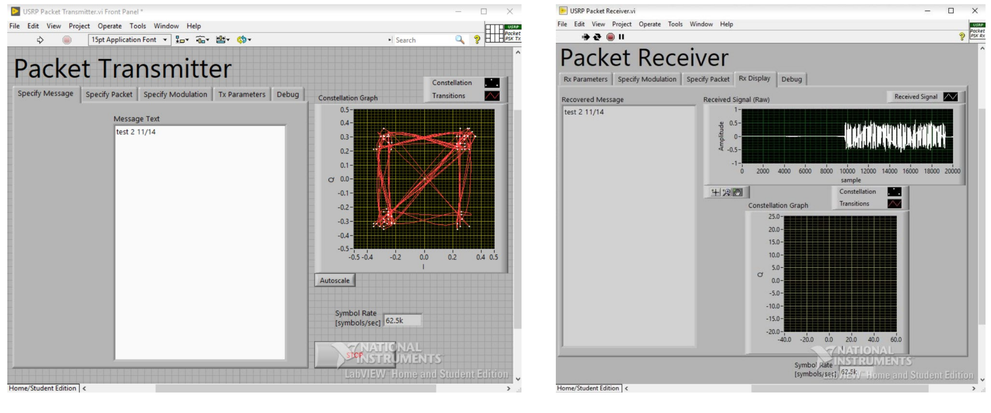

Figure 3: Transmitter and Receiver

The images above show the Graphical User Interface (GUI) of the project. The transmitter (left) allows the operator to generate a sample message to be sent. Once the sequence is initiated the message is separated into packets and sent across the transceiver relay system, which is a combination of the transmitter and receiver GUIs pictured above. Once the message is received by our sample base station, it will appear in our packer receiver interface (right). Shown above is a message being transferred successfully.

Conclusion

Once the USRPs were configured, messages were transferred from transmitter, to a transceiver acting as the middleman between the transmitter and receiver, and then to receiver itself. One relay point was used as a proof of concept of the relaying system, but the modularity that comes with using SDRs allows this relay system to be upscaled with as many transceivers in between as needed.

In the process of transmitting the messages different communication modulation schemes were tested in order to determine the most effective way to transmit a message. Many different protocols were tried during testing, and after analyzing the time to transfer in relation to the success rate of the packet reaching its destination I determined that the ideal protocol for our use case is Quadrature Phase Shift Keying (QPSK), which allows a higher rate of data to be transferred in the same amount of space as other protocols.

In the results section of this poster the transmitter and receiver show the sample message "test 2 11/14" successfully transmitted. After testing multiple times and achieving the same results it is seen that this type of solution is completely viable for use in the real world.

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