RUSH – Avalanche Search and Rescue Drone

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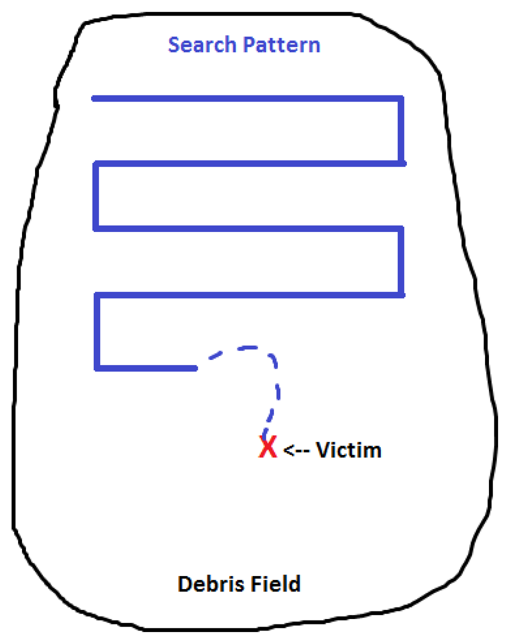
Introduction

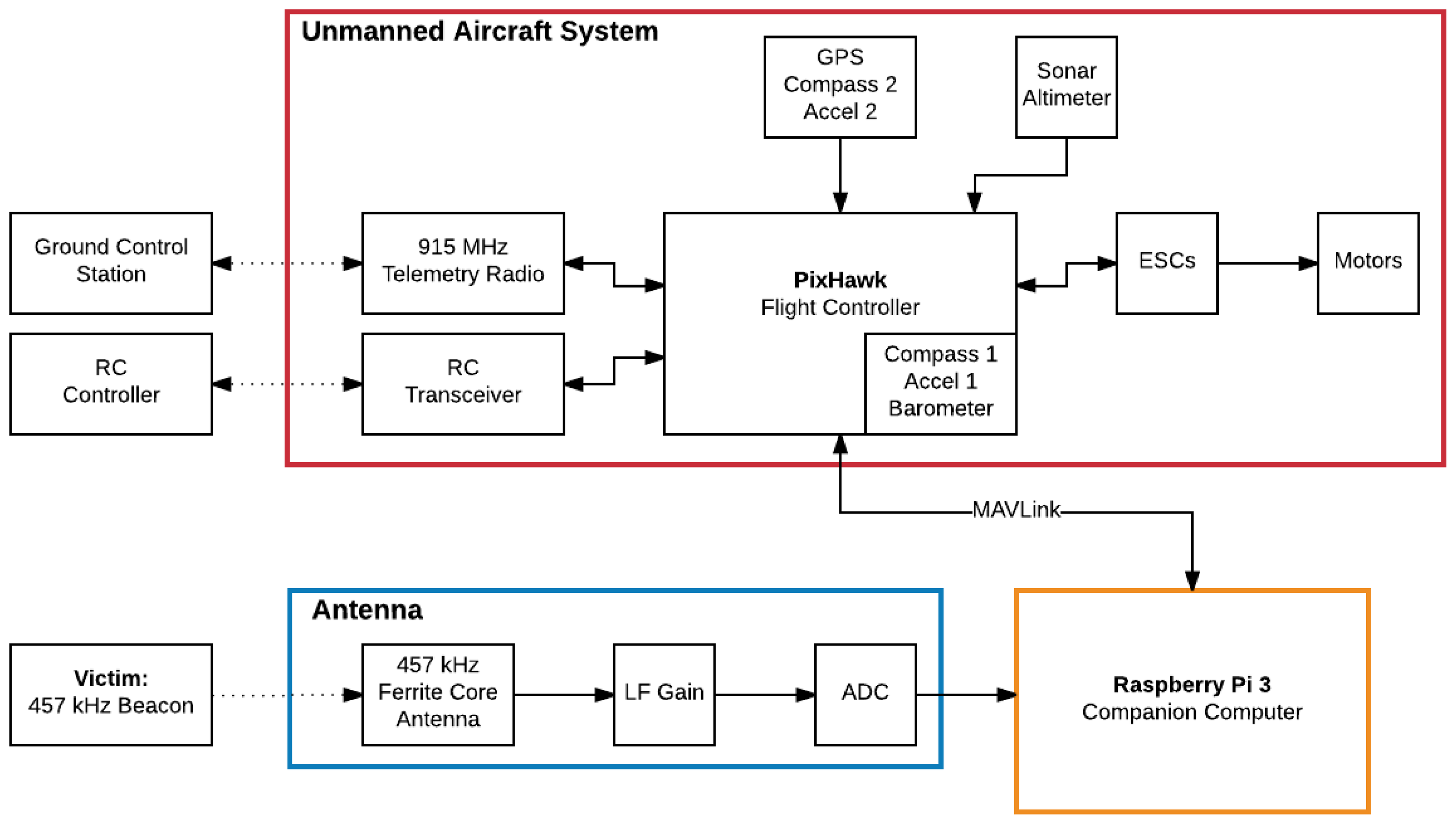
Current avalanche Search and Rescue methods require combing a large debris field on foot in attempt to find victims before they die from asphyxiation.

By introducing UAS search capabilities, we aim to improve efficiency to conserve energy of the SAR team, improve the search speed to increase victim survival odds, and decrease movement to avoid another avalanche. This system will search for victims equipped with the universal 457 kHz avalanche beacon.



Solution

UAS with a flight control suite that will allow for accurate location and altitude control along with the ability to take external control of the flight plan. Companion computer that can read flight telemetry, interpret digitized antenna signal, and generate a new flight plan. Receiving antenna that can maximize 457 kHz reception, minimize noise, and provide conversion from analog to digital signal.

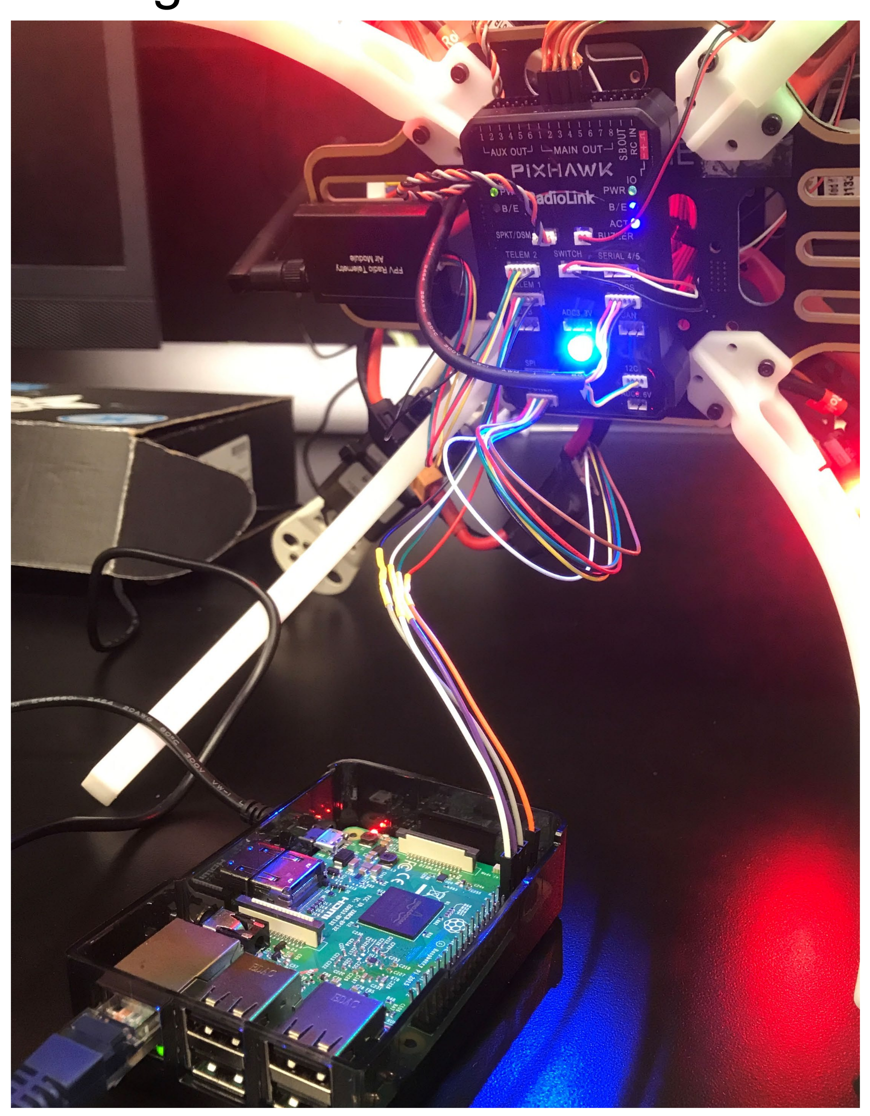


UAS

- > PixHawk flight controller
- > F450 frame
- > DJI E310 ESC/motor set
- > Loiter & Spin waypoints
- > ArduCopter firmware
- > 20+ min operating time
- > Telemetry radios
- > RadioLink GPS
- > Flight plan from Mission Planner & QGroundControl
- > Full control from Ground Control Station

Companion Computer

As an embedded device to perform the processing on the data, Raspberry Pi Model 3 is used. The purpose of using Pi is to read the antenna values and use those values to generate next actions for the drone to perform the search of the victim. Pi also communicates with the PixHawk Flight Controller using Mavlink protocol to read the GPS coordinates and keep logs that are generated during a flight. Pi is used along with a 10-bit ADC to constantly sample the antenna. As the drone flies through a pre-determined flight plan, Pi reads the values from the antenna at the waypoints. It keeps track of these values, which represent the signal strength, alongside corresponding GPS coordinates. After the drone has completed the flight plan, the max of these values is chosen. There is a pre-defined threshold in order to avoid getting stuck in the local minima. If the max value is less than this value, then the drone flies the next pre-determined flight path. The ultimate goal of Pi is to guide the drone to the GPS coordinate where it has seen the maximum strength of the avalanche beacon.

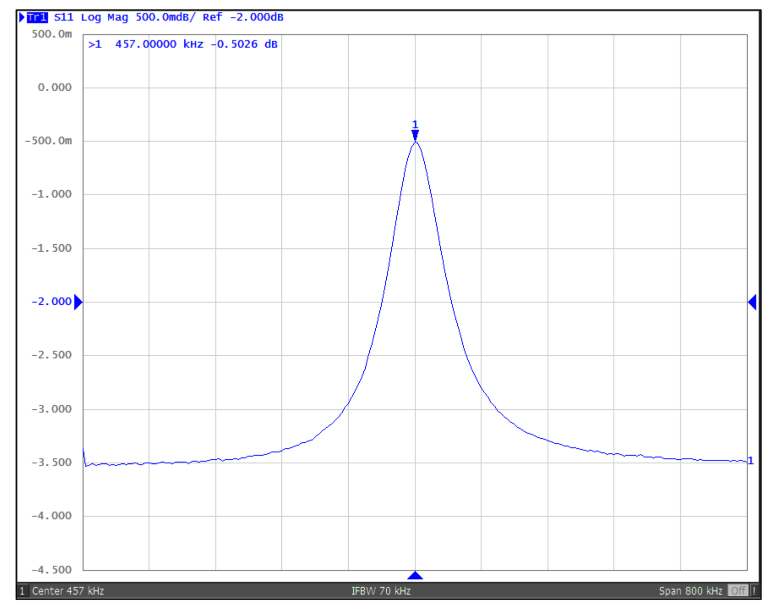


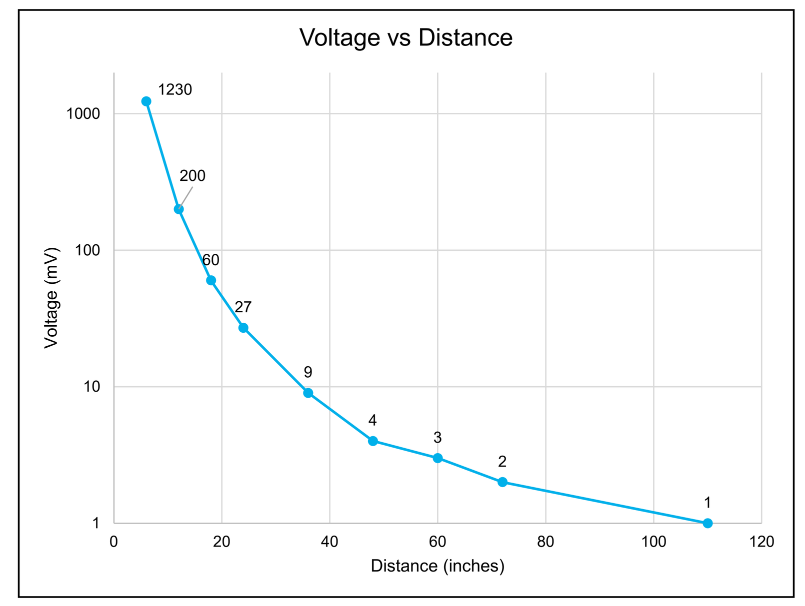
Receiving Antenna

Since the avalanche victim will be strapped with a 457 kHz avalanche beacon, we designed an antenna that can detect this signal. This design has the following components:

- > Ferrite core wrapped with copper wire creating an inductance of 60 mH.
- > Capacitor with a value of 7.2 nF.
- > Operational amplifier with a gain of 2.

A major concern in designing the antenna is the Q factor, which determines the bandwidth of the antenna reception. Through calculations and testing we achieved a BW ≅ 160 kHz and F_0 = 457 kHz. This is allows us to generate the most energy at 457 kHz while minimizing noise from undesired frequencies.





Future Work

- > Improved antenna range
- > Collapsible frame
- > Distance to target estimates
- > Terrain following
- > Victim location display on ground control
- > Transition from logs to real-time SAR
- > Throw mode take-off
- > Object avoidance
- > Ground control through companion computer WiFi/BT

Conclusion

Our work has produced promising results and provided proof of concept in many areas. We are hopeful that our progress can be used to fuel further interest and investment.

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