2016

Universal Communications Hub

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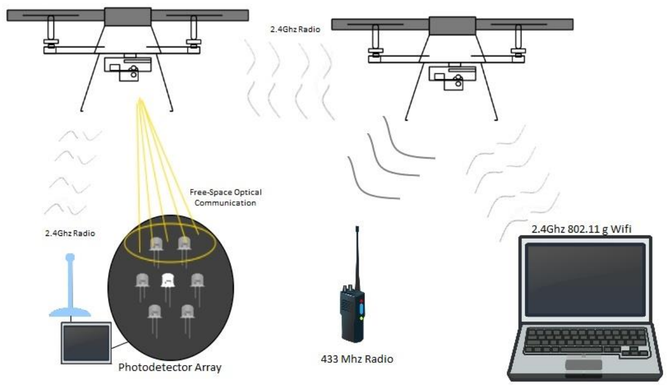
Objective:

To design a mobile communications system capable of maintaining a data and communications link in scenarios where traditional communications have been lost or are unavailable. In a practical scenario, this type of hub would be mounted to several UAVs and deployed in a matter of minutes to create a mesh network which facilitates emergency communications over a variety of methods.



Overview:

To minimize risk of malicious use as well as dependency on radio communication this hub is intended for use on autonomous UAVs. It is however able to receive data while acting as a Wifi access point and additionally through its 2.4Ghz RF radio. This data is then stored and can be rebroadcast to the other nodes in the network or receivers on the ground.

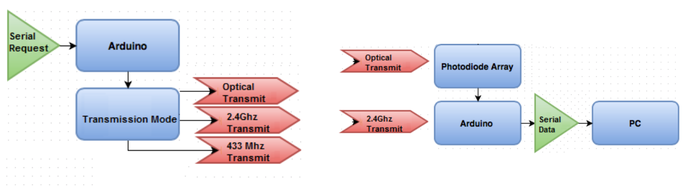
Communications Methods Include:

•One Way Optical Data Transfer- To provide messages, images, or file transfers to the ground in scenarios where traditional radio is jammed or being intercepted.

•433 MHz RF to provide simple emergency codes to more common radio receivers.

•2.4 Ghz RF to transfer large amounts of data or files.

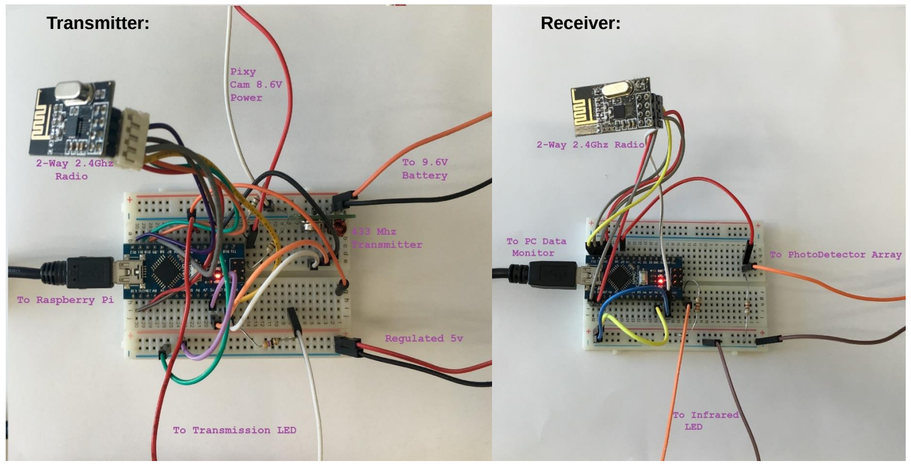
•Wifi to provide communications with common laptops, or handheld devices.



Design:

The design consists of a central hub acting as the data transmitter and a custom designed ground receiver.

The hub facilitates optical communications through a Pixy CMU Cam with mounted LED transmitter and pan/tilt tracking system. This tracking system is programmed to track an Infrared LED on the ground receiver which is in turn surrounded by a photodiode array. While the Pixy Cam is tracking the IR LED, the receiver's phototransitors are able to capture digital data, which is then verified through a checksum and passed through to the base.



Specifications:

Hub:

Raspberry Pi- Managing central control, data storage, tracking routine and web server.

Arduino Nano – Managing transmission of data from raspberry pi and reception of radio data

Pixy CMU Cam- Managing tracking of base receiver and maintaining optical communications link

NRF24L01-2.4Ghz RF Tranceiver

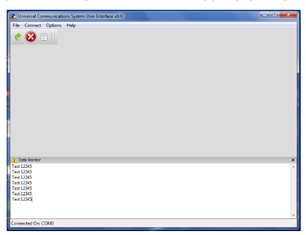
433 Mhz Radio for analog communications

Receiver:

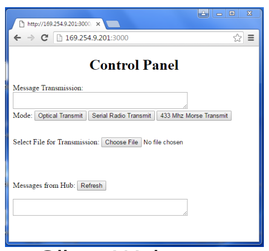
Arduino Nano- To process received data from the photodiode array

Photodiode Array-Acting as optical receiver

NRF24L01-2.4Ghz RF Tranceiver



Base Control Application



Client Webpage

Results:

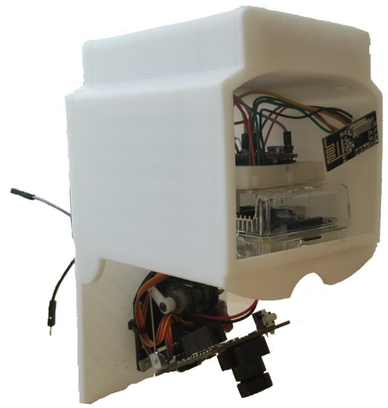
Our assembled Communications Hub is fairly large but weighs only 542 grams. This can be easily be carried by a professional quality quad-copter.

Our 2.4Ghz radio provided very stable communication and was able to keep up with serial baud rates of 19200.

Our photodetector array received a stable signal at close ranges within 1 foot or longer ranges with low background lighting.

For best performance we found that the photo detector should be adjusted based on the background lighting conditions of its operating area.

The Receiver GUI effectively receives data and supports writing of files from transmission while the client web page supports requests for each mode of transmission as well as file uploads.



Assembled Hub

Optical Receiver

Future:

While this demonstrates one possible use of this system, the idea could be built upon for a variety of different scenarios and applications. For instance, the optical receiver portion could be added to the hub itself allowing optical communication with other UAVs rather than just ground stations, thus removing an additional dependency upon radio communication. The UAV network could additionally be used to provide Internet access and other services across the network.