Introduction

Team Capilene was assembled to construct an antenna system for a UAV to research the patterns of the painted dogs in Africa. The team’s goal was to develop and antenna array system that could receive a signal transmitting GPS coordinates and other identifiers from a dog collar at greater than 2 km in distance.

Description of Culminating Design

The culminating design consists of three parts; an antenna, a transceiver, and the software.

The antenna is a two element Yagi-Uda with a gain of 3.1 mounted at 120° about the UAV. Due to the gain pattern of the antenna, the system will have a minimum of 2.5 dBi gain in all 360° about the UAV.

The transceiver is an HC-12 board utilizing a SiLab 4463 controller chip capable of receiving, demodulating, and transmitting a 433 MHz signal in various modulation schemes. The chip is set to transmit at 20 dBm, the maximum output power of the SI4463.

The software is run aboard a raspberry pi in conjunction with the AI for the UAV. The python code listens on the TX and RX pins of the pi for incoming pings from a collar. Upon reception, the message is stored into a file and parsed for GPS coordinates. These coordinates are then passed to the AI using sockets. The C code provided to the AI will continuously listen on that socket. When a GPS coordinate has been received, the AI will redirect the UAV to that location for greater data rates to record data from the collar.

Simulation

Several simulations were implemented to test the viability of the Yagi-Uda and HC-12 boards. The first simulation shows the affect of altitude on power received, where the other compares power transmitted to power received.

Beta Prototype Test Results

The beta prototype was tested on the Moscow-Pullman trail, where over 1000 ft. of straight trail was available. The transmitter, a GPS unit connect to an Arduino that pinged its coordinated every as often as possible, was walked down the trail until the receiver no longer received the signal, reaching an approximate distance of 300 m with multiple obstructions which will not be present on the UAV.

Broader Impacts

The UAV will have many affects on the way conservation in done in Africa. Painted dogs will easily be able to be tracked, keeping tabs on the dogs that would often disappear. Zimbabwe, suffering from drought, was looking at selling some of their painted dogs to aid in the struggle. For better or worse, the UAV would prevent Zimbabwe from selling the dogs without being noticed.

Poaching is a large reason for the decline of the painted dogs. Poachers set snares, which catch the dogs and eventually kill them. By aiding the project, Capilene is encouraging that snare-proof collars are placed on the dogs, helping prevent their extinction.

Beyond this, there are many economic, social, and environmental factors that this design could impact that could not be initially recognized.

Recommendations and Conclusion

The current state of the project creates several limitations for the collar system. Firstly, because the HC-12 is not a custom chip, it is not capable of accessing all desired functions on the SI4463, such as the RSSI functions.

The current method connects the HC-12 chips to the UAV via a serial UART, which makes connecting multiple HC-12’s difficult. Due to these two factors, we high recommend that a PCB solution be developed too enable all SI4463 functions as well as give the capacity to connect the Raspberry Pi in a more simple manner.

The software will need to be revamped to communicate of the new communication protocol of the PCB. The software will need to be constructed to function with collars specifically, not just a theoretical collar. Finally, the software needs to be tested and run aboard the UAV with the other software and divert patters set by the software team. This will be a final test to ensure that the antenna system is capable of tracking painted dogs.

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