CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Patrick D. Kao

Project Number

S0814

Project Title

Developing a Sentry Drone for Area Protection

Abstract

Objectives/Goals

Drones are being flown in sensitive locations where they pose a risk to human safety and security (e.g., near the White House and over forest fires or airports too close to manned aircraft).

One possible solution to this problem is to create a network of "police drones" to secure an area's perimeter against intruder drones. My project seeks to address one facet of this problem: creating a single drone that can detect and intercept intruder drones using visual information.

Methods/Materials

I built a sentry drone that uses a camera to capture images and a computer to interpret those images to guide it towards intruders. It uses a PixHawk flight controller with ArduCopter firmware installed to perform basic flight functions, and a more powerful companion computer, the Odroid XU4, to process images from the depth camera, an Intel Realsense R200.

I partitioned the software into 2 modules: a detection module which locates the intruder, and a control module which moves the sentry towards the intruder. To prevent program bugs from causing crashes, I used Software-in-the-Loop simulation combined with a manual override of the autonomous flight control systems.

Results

I solved a number of technical problems. First, I wrote software running on the Odroid to control the flight of the drone. Next, I wrote software on the Odroid to read and interpret data from the RealSense camera. I wrote subroutines to create point clouds from the camera data, separate these point clouds into objects, and identify intruder drones from those objects. I used Matlab and OpenCV to visualize results.

I was able to get a hardware sentry drone to track a simulated intruder drone and a simulated sentry drone to track a hardware intruder drone.

Conclusions/Discussion

I learned that the efficiency of the point cloud segmenter is critical to the efficiency of the system. I also discovered that although open source software contains bugs, it is possible to fix them. I also learned that it can be surprisingly difficult to integrate numerous disparate software packages into a cohesive system, especially because different APIs were developed by different people. It is possible to design a system efficient enough to locate, identify, and intercept an intruder drone in real time.

Summary Statement

Through careful software optimization, I designed and built a sentry quadcopter that can detect and intercept an intruder quadcopter to secure an area.

Help Received

My Dad paid for all of the hardware used for the experiment.