CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

36033

Project Title

The Last 3 Meters: Development of a Multi-Sensor Method for Safe Multicopter Landings

Abstract

Objectives/Goals

Develop a procedure based on novel hardware and software for a compact, low cost multi-sensor system to enable safe remote landings for autonomous multicopter operation. The landing procedure should be capable of a smooth, controlled descent at a specified location.

Methods/Materials

The multi-sensor system utilized GPS, barometer, Sonar and accelerometer sensors interfaced to Arduino microcontrollers, with data recorded to microSD memory cards. Arduino sketches were written to acquire data (GPS 10Hz, other sensors 30Hz). A tricopter model "Crusty" was custom built for flight duties. Raw data were processed with novel C applications. Results were exported for 3D-plotting with a custom Gnuplot script.

Results

GPS data met specifications (<4 m) for latitude and longitude, but GPS altitude data showed drift errors of up to 10 m. The accuracy of barometer data was limited by variations in atmospheric pressure arising from changing weather (1 mbar : 8.4 m). Accelerometer data was numerically integrated to calculate changes in altitude, but variations in the sensor's zero offset made this approach impractical. Despite noise spike problems, the Sonar data proved to be very reliable for low altitude measurements (<3.5 m). Combing GPS data for position measurements, and barometer and Sonar data for altitude determination allowed 3D plots of actual flight paths to be reconstructed.

Conclusions/Discussion

A compact, low cost multi-sensor system for a proposed multicopter landing method has been developed. GPS, barometer, accelerometer and Sonar sensors have been evaluated. Combing GPS data for position measurements, and barometer and Sonar data for altitude determination, allowed 3D plots of actual flight paths to be reconstructed.

Blending Sonar data (for low altitude) with barometer data (higher altitudes), and GPS for location, suggests a reliable approach for safe, autonomous landing.

Summary Statement

A multi-sensor system combing GPS data for location, and blending barometer and Sonar data for altitude determination, has been developed and evaluated for a proposed autonomous multicopter landing procedure.

Help Received

I built the hardware and wrote the software myself. My school district mentor, Dr. Jamshed Gahndhi, provide guidance and helped to keep me on track. My grandfather helped with some math and the data smoothing algorithm.