CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

S0315

Project Title

Project ARROW: Autonomous Rocket Return on Wings

Abstract

Objectives/Goals

To decrease the distance required to recover model rockets-which can drift several miles after deploying a recovery system-the project goal was to develop a low-cost guided recovery system that would bring a rocket directly back to the launch area.

Methods/Materials

After considering several recovery options based on previous large-scale NASA work, a 98mm diameter rocket was constructed to test a guided parafoil system. I built a small gondola module to drop test the parafoil off buildings. For the rocket, an internal avionics bay initiallly used a radio-controlled servo to steer a 0.5 square meter parafoil. To ease deployment difficulties, the final design uses a larger 2.5 square meter wing and a 140mm diameter rocket, combined with an Arduino-based guidance computer for autonomous control.

Results

Eighteen drop tests of the guidance module from buildings (6.5m to 16m height) showed that very small control inputs were adequate to steer the parafoil. Although tangling of lines was an issue in 5 of 18 drop tests, only a <5cm rotational arm was needed to provide control of the parafoil. After ground testing, a serendipitous design improvement showed an internal avionics bay could double as both a guidance module and a piston to deploy the recovery system. However, half of the launch vehicle tests still failed due to parafoil line tangling after deployment. Simultaneous to launch vehicle tests, navigational algorithms were simulated in MATLAB and ported to the Arduino guidance computer for autonomous recovery control. The Arduino GPS module was launch tested and collected data successfully and servo control worked correctly. The larger rocket design flew with two nominal recovery deployments at 281m and 615m.

Conclusions/Discussion

After my ground testing provided a serendipitous design improvement, subsequent ground testing revealed several major changes needed for complete recovery deployment. Drop testing proved parafoil guidance worked, and Arduino flight computer testing proved that autonomous guidance was possible. Additional testing is underway to optimize a reliable steering configuration for Project ARROW. This low-cost autonomous recovery system could have useful applications beyond model rocketry for small-scale payload delivery applications.

Summary Statement

Drift from wind is a challenge for model rocket recovery, so this project focused on controlling the rocket to autonomously fly back to a target area after launch.

Help Received

Supervised rocketry testing at TCC & LUNAR (J. Dougherty, D. Raimondi, J. Friedland). Aircraft testing at RC Bees with support of D. Morris, J. Boracca, S. Boracca. Drop testing support from J. Gerer. Design assistance from G. DeVault and L. Workman. Participant - Tripoli Mentoring Program.