CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

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Project Number

S0318

Project Title

Perching a Fixed Delta M-Wing UAV with a Variable Incidence Tail

Abstract

Objectives/Goals

The objective is to determine the perching fesability of the novel design, a Delta M-Wing aircraft with a variable incidence tail, by finding the optimum design and weight required for a successful perching manuver through practical applications. Perching, or spot landing on a structure, allows a fixed-wing aircraft to land on a specified point with minimal horizontal and vertical velocity, permitting the vehicle to safely land in any terrain including urban environments while also providing an alternative pathway to loitering, decreasing overall energy expenditure and increasing mission time.

Methods/Materials

Four independent designs were constructed in the programs XFLR5 and Solid works to attain the aerodynamic data and physical properties of each model at tail deflection angles varying from zero to seventy degrees. This data was used in coding written in Matlab to determine the angle of attack, velocity and trajectory of the model at an initial velocity of 15 f/s.

Results

Optimum results obtained from experimentation included a 50° sweep with NACA 9410 airfoil at a deflection of 40° with a weight of 0.002 slugs, decreasing the initial velocity from 15 ft/s to a terminal velocity of approximately 5.5 ft/s while exhibiting the perching trajectory. Results from the initial design had an insufficient lift coefficient, design two produced instabilities due to a positive moment, and design three was impractical due the low lift coefficient and high mass.

Conclusions/Discussion

A successful perching maneuver was exhibited at a 50° sweep with NACA 9410 airfoil at a deflection of 40°. This design can be directly applied to civilian and military situations, solving two main problems; the massive energy expenditure due to loitering UAV's as well as landing in urban and dangerous environments.

Summary Statement

To determine the optimum deflection angle and mass per design to successfully perch a Fixed Delta M-Wing UAV with a variable incidence tail, while attaining an optimum perching trajectory and a landing velocity under 9 f/s.

Help Received

Mentors Dr. Gustaaf Jacobs and Daniel Nelson mentored me by teaching how to use the programs XFLR5, Solidworks and Matlab, but took no part in the conception, building, attaning data or data analysis. All equipment was self provided.