CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

S0320

Project Title

Perching a Fixed Delta M-Wing MAV: Year 2

Abstract

Objectives/Goals

The perched landing maneuver allows a fixed-wing aircraft to land on a specified point with minimal horizontal and vertical velocity, permitting the vehicle to safely land in adverse terrain while decreasing energy expenditure. The deepstall maneuver, demonstrated in avian landings, is the most pragmatic approach toward perched landing.

Methods/Materials

A novel fixed wing MAV with an M-wing configuration and variable incidence tail was designed and aerodynamically verified. Based on previous aerodynamic analysis, a preliminary design was developed through modifications to the conceptual design through Solidworks. Design changes from the conceptual design include the addition of a fuselage for structural integrity and electrical component housing, a detailed design of the tail hinge, and a size increase of the wing tips to a tip airfoil of three inches for manufacturing reasons. Materials were selected based on their strength to weight ratio and durability. Specific materials used in the preliminary design include Pink Extruded Polysterene foam core, the primary structure, with a biased stitched layer of carbon fiber and 8.5## carbon spars length with a 0.138## radius to reinforce the wings. Preliminary structural testing was conducted in Solidworks on the carbon fiber spars, and the max stress at the base of the wing was 3.159e6 N/m2 and 61.0N/m2 was below the factor of safety. A wind tunnel model was constructed out of wood via CNC machining and 3-D printing, with modifications to mount onto the wind tunnel force balance.

Results

As the angle of attack increases, it is evident that the flow remains attached with minimal vorticies. At a 40° tail deflection, the flow remains attached with minimal vortices, with a large increase in lift. The maximum lift coefficient of 1.56 occurs at a 15 degree angle of attack and 40 degree tail deflection angle, while the largest drag coefficient of 0.017 occurs at a 20 degree angle of attack and 40 degree deflection angle.

Conclusions/Discussion

Results confirm aerodynamic and structural testing, where lift and drag are comparable to previous analysis, while flow proves to be attached with minimal vortices.

Summary Statement

Using perching methods to analyze the fesability of a Delta M-Wing MAV with a variable incidence tail.

Help Received

Daniel Nelson and Dr. Gustaaf Jacos