CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
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Project Number
S0316

Project Title
Comparison of Fanwing Configuration Efficiency: Year III

Abstract

Objectives/Goals
This project was designed to continue research into finding the optimal ducting configurations of a fanwing propulsion system in respect to its efficiency in lift and thrust.
Year I confirmed the feasibility of improved efficiency through ducting. Year II identified optimal ducting configurations and the variables under which these ducts performed best. Year III focused on dynamic duct designs in conjunction with a morphing wing to increase the efficiency and performance.

Methods/Materials
A new wing was designed with the cross flow fans running almost the entire length of the wing and a twin drive system, reducing weight from 0.9 kg to less than 0.75 kg (16% reduction). Two remote control servos were installed to adjust the duct angle and to adjust camber by curving the bottom of the wing (without flaps).
This remote control fanwing was tested in a subsonic wind tunnel. The fanwing was tested in over 45 different configurations each with different duct shapes, positions, and wing shapes. The inherent lift and drag of all configurations were measured and factored out of the raw data. Additionally, smoke tests were performed on all high performance configurations to gather qualitative data that could lead to a trend or pattern behind successful fanwing ducting designs. All data was compared to the control configuration of a ductless wing.

Results
The average lift of configuration F (6,5) was the greatest at 173.2 grams resulting in a 64% improvement over the control configuration of 105.9 grams of lift. The average thrust of configuration A (6,5) was the greatest with 36.3 grams of thrust resulting in a 154% improvement over the control configuration of 14.3 grams of thrust.

Conclusions/Discussion
Because the Fanwing is ideal for low speed high lift applications configurations F (6,5) was selected as the best overall configuration. The smoke tests revealed that the control configuration had airflow separation over the trailing edge of the wing while the ducted versions vectored the airflow and improved laminar flow
Even though configuration F (6,5) was found to be the best out of all tested configurations, research is not over. Internal ducting, genetic programming, larger scale models, and many other modifications could reveal more efficient designs. This experiment, however, has determined several trends that further reinforce the promise of efficiency improvement through ducting.

Summary Statement
This project used dynamic ducting and morphing wing technology to increase the efficiency of the Fanwing propulsion system to unprecedented levels.

Help Received