CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
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Project Number
J0118

Project Title
Elliptical Wingtip Extensions: A Novel Way to Improve Airplane Performance

Abstract

Objectives/Goals
My research focuses on designing prototypes of novel wings with elliptical wingtip extensions that can increase the lift-to-drag ratio of an airplane. This research also seeks to find the optimal length of the wingtip that can improve performance under various flight conditions.

Methods/Materials
After surveying existing wing designs, I designed eight different model wings including wings with various lengths of elliptical wingtips. Desmos, a graphing calculator application was used to calculate and plot coordination of the wings. The plotted geometric data of wings were transferred to Matlab, and I used Tornado (A Vortex Lattice Method Simulator that runs on Matlab) to simulate the lift to drag ratio of each of them.
The computer simulation results were verified with wind tunnel tests of 3D printed wings. Lift and drag of each model were measured with LabQuest 2 Vernier with force sensors. To create physical wings, Matlab lattice data of wings were imported to SketchUp, and airfoil shape was applied to them. Then the 3D models were sent to Sculpteo, a 3D printing service.

Results
In the computer simulation trials, wings with Elliptical Wingtip Extensions have produced a better lift-to-drag ratio compared to the conventional wings or the vertical winglet extension. Among them, a specific Elliptical Wingtip Extension model has shown the most efficient lift-to-drag ratio compared to other wings throughout the majority of the testing conditions.
In the wind tunnel tests, the measured results of lift-to-drag ratio showed higher sensitivity to the angles of attack than the computer simulation. While there was no single model that had the highest lift-to-drag ratio across all the angles of attack, but two models with Elliptical Wingtip Extensions have shown the best lift to drag ratios during several testing conditions.

Conclusions/Discussion
Throughout the computer simulations and wind tunnel tests with different speeds and angles, wings with elliptical wingtip extensions have shown to produce a higher lift-to-drag ratio than conventional wing designs in general. The optimal length of the wingtip was identified through the computer simulations.

Summary Statement
I designed new wing models with elliptical wingtip extensions that can increase the lift-to-drag ratio of an airplane. Performance of the wings were computer-simulated and verified with wind tunnel tests.

Help Received
John Briner, my science teacher and Deborah Terra, a science teacher of Fairmont Prep School allowed me to borrow a wind tunnel and my parents bought Matlab and placed orders for 3d printing. I could design and create wing models and performed computer simulation and wind tunnel tests by myself with