CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

34478

Project Title

Analysis of Synthetic Jet Actuators to Enhance Airfoil Safety and Performance

Abstract

Objectives/Goals

The purpose of this study was to evaluate the application of Synthetic Jet Actuators inserted into the upper surface of an NACA 2414 type airfoil to avoid stall and to improve airfoil efficiency.

Methods/Materials

The airfoil was tested over a range of angles of attack from 1 # 20 degrees and airflow velocities from 0 # 44.7 m/sec to study the impact of the Synthetic Jet Actuators on airfoil performance. The Synthetic Jets were tested at 3 pulsation frequencies (550, 650, 750 Hz) and compared against the control case with the Synthetic Jets turned off.

Synthetic Jet Actuators inserted into the top surface of the airfoil were located at 33% and 55% of the chord. Six primary forces on the airfoil were measured, and in order to non-dimensionalize the results, the Lift Coefficient (Cl) and the Drag Coefficient (Cd) were calculated along with Cl/Cd ratio

Results

Generally, at all frequencies, the Cd decreased indicating that use of the Synthetic Jets resulted in a decrease in drag, however, at some angles of attack and velocities the drag increased. Generally results demonstrated that the lift/drag ratio improved at these conditions indicating a relative benefit.

Testing at 650 Hertz Pulsation Frequency showed the most improvement in the Change in the Cl with the Synthetic Jets on vs. off. The maximum lift enhancement was observed at the highest airflow velocity of 44.72 m/s and 7 to 8 degrees angle of attack. The Cl increased by 40% versus the same test conditions with the Synthetic Jet Actuators turned off. The Cl at 10 to 11 degrees angle of attack increased by 26%. The greatest improvement in Cl/Cd was seen at 44.72 m/s at 7-8 and 10-11 degrees angle of attack. At the highest air velocity at 7-8 degrees angle of attack the change in Cl / showed an improvement of about 45%.

Conclusions/Discussion

The Synthetic Jet Actuator is a very promising device to avoid stall and to improve the performance of airfoils, especially relative to lift.

Key factors affecting the ability of the Synthetic Jets to enhance performance are:

1. The oscillating frequency of the Synthetic Jets
2. The location of the synthetic jets

The effect of the Synthetic Jets on drag is very complex. At certain conditions drag is while at other

Summary Statement

This study is an evaluation of synthetic jet actuators to enhance the lift performance of commercial and/or military aircraft in a high angle of attack situation.

Help Received

Used lab equipment at San Diego State University under the supervision of Mr. Ricardo Torres