MASTER OF SCIENCE
IN
AERONAUTICAL ENGINEERING

COMPUTATIONAL INVESTIGATION OF SUBSONIC TORSIONAL AIRFOIL FLUTTER

Constantinos Kakkavas-Captain, Hellenic Air Force
B.S., Hellenic Air Force Academy, 1989
Master of Science in Aeronautical Engineering-December 1998
Advisor: Max. F. Platzer, Department of Aeronautics and Astronautics
Second Reader: Kevin D. Jones, Department of Aeronautics and Astronautics

In this thesis single-degree-of-freedom torsional airfoil flutter is investigated using an incompressible potential flow code, a compressible inviscid Euler code and a compressible viscous Navier-Stokes code. It is found that the classical linearized incompressible and compressible flow theories yield unconservative flutter estimates. The computations based on the non-linear codes show for NACA 0006, NACA 0009, NACA 0012 and NACA 0015 airfoils that the regions of torsional flutter instability increase as the airfoil thickness and the flight Mach number is increased. On the other hand, the comparison of the flutter boundaries computed with the viscous Navier-Stokes code versus the inviscid Euler code shows that the effect of viscosity is stabilizing. Also, the computed flutter boundaries display the effect of pitch axis location on flutter. Axis locations in the range between half a chord upstream of the leading edge of the airfoil and the leading edge are most prone to induce flutter. Axis locations downstream of the quarter chord are flutter free.

DoD KEY TECHNOLOGY AREA: Air Vehicles

KEYWORDS: One Degree-of-Freedom Flutter, Reduced Frequency, Mach Effect, Airfoil Thickness Effect, Viscosity

SOOT PARTICLE SIZE AND CONCENTRATION DETERMINATION FROM A KEROSENE/GASEOUS OXYGEN ROCKET PLUME

Silvino L.C. Silva-Major, Brazilian Air Force
B.S., Instituto Tecnologico de Aeronautica, 1980
Master of Science in Aeronautical Engineering-December 1998
Advisors: David W. Netzer, Department of Aeronautics and Astronautics
Christopher M. Brophy, Department of Aeronautics and Astronautics
Second Reader: Oscar Biblarz, Department of Aeronautics and Astronautics

An experimental investigation was conducted to measure soot properties and concentration, and the infrared signature of the plume of a kerosene/gaseous oxygen rocket motor. Multiple-wavelength measurements were used to obtain soot parameters. It was found that the multiple-wavelength technique appeared to work well for obtaining soot properties and concentration. The results implied that the soot particulate was very porous for the most fuel-rich conditions and became more compact as the O/F ratio increased. Soot mean diameter (D32) was less than 0.1 μm when the O/F ratio was less than 0.75, but increased to 0.2→0.36 μm for higher O/F ratios. The soot particle diameters obtained from the Scanning Electronic Microscope (SEM) photomicrographs of collected soot samples were in qualitative agreement with the diameters measured optically. Soot concentration in the plume was found to rapidly increase and then decrease as the O/F ratio was increased from 0.3 to 1.1 , with a peak near O/F = 0.76. Infrared measurements in the 3.5-5 μm band indicated a probable shift in the dominant radiation source from gas to particulate as the soot concentration increased.

DoD KEY TECHNOLOGY AREA: Aerospace Propulsion and Power

KEYWORDS: Particle Sizing, Rocket Motors, Soot, Infrared Signature

VISION GUIDANCE CONTROLLER FOR AN UNMANNED AERIAL VEHICLE

Mark T. Watson-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1983
Master of Science in Aeronautical Engineering-December 1998
Advisor: Isaac I. Kaminer, Department of Aeronautics and Astronautics
Second Reader: Russell W. Duren, Department of Aeronautics and Astronautics

The use of Unmanned Aerial Vehicles (UAVs) in modern military operations for reconnaissance and other missions continues to grow. UAV systems using remote control guidance are limited in range and subject to Electronic Warfare concerns. Guidance systems using only Global Positioning Service (GPS) or an Inertial Navigation System (INS) are limited to a pre-programmed route of flight. A vision guidance system that can control the UAV over an arbitrary course is not subject to these limitations. This thesis uses classical control methods to develop and test an autonomous vision controller for the FOG-R UAV (FROG). First, a computer model of the camera output for a flight that tracks a river is made to develop the controller and to test it in nonlinear simulation. Finally, the complete system is flight tested on the FROG UAV.

The design and test equipment include a highly modified FOG-R UAV from the U.S. Army, the $MATRIX_X$ Product Family of software tools developed by Integrated Systems, Inc., and a Ground Station built at NPS from commercially available computer and communication equipment.

DoD KEY TECHNOLOGY AREAS: Air Vehicles, Modeling and Simulation, Unmanned Air Vehicles

KEYWORDS: Unmanned Aerial Vehicles, Rapid Prototyping System, Flight Management System, Vision Controller