MASTER OF SCIENCE
IN
AERONAUTICAL ENGINEERING

THRUST AUGMENTATION FOR A SMALL TURBOJET ENGINE

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A Sophia J450 (nine pounds of thrust) gas turbine engine was used first to examine the thrust augmentation generated using an ejector shroud. Experimental results obtained with and without the ejector were compared with performance predicted using an engine code and a one-dimensional ejector analysis. The engine code was revised to incorporate a radial turbine and the correct compressor map. Thrust augmentation of three to ten percent was measured and the trends were correctly predicted. Second, an engine shroud was designed and installed around the engine and flow measurements were conducted to determine the entrainment rate in the shroud. The engine shroud was the initial step toward designing a turboramjet.

DoD KEY TECHNOLOGY AREA: Aerospace Propulsion and Power

KEYWORDS: Micro-Turbojet, Ejectors, Micro Turbomachinery, GASTURB, SMOOTHC, Engine Shroud, Combined Cycle, Turboramjet, Sophia J450, and Microturbine Performance

DYNAMIC EFFECTS OF THE RAH-66 COMANCHE 20MM GUN ON TARGET ACCURACY AND SENSOR AIMING ERROR

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This thesis investigates the structural dynamic response of the RAH-66 Comanche airframe due to firing of the three barrel nose mounted 20mm gun.

An MSC/NASTRAN finite element model of the Comanche was excited by simulated recoil loads applied at the gun's center-of-gravity. These sinusoidal loads resulted in structural dynamic response of the airframe. Transient and steady state displacements were output for the gun and three additional sensor locations at specified gun azimuth and elevation positions. These displacements were transformed into coordinate frames corresponding to the aiming vector of each individual output point. From there, the local displacements were used to compute errors on the target face at a range of 1000 meters.

Additionally, the firing frequency was varied in order to compare response magnitudes in the vicinity of fuselage natural frequencies that are near certain firing frequencies which could lead to increased error due to strong fuselage coupling.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Other (Design Automation)

KEYWORDS: Comanche, Helicopter, Rotorcraft, Dynamics, Structures, NASTRAN, Gunfire

STABILITY AND CONTROL MODULE FOR JOINT ARMY/NAVY ROTORCRAFT ANALYSIS AND DESIGN (JANRAD) SOFTWARE AND GRAPHICAL USER INTERFACE (GUI)

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The Joint Army/Navy Rotorcraft Analysis and Design (JANRAD) computer program has been developed at the Naval Postgraduate School to aid in the preliminary design of rotorcraft and has been updated to include a Graphical User Interface (GUI). This thesis is a continuation of the program, focusing on stability and control analysis. The trim solution for a specified flight condition is computed from the performance module of the program. This trim solution is then used to compute stability derivatives for the specified flight condition and a linear state space model is created. This solution can then be used to perform various time and frequency domain analyses or can be saved to a file for future use.

DoD KEY TECHNOLOGY AREAS: Air Vehicles, Computing and Software, Modeling and Simulation

KEYWORDS: Stability, Control, Design, Rotorcraft, Linear, Modeling, Helicopter, JANRAD

MODELING THE COUPLED ROTOR/FUSELAGE RESPONSE OF THE H-3 SEA KING UTILIZING THE NPS FULL NONLINEAR RESPONSE

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Adapting the Naval Postgraduate School full nonlinear simulation model of coupled rotor/fuselage response to the H-3 Sea King, the concentration of this work rests on validating the rotor simulation against an actual rotorcraft. The parameters of the H-3 from the characteristic equation of a modeled mass-spring-damper system are inputted into a five-bladed model initially utilizing MAPLE to process LaGrange's equation defining the helicopter's full set of nonlinear equations of motion. Results are converted to MATLAB and are then processed in SIMULINK returning time history plots of blade/fuselage motion. Conclusions are in accordance with literature of Coleman, Feingold and Deutsch.

DoD KEY TECHNOLOGY AREA: Other (Helicopter Ground Resonance)

KEYWORDS: Helicopter Ground Resonance, Mechanical Instability, Dynamics, MAPLE, MATLAB, SIMULINK, Hilbert Transform

SIMULATION VALIDATION AND FLIGHT PREDICTION OF UH-60A BLACK HAWK HELICOPTER/SLUNG LOAD CHARACTERISTICS

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Helicopter/slung load systems are two body systems in which the slung load adds its rigid body dynamics, aerodynamics, and sling stretching dynamics to the helicopter. The slung load can degrade helicopter-handling qualities and reduce the flight envelope of the helicopter. Confirmation of system stability parameters and envelope is desired, but flight test evaluation is time consuming and costly. A simulation model validated for handling qualities assessments would significantly reduce resources expended in flight testing while increasing efficiency, productivity, and safety by aiding researchers, designers, and pilots to understand factors affecting helicopter-slung load handling qualities.

This thesis describes a comprehensive dynamics and aerodynamics model for slung load simulation, obtained by integrating the NASA Ames Gen Hel UH-60A simulation with slung load equations of motion. Frequency domain analysis is used to compare simulation to flight test frequency responses and key system stability parameters.

Results are given for no load, a 4K lb Block, and a 4K-lb CONEX load. Handling quality parameters, stability margins, and load pendulum motion roots for cases without load aerodynamics and with static wind tunnel data will be compared. Results illustrate state-of-the-art simulation modeling of helicopter/slung load dynamics and its accuracy in predicting key dynamic parameters of interest.

DoD KEY TECHNOLOGY AREAS: Air Vehicles, Computing and Software, Modeling and Simulation

KEYWORDS: Air Vehicles, Helicopter/Slung Load, External Load, Handling Quality, Stability Margin, Flight Simulation