MASTER OF SCIENCE
IN
ASTRONAUTICAL ENGINEERING

DESIGN, CHARACTERIZATION, AND PERFORMANCE OF A VALVELESS PULSE DETONATION ENGINE

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Current interest in developing a low cost, less complex tactical missile propulsion system that operates on readily available liquid fuels and can operate from low subsonic to a flight Mach number of 5 is driving research on pulse detonation engines.

This research program involved the design, construction, and testing of a valveless Pulse Detonation Engine using a JP-10/air mixture as the primary combustible reactants. A small JP-10/oxygen pre-detonation tube was used to initiate the detonation in the JP-10/air mixture in the engine. The engine was tested at various inlet conditions and equivalence ratios in order to determine the detonable regime of the fuel/air mixture. The original area transition from the pre-detonation tube to the main combustion tube appeared to be too extreme, so a tube was added to extend the pre-detonation tube into the throat of a shock focusing device inserted flush with the head end of the main combustion tube to promote more favorable transition conditions.

In addition, the effects of a transient detonation process on the inlet operation and performance of the engine was theoretically predicted, using a two dimensional grid in a viscous computational fluid dynamics code, and experimentally evaluated from subsonic to supersonic operation.

DoD KEY TECHNOLOGY AREA: Aerospace Propulsion and Power

KEYWORDS: Pulse Detonation Engine, JP-10, Liquid Fuels, Combustion

CALIBRATION TO DETERMINE PRESSURE AND TEMPERATURE SENSITIVITIES OF A PRESSURE-SENSITIVE PAINT

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In order to obtain quantitative surface pressure measurements of a transonic compressor rotor using pressure sensitive paint (PSP), the temperature dependence of the paint must be taken into consideration. In the present study, a calibration chamber was built and instrumented such that pressure and temperature could be controlled independently. Photodiodes were used to measure the intensity of light emitted by the PSP. An acquisition program was developed to record the necessary calibration data to obtain an analytical representation of the luminescent response of the pressure-sensitive paint over a range of pressures and temperatures characteristic of transonic fans.

DoD KEY TECHNOLOGY AREA: Aerospace Propulsion and Power

KEYWORDS: Pressure-Sensitive Paint, Photoluminescence, Luminescence, PtOEP, UV Illumination, Detection, Emission, Aerodynamics, Measurements, Temperature and Pressure Calibration

PROTOTYPE DESIGN OF NPSAT VISIBLE IMAGER

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The objective of this work was to design and construct a prototype imager for the NPS remote sensing satellite. This project is a low-earth orbiting satellite designed to image the earth in VNIR and LWIR at a resolution of 100–200 m.

The specific imager design considered here is the VNIR instrument, designed to image the daylit earth and atmosphere, as well as the relatively dim aurora (northern lights) at multiple discrete wavelengths. This project defined the desired wavelengths to be: 427.8 nm, 470.9 nm, 557.7 nm, 630.0 nm, 636.4 nm, and 844.6 nm.

A Kodak 763 X 512 CCD was implemented into a push-broom scanner design appropriate for our mission. Design optics are for a nominal F/2, 90 mm Leica lens. The prototype was completed and demonstrated to operate.

DoD KEY TECHNOLOGY AREAS: Sensors, Electronics

KEYWORDS: Satellite, Imager, Aurora, Optics

FEASIBILITY OF TWO-GIMBAL PLATFORM TUMBLING TO MINIMIZE VELOCITY ERROR (U)

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Abstract is classified.

DoD KEY TECHNOLOGY AREAS: Air Vehicles, Space Vehicles, Surface/Under Surface Vehicles - Ships and Watercraft

KEYWORDS: Gimbal Tumbling, Trajectory Optimization