MASTER OF SCIENCE
IN
ASTRONAUTICAL ENGINEERING

PERFORMANCE AND SPACE BORNE APPLICATION ANALYSIS OF THE HIGHER ORDER CYCLOSTATIONARY BASED CLASSIFIER

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Testing of the Higher Order Cyclostationary Based Classifier (HBC) is conducted to evaluate system operational performance. Utilizing Higher Order Cyclostationary (HOCS) analysis techniques, the HBC is designed to automatically detect and classify communication and radar signals contained in input signal samples. While test results utilizing earlier data were inconclusive on the effectiveness of the system, a more rigorous testing for Binary Phase-Shift Keying (BPSK) modulation scheme is herein carried out. The results of the HBC analysis reveal a system which experiences difficulty in performing modulation detection and classification of the input data at signal-to-noise ratios above 10 dB. The HBC automatic band-of-interest detector also shows evidence of interfering with accurate signal classification results. Recommended improvements to the algorithms and interface are presented to address these and other observed trends. An application of the HBC system to the Naval Research Laboratory's Pre-Configured Interface Payload (PCIP) program are assessed for space borne testing of the HBC system.

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

KEYWORDS: Cyclostationary, Cyclostationarity, Digital Signals, Signal Classification, Signals Intelligence (SIGINT), Spacecraft Payload Integration, Pre-Configured Interface Payload (PCIP)

A NUMERICAL STUDY OF FUEL-OPTIMAL LOW-EARTH-ORBIT MAINTENANCE

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This thesis studies the fuel optimal periodic reboost profile required to maintain a spacecraft experiencing drag in low-earth-orbit (LEO). Recent advances in computational optimal control theory are employed, along with a Legendre-Gauss-Lobatto Pseudospectral collocation code developed at the Naval Postgraduate School, to solve the problem. Solutions obtained by this method are compared against a previous study. Key issues were checking the optimality of the solutions by way of the necessary conditions and the behavior of the solution to changes in the thruster size. The results confirmed Jensen's findings of propellant savings of one to five percent when compared against a middle altitude Forced Keplerian Trajectory (FKT). Larger savings are predicted if compared against a finite-burn Hohmann transfer with drag. The costates estimates compared favorable against necessary conditions of Pontryagin's Minimum Principle. Analysis of the switching function yielded periods of thrust-modulated arcs. The optimal thrust

profile appears to be a thrust-modulated burn to raise the orbit followed by an orbital decay and a terminating thrust-modulated arc. For a sufficiently low thrust-control authority, the switching structure includes a maximum thrust arc. Indirect optimization techniques to confirm these findings were unsuccessful.

DoD KEY TECHNOLOGY AREA: Space Vehicles

KEYWORDS: Orbital Mechanics, Optimization, Optimal Control Theory, Orbit Maintenance

TELEMETRY SYSTEMS ANALYSIS AND DESIGN

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The Navy has a valuable opportunity to improve its own products and operations efficiency by showing its future leaders and designers how to design effective and viable telemetry, tracking, and commanding (TT&C) systems, and their operation. One system is the FLTSAT military communications constellation of spacecraft, one of which has been a static display at the Naval Postgraduate School (NPS) until June, 2000. The primary objective was to make this spacecraft operational and thus provide a new operational spacecraft laboratory for other NPS students. This thesis may also be used as a primer for the space engineering or space operations student regarding TT&C systems design. Great effort has been taken to document and discuss current design practices and standards adopted by DoD laboratories, test facilities, and operation centers. A TT&C system designed for a spacecraft incorporating all the traditional subsystems (payload, thermal, structural, power, TT&C, attitude control) is included.

DoD KEY TECHNOLOGY AREAS: Space Vehicles, Other (Communications)

KEYWORDS: Space Vehicles, Communications

SIMULATION OF GUIDED AEROASSISTED MANEUVERS FOR PLANETARY MISSIONS

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Aeroassisted maneuvers are distinguished from purely propulsive maneuvers in that aerodynamic forces are used to assist in orbital maneuvers of spacecraft. These types of maneuvers can vary from aerocapture to direct entry. The NASA Solar System Exploration Program lays the foundation for the future of interplanetary exploration using various versions of these aeroassisted maneuvers. The computer program ACAPS, designed at the Naval Postgraduate School, was developed for the Jet Propulsion Laboratory (JPL) to conduct high-level mission design for exploration missions to Mars. The primary research objective of this thesis was to upgrade the previous version of ACAPS, to produce a tool that provides new capabilities in support of the Solar System Exploration Program. The secondary research objective of this thesis was to provide direct support to JPL mission planners. The first major upgrade was the incorporation of additional planets which allows for simulation at Venus, Saturn, Neptune, and Titan. The second focus of work was the incorporation of guidance to include ballute guidance and the Apollo derived Mars Precision Lander guidance algorithm. This thesis also documents how these upgrades were used to support future missions to Venus, Neptune, Saturn and Titan; particularly in the possibilities of using ballutes.

ASTRONAUTICAL ENGINEERING

DoD KEY TECHNOLOGY AREAS: Space Vehicles, Modeling and Simulation

KEYWORDS: Aerocapture Simulation (ACAPS), Aeroassist, National Aeronautics and Space Administration (NASA), Jet Propulsion Laboratory (JPL), Mars Sample Return (MSR) Mission, Mars Micromission, MATLAB, SIMULINK, Ballute, Parachute