MASTER OF SCIENCE IN ASTRONAUTICAL ENGINEERING

FUEL-OPTIMAL LOW-EARTH-ORBIT MAINTENANCE

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First-order solutions indicate that a forced Keplerian trajectoiy (FKT) obtained by thrust-drag cancellation is as fuel-efficient as a Hohmann transfer. Further analysis has shown that the FKT is not Mayer-optimal. Therefore, there must exist another trajectory that matches or exceeds the efficiency of the Hohmann transfer. The application of this result to the fuel-optimal orbit maintenance problem implies that periodic reboosts must be more efficient than an FKT profile. This research begins with the formulation of an optimal periodic control (OPC) problem to determine the minimum fuel-reboost strategy. The problem is numerically solved by a spectral collocation method. The optimization code is further modified to increase accuracy and reduce sensitivity to initial guesses. The results of this effort identified a trajectory for a sample satellite that was 3.5% more efficient than an ideal impulsive Hohmann transfer over the same period of time. From the optimal code, a maximum thruster size is also identifiable for a set of initial conditions. The optimal trajectory can save as much as 10% of the propellant budget when compared to finite-bum Hohmann transfers.

DoD KEY TECHNOLOGY AREAS: Aerospace Propulsion and Power, Space Vehicles, Modeling and Simulation

KEYWORDS: Orbital Maintenance, Orbital Mechanics, Hohmann Transfer, Orbit Reboost, Orbit Transfer, Forced Keplerian Trajectory, Optimization, Periodic Control

MODAL ANALYSIS AND ACTIVE VIBRATION CONTROL OF THE NAVAL POSTGRADUATE SCHOOL SPACE TRUSS

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This thesis examines active control of the Naval Postgraduate School (NPS) Space Truss using a piezoceramic stack actuator. Preceding the development of an active control mechanism for the NPS space truss, modal testing was performed to identify the modal properties of the truss. An impact hammer provided excitation to the truss and accelerometers measured the trussí response. Two data acquisition systems, dSPACE and an Hewlett Packard spectrum analyzer, were used independently to gather and analyze data. For active control, an active strut, consisting of a piezoceramic stack, a force transducer, and mechanical interfaces, was substituted in place of a critical diagonal strut and acted as a control actuator. The frequency

response of the system was determined and an integral plus double-integral force feedback control law was designed and implemented. A linear proof mass actuator was employed to excite one of the trussí vibrational modes. The controller then suppressed the vibration along the length of the structure resulting in power attenuation on the order of 10-15 dB. Various combinations of velocity and position feedback gains were investigated in order to optimize the control action. Additional testing was also performed to determine the controlleris sensitivity over a frequency band.

DoD KEY TECHNOLOGY AREA: Space Vehicles

KEYWORDS: Active Vibration Control, Piezoceramic Actuators, Modal Testing, Modal Analysis