AERONAUTICAL AND ASTRONAUTICAL ENGINEER

FUEL-OPTIMAL LOW-EARTH-ORBIT MAINTENANCE

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First-order solutions indicate that a forced Keplerian trajectory (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

TURBOCHARGERS TO SMALL TURBOJET ENGINES FOR UNINHABITED AERIAL VEHICLES

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Three test programs were conducted to provide the preliminary groundwork for the design of a small turbojet engine from turbocharger rotor components for possible Uninhabited Aerial Vehicle applications. The first program involved the performance mapping of the Garrett T2 turbocharger centrifugal compressor. The second program involved the bench testing of a small turbojet engine, the Sophia J450, at 115000 RPM, and comparing the results to another small turbojet, the JPX-240, from previously documented research. The compressor radii of the two engines were identical but greater than that of the Garrett compressor. The two engines, despite their physical similarities, had different fuel requirements. The J450 used heavy fuel (fuel pump required) while the IPX used liquid propane (pressurized fuel tank required). The third program involved the performance prediction of the J450 using GASTURB cycle analysis software. The compressor map generated

from the Garrett T2 test was imported into GASTURB and used to predict the J450 performance at 94000, 105000, 115000, and 123000 RPM. The performance predictions agreed reasonably well with actual J450 performance.

DoD KEY TECHNOLOGY AREAS: Aerospace Propulsion and Power, Air Vehicles

KEYWORDS: Centrifugal Compressor, Turbomachinery, Uninhabited Aerial Vehicles (UAV), GASTURB, SMOOTHC, Turbojet, Turbocharger