ITERATIVE ANALYTICAL TECHNIQUES FOR THE DESIGN OF TRANSFER TRAJECTORIES FOR DIRECT INTERPLANETARY ORBITER MISSION

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by

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ABSTRACT

In an interplanetary transfer, the spacecraft experiences the gravitational pull of many celestial bodies. The motion of the spacecraft is studied by solving the n-body equations of motion using numerical techniques. As the interplanetary transfer is a two-point boundary value problem, there is no complete information on the initial or departure states. To find the initial states, exorbitantly large number of trajectory propagations under high fidelity force models are required making the process computationally intensive. Usually analytic techniques that are based on simple force models are used to generate an initial guess of the transfer trajectory design. The current research focuses on developing ***efficient analytical techniques*** that generate improved trajectory designs for an interplanetary orbiter mission.

The analytical techniques proposed are based on the patched conic and pseudostate concepts. These techniques are iterative in nature and identify the four distinct trajectory design options for an opportunity which the conventional design techniques fail to do. The gravity perturbations of the non-spherical Earth and third body effects of the Moon and the Sun are included in the analytical design process. The numerical propagation of the proposed analytical designs, under a force model that includes major perturbations, achieves the arrival target parameters with good accuracies. The numerical refinement of these analytical designs require very less computation time as compared to that of the conventional designs. An analysis of the MOM and MAVEN mission designs generated using the proposed technique is presented. Also, trajectory designs are generated for direct transfers from Earth to Venus and Earth to Jupiter for the minimum energy opportunities of 2023 and 2022 respectively. The use of the proposed analytical techniques as a quick mission design and analysis is demonstrated using an Earth to Mars orbiter mission for Type I (2018) and Type II (2022) minimum energy transfers. Fortran 95 codes have been developed based on the proposed analytical techniques and used to analyze realistic mission scenarios.