

Public Abstract

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Graduation Term: SS 2012

Department: Mechanical & Aerospace Engineering

Degree: PhD

Title: Optimal Orbit Transfers for Satellite Formation Flying Applications

This dissertation focused on trajectory optimization problems arising from the application of satellite formation flying, and contributed to the methodology of trajectory optimization.

For impulsive thrust trajectory optimization, this dissertation proposed an algorithm for finding multi-impulse, fuel-optimal trajectories. The proposed algorithm modified Jezewski's algorithm, which was designed for trajectory optimization under linear relative dynamics. The modification included the computation of nonlinear terms derived from a symmetry property between second-order state and costate vectors. Numerical tests showed that the proposed method was particularly efficient for solving coplanar problems. Moreover, to ensure the optimality of the solution, the dissertation derived sufficient conditions of optimal impulsive trajectories. Numerical examples showed that this verification step was necessary for fixed-time transfer problems.

For continuous thrust trajectory optimization, the dissertation presented a novel analytic approximation method, termed the "primer vector approximation method," for finding low-thrust, power-limited, fuel-optimal trajectories. Different from other approximation methods that simplified the nonlinear dynamics, the proposed method made no simplification on the dynamics but instead approximated the optimal primer-vector function. Numerical tests showed that this approximation method was effective for both close-range and long time-of-flight transfer problems.