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AUTONOMOUS NAVIGATION BETWEEN TRANS-MARS SATELLITE AND SUN-EARTH L2 ORBITER

Abstract

In this paper, the LiAISON (Linked Autonomous Interplanetary Satellite Orbit Navigation) has been conducted on the Mars exploration. Since the satellite-to-satellite range measurements supply sufficient message to perform absolute state estimation in an asymmetric gravity field, a natural application is deep space exploration, because the spacecraft undergoes a typical multi-body gravities.

Firstly, the Sun-Earth L2 orbiter is located on the halo orbit, which can be constructed using Richardson three order approximate solutions and a differential corrections scheme. The trans-Mars orbit is also developed using patch conic technique and differential corrections.

Then, the orbit determination is performed in the heliocentric ecliptic reference frame using Extended Kalman Filter. The observation include the satellite-to-satellite range and range rate, while the simulations include dynamical modeling errors, measurement errors, and measurement biases.

The methodology proposed in this study shows that the accuracy of LiAISON can satisfy the requirement of trans-Mars orbit given proper initial state error. Compared with Earth ground-only tracking, the autonomous navigation between the Sun-Earth L2 orbiter and trans-Mars spacecraft saves labor cost and deep space network, and increases the reliability of the mission as an redundant navigation method.