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Automated Periapsis Time Estimation for the Aerodynamic Deorbit Experiment

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Abstract

Periapsis time estimation may be used to schedule on-orbit activities in an automated fashion. Previous applications of periapsis time estimation include aerobraking sequence timing adjustments for Mars orbiter missions. The Aerodynamic Deorbit Experiment (ADE) CubeSat will apply an algorithm for periapsis time estimation to autonomously schedule inertial measurement unit data acquisition during low-altitude atmospheric drag passes in Earth orbit. Following deployment of a drag sail, ADE will deorbit from an initial geosynchronous transfer orbit. During each drag pass, centroiding and integration of the measured acceleration profile are used to determine estimates of the periapsis time and the change in velocity, respectively. The orbital period is then updated, and the time of the subsequent periapsis is predicted. Simulation and analysis of the periapsis time estimation performance shows that the algorithm can predict periapsis times with an average error of 60 seconds and 1-sigma deviation of 20 seconds, based upon the root-sum square of individual error sources. This level of accuracy in the periapsis time estimation is sufficient to meet the measurement objectives for the Aerodynamic Deorbit Experiment.

1. Introduction

A periapsis time estimation (PTE) algorithm may be used for autonomously predicting future periapsis times based upon acceleration data collected during previous periapsis passes. For an orbital mission with periapsis within the sensible atmosphere, PTE can be useful for adjusting on-board sequence timing. Previously, PTE algorithms have been developed for

aerobraking applications at Mars (Johnson, 2003; Spencer, 2007; Denis, 2018). Aerobraking missions including Mars Odyssey, Mars Reconnaissance Orbiter (MRO), Mars Atmosphere and Volatile Evolution Mission (MAVEN), and ExoMars have each utilized some aspect of PTE to enact sequence timing adjustments.

PTE was initially developed for Mars orbiter projects by Lockheed Martin. The algorithm was devel-

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