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Author: Mr. William Crowe
UNSW Australia, Australia, w.crowe@unsw.edu.au

Dr. Nathan Kinkaid
UNSW Australia, Australia, n.kinkaid@unsw.edu.au
Mr. John Page
UNSW Australia, Australia, j.page@unsw.edu.au
Dr. John Olsen
UNSW Australia, Australia, j.olsen@unsw.edu.au

SMALL BODY MASS ESTIMATION FROM SPACECRAFT SWARM FLYBY DYNAMICS

Abstract

The current best measurements of the mass of small planetary bodies have been obtained through detecting perturbations to spacecraft during flybys. This method requires the use of large sensors and radio equipment with high power requirements. This study proposes a novel method of determining mass through the use of spacecraft swarms. During flyby of a small body, the relative positons and velocities of the swarm agents are perturbed due to variations in the gravitational potential. These variations can be used to infer the small body's mass. This method has been found to be robust to different swarm formations, and does not require precise attitude control, allowing for other science to be performed at the same time. This paper outlines the flyby relative dynamics of the spacecraft swarm that are exploited, and the instruments and processing required to infer the mass of the small body. To illustrate the process, simulations were conducted using known asteroid data. The results produced in the simulations match the actual mass with error that changes with initial conditions. The simulations provide insight into the difficulties that arise in the presence of a non-uniform gravity field and other perturbations. The limitations on using the method are discussed, along with sensitivity to unknown perturbations.