SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations (IP)

Author: Mr. William Crowe
UNSW Australia, Australia

Dr. John Olsen
UNSW Australia, Australia
Mr. John Page
UNSW Australia, Australia

SIMULATION OF AN ASTEROID GRAVIMETRY MISSION USING A SPACECRAFT SWARM

Abstract

This paper examines a new approach for mapping the bulk mass and density of asteroids. The approach takes advantage of a swarm of spacecraft that investigates an asteroid's gravitational field. The field is investigated via measurement of the relative dynamics of the individual spacecraft while they are perturbed by the gravitational field. Swarm spacecraft missions have several benefits over single spacecraft missions, but in particular, they minimise the time required on deep space telecommunications networks during gravitational measurements.

Although the swarm approach has been studied, there have as yet been few attempts to simulate a mission, particularly where the swarm does not "piggy-back" on a mothership. The "piggy-back" strategy loses efficacy as the spacecraft flyby multiple targets and the spacecraft become more complex.

The research presented in this paper looks at swarm deployment, the physical relationship between the swarm spacecraft with time and their data transmission to Earth. A scenario has been developed where the swarm is sent past several asteroids. Several simulation runs are made in which both spacecraft deployment and trajectories are systematically varied. The swarm simulated here takes on the spacecraft swarm instrument suite described previously by Crowe et al, where the spacecraft use time-of-flight radio ranging and Doppler measurements to detect variations in relative movement between spacecraft. The simulations are used to estimate asteroid mass *in situ* with onboard analytical analysis, without the need to relay data back to Earth for full numerical analysis. The uncertainty of relative measurements from spacecraft in different formations is thus investigated using these strategies.

This research indicates the practical challenges that are present in the design of an asteroid gravity estimation mission when using swarms of spacecraft and explores ways in which they might be alleviated. This focuses particularly on station-keeping before rendezvousing with the target asteroid in order that the spacecraft be appropriately aligned prior to the flyby.