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TOWARDS ENDOGENOUS MAPPING OF SMALL SOLAR SYSTEM BODIES DURING MULTI-AGENT RENDEZVOUS

Abstract

Multi-agent rendezvous with small solar system bodies has the potential to improve study of asteroids and comets, develop efficient landing strategies and explore possibilities of in-situ resource utilization. In near present times, flyby missions with single spacecrafts are usually targeted towards a specific zone of the target body and inadvertently might miss surveying features or events that are of utmost scientific and galactic significance, especially when encountering a pristine body. However, a multi agent flyby shall be able to perform measurements from varied spatial locations as compared to a single spacecraft. Mapping these bodies of interest, by means of multiple spacecrafts, is important during fly-bys as the event is transient and measuring opportunities are limited in time and space. Thus, more information about the target body can be acquired by spacecraft flyby maneuvers from different orbital locations in a relative time domain to ensure a sizable geographical survey. Furthermore, the concept of the multi agent mapping is relevant to a variety of missions and space exploration concepts.

The current research focuses on the mapping endogenous attributes of small solar system bodies by a system of multiple exploring spacecrafts. The trajectories are designed for a multi-agent system over non conflicting hyperbolic trajectories using kinematic equations. They are optimized over an advancing horizon control within a finite time domain to estimate near optimal flyby maneuvers for the spacecraft. In the course of the flybys, they perform scientific observations and scrutinize distinct proportions of the target body. This, in particular, is achieved by conducting measurements within the gravitational sphere of influence of the body under consideration. During the flyby, the agents map the gravitational influence exerted on them by the body. This results in the developing a higher fidelity in-orbit gravitational field model as compared to earth-based measurements. Optical sensors onboard the spacecraft capture images of the body during the event. The body is subsequently captured from different orbital positions. Surface reconstruction approaches can then produce a highly detailed terrain profile of the target body. Studying the terrain perturbations helps in studying surface intrinsic and craters formed due to probable impact of foreign bodies and micrometeorites.

Fusing such measurements can expand information about the mass-density distribution of the body. The research bears the potential to expand multi-body explorations of celestial bodies to better understand their constitutional characteristics and map natural dynamic phenomena that elevate in-situ resource utilization and space exploration.