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SWARM INTELLIGENCE AND ADAPTIVE NEURAL NETWORK BASED CONTROL AROUND ASTEROIDS

Abstract

A lot of asteroids lack an accurate ephemeris and characterisation of their gravitational fields. NASA's Deep Space Network (DSN) communication and tracking system has its disadvantages as there is significant uncertainty in distance between a spacecraft and a target which can jeopardise mission success. This paper tries to present a strategy to control a swarm of small satellites around asteroids or other irregular bodies whose gravitational parameters are unknown. We propose using a swarm of autonomous satellites with a neural-network based ADCS system which learns and adapts on the go to the arbitrary gravitational fields of these asteroids or other irregular bodies. These satellites will work together with the 'mother satellite' that helps coordinate with the swarm and increases mission success probability without the use for DSN in the asteroid belt and other environments that need real-time adaptation and communication. The mothership will continuously coordinate with the swarm satellites learning from each individual satellite's manoeuvres and in turn use those learnings to help other satellites' control system adapt in real time around the irregular body for optimised scouting and monitoring. This is achieved using an integration of different combinations of sensors and actuators, a coordinating mothership, and an adaptive neural network based attitude determination and control system to autonomously search and 'home-in' on the target body and adjust to the arbitrary gravitational field in real time.