30th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Spacecraft for Deep-Space Exploration (8)

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CONCEPT STUDY OF AN ASTEROID LANDING MISSION WITH CONTROL USING NEURAL NETWORK ALGORITHMS

Abstract

Small celestial bodies such as asteroids and comets carry the history of the solar system formation, and provide evidence to how water was distributed among planets. Several deep space missions targeting asteroids have been launched either fly-by, landing, or sample return (e.g. Hayabusa, NEAR Shoemaker, OSIRIS-REX, DART and others). It is important to understand the surface and the regolith properties of asteroids to evaluate the processes that formed the asteroids and how they may affect their future orbit. In this study, we will describe a potential mission to land a small spacecraft on an asteroid. The concept will be developed by the Propulsion and Space team at the Technology Innovation Institute (TII) in United Arab Emirates (UAE). In October 2021, the UAE space agency announced a new interplanetary mission to Venus and the asteroid belt which is scheduled to be launched in 2028. We consider this opportunity to carry our small spacecraft to the asteroid belt and then deploy it into the targeted asteroid's orbit.

One of the main objectives behind this project is to build and enhance the capabilities of the UAE local engineers in spacecraft design, assembly, integration, and testing. The team will conduct trade-offs to choose the sensors, actuators, and payloads. We anticipate a number of challenges to overcome: complex dynamic environment; designing algorithms for optical GNC, possibly utilizing the latest developments in Reinforcement Learning (RL) methods for control; unknown asteroids gravitational field; autonomous functioning of the spacecraft, without ground in the loop; long time storage in the main spacecraft before deployment; landing algorithms and actuators.

For the asteroid orbit insertion and landing, a propulsion system will be integrated into the CubeSat. The size and the mass of the CubeSat will be decided based on the mission requirements and the main spacecraft limitations. The required tests will be executed using the available facilities in the UAE. It might be also possible to demonstrate the event-based system autonomy on a LEO CubeSat mission, prior to the asteroid mission. Following a successful asteroid orbit insertion and landing, the team will start receiving data transmitted via the main spacecraft in orbit. The onboard cameras also will be used to capture images of the asteroid's surface which will be downlinked to the ground station. We will also study a possibility of a small subsurface probe to study thermal conductivity in the top 10-20 cm of the regolith.