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15th IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Novel Concepts and Technologies to Enable Future Building Blocks in Space Exploration and Development (3)

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NETWORK OF NANO-LANDERS FOR IN-SITU CHARACTERIZATION OF ASTEROID IMPACT STUDIES

Abstract

Exploration of asteroids and comets can give insight into the origins of the solar system and the Earth and be instrumental in planetary defense and in-situ resource utilization (ISRU). Asteroids, due to their low gravity make them a challenging target for surface exploration. Current missions envision performing touch-and-go operations over an asteroid surface. In this work, we analyze the feasibility of sending scores of nano-landers, each 1 kg in mass and volume of 1U, or 1000 cc. These landers would hop, roll and fly over the asteroid surface. The landers would include science instruments such as stereo cameras, hand lens imagers and spectrometers to characterize rock composition. A network of nano-landers situated on the surface of an asteroid can provide unique and very detailed measurements of a spacecraft impacting into an asteroid surface. A full-scale, artificial impact experiment into an asteroid can help characterize its composition and geology and help in the development of asteroid deflection techniques intended for planetary defense. Scores of nano-landers could provide multiple complementary views of the impact, the resultant seismic activity and trajectory of the ejecta. The nano-landers can analyze the pristine, unearthed regolith shielded from effects of UV and cosmic rays that may be millions of years old. Our approach to formulating this mission concept utilizes automated machine learning techniques in the planning and design of space systems. We use a form of Darwinian selection to select and identify suitable number of nano-landers, the onboard instruments and control system to explore and navigate the asteroid environment. Scenarios are generated in simulation and evaluated against quantifiable mission goals such as area explored on the asteroid and amount of data recorded from the impact event. Our earlier work in this field applied to excavation robotics has shown that a machine-learning approach can discover creative solutions that exceed the capability of human-devised solutions. In this work, we once again intend to compare a human-devised system to these machine evolved systems. The results from these mission formulation and preliminary design studies will be used to identify a pathway towards a future asteroid CubeSat mission.