IAF SPACE EXPLORATION SYMPOSIUM (A3)
Small Bodies Missions and Technologies (Part 2) (4B)

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MISSION ARCHITECTURE AND SPACECRAFT DESIGN FOR LONG-TERM CONTACT STUDIES OF THE INTERSTELLAR ASTEROID 1I/OUMUAMUA

Abstract

The asteroid of interstellar origin, 1I/Oumuamua, was spotted during flyby through the solar system in 2017. According to the results of astronomical observations, this asteroid has an elongated shape not observed before, which, along with its interstellar origin and long-term interaction with the interstellar medium, presents a great value if studied in detail. The greatest difficulty of conducting such studies is the speed of over 26 km/s and a distance of more than 10 astronomical units from Earth. The report presents results of an explorative study that was conducted by a team of more than 100 undergraduate and graduate students and young scientists from Russia, USA, France, Switzerland, Italy, UK, participated in the International Youth Scientific School "Space Development: Theory and Practice - 2021", held at Bauman Moscow State Technical University. The team developed a technical proposal for a complex of spacecraft for long-term contact study of the interstellar asteroid 1I/Oumuamua. Project's goals included exploring and proposing innovative technologies for the study of small bodies and overall mission architecture that ensures long-term contact studies of the asteroid.

The design of a main spacecraft included a braking unit to reduce the speed when approaching the asteroid. In addition to a possibility to observe the surface from a short distance, the spacecraft would deploy a special net to cover the entire surface of the asteroid. This net will allow a spacecraft-delivered spider robot to move across the surface of the asteroid and perform surface exploration and drilling.

For precise targeting of the main spacecraft to asteroid 1I/Oumuamua, designs of other two spacecraft were developed to ensure the detection of the asteroid in the interstellar medium. One of them is a large optical range space telescope comparable to the Hubble Space Telescope. The second spacecraft - the relay spacecraft was developed as a backup solution for the space telescope in case it experience difficulties with simultaneous accurate pointing of the optical axis of the telescope to the object of observation and the axis of the highly directional antenna to the Earth.

The team performed synthesis and analysis of possible technical solutions using existing technologies and technical means, as well as those that are currently under development. The paper concludes with the results of the study and presents computational analysis of various options for defining mission architecture, most rational schematic design solutions and necessary new technologies for small bodies studies.