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

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ASTEROID RESOURCE EXPLORATION MISSION BY RECONNAISSANCE AND LANDED INVESTIGATION

Abstract

Shanghai Engineering Center for Microsatellites (SECM), which has been developed near forty satellites into Earth orbit for space science, communication and navigation, and Earth observation, now shows an increasing interest of exploring deep space targets in a cost-effective way. Asteroid Resource Exploration Mission by Reconnaissance and Landed Investigation (AREM) is the first interplanetary mission of SECM, and has been planning and researching for two years. By sending a small spacecraft below 500 kg to a near Earth asteroid to survey the resources composition, internal structure, and fine mapping, the category of mineral and mining environment can be better understood. This could lead to future asteroid mining as well as resource utilization mission.

AREM is considered as a secondary payload on the Long March 3 Rocket riding up to Geostationary Transfer Orbit and takes advantages of Moon's gravity assists to obtain the desired orbit energy with minimal fuel cost. Several 100 m diameter asteroids, 2013WA44, 2007YF, 2012UV136, 2005TG50, 2001CQ36, have been selected as the candidates on the constraint of 2020-2022 launch windows.

Unknown asteroid environment, shape, rotation rate, topography, and gravity field will result in complicated and time-consuming operation in the vicinity of asteroid. The autonomous trajectory programming and data processing onboard will guide craft to approach the 100 m diameter target asteroid from 100000 km faraway and to map the shape and pole position. Then, slowly km-distance flyby trajectories are designed to estimate the rough mass. Global topography and mapping are completed by progressively lower flyby trajectories. After obtaining fine global map and mass, spacecraft descends to a low orbit for very high-resolution characterization of the surface, and to select the land site. The science data from thermal emission spectrometer and visible/IR spectrometer is sent to Earth for mineralogical, water, and organics evaluation.

Finally, a mini probe is designed to land on the asteroid surface in a low-cost hopping way and explore the surrounding of land site. The hopping probe mainly consists of flywheel shafting, external frame, brake mechanism, and scientific payloads. The torque of the flywheel will be controlled to hop this 5 kg probe. The high-resolution surface images, temperature gradient, etc. is obtained by the scientific payloads.

In this proposal, the micro-spacecraft, mini-rover, and piggyback launch is designed to reduce the manufacture fee. Autonomous trajectory programming and GNC, data processing onboard is applied for low-cost deep-space operation. A low-cost mission of about 30 million dollars is pursued.