IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 2 (2B)

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SMALL HOPPING ROBOT FOR LUNAR EXPLORATION

Abstract

Japan will launch a lunar landing spacecraft 'SLIM" in 2023. The main purpose of the mission is making a pin-point landing to the designated coordinates on the lunar surface. There is an autonomous obstacle avoidance capability using the onboard imagery equipped with the lander to make a final touch-down at the safe area. Currently the spacecraft is almost ready for launch.

The authors have installed a small hopping robot for SLIM spacecraft in order to make a surface exploration over the Moon surface. The robot named "LEV" has a mass of approximately 2.1 kilograms, with a hopping capability to move around the surface. It also has one wheel to turn around. The hopping direction and the attitude of the robot are controlled by rotating the wheel.

The robot will be deployed onto the Moon a few meters above the surface just before the spacecraft lands. After the deployment, it will make a fully autonomous exploration using the camera images with no help from the mother spacecraft.

The onboard image processing system firstly searches the landed spacecraft. Once the spacecraft is found in the image, the robot turns and hops to the spacecraft direction in order to get a close view of the spacecraft after landed. Then it searches for nearby terrain features such as hills and rocks. The robot hops to such terrains and takes pictures of the surroundings. The exploration continues until the power runs out.

After a ballistic motion by hopping, the attitude of the rover is recovered by rotating the wheel to put the robot upright where the solar cells and the antenna pointed to the upward. The next hopping action is also possible in this upright attitude.

The obtained data by the robot including images are directly transmitted to the Earth with no relay by the lander. The robot has a S-band transmitter and the transmitter is switched on when the attitude of the robot is upright.

The robot has secondary batteries and solar cells. The robot is deployed when the secondary batteries have been fully charged. But since the power consumption by S-band radio transmission is much larger than the power generation by the solar cells, the assist from the batteries is needed to communicate to the Earth.

This paper describes the system configuration of the robot, as well as the operational results during the cruise to the Moon before landing.