Status on Japanese Lunar Polar Exploration Mission

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Introduction:

JAXA aims to conduct sustainable lunar exploration activities in the next 50 years, such as operation of lunar base with international partners and private sectors. To realize this goal, we will conduct technology demonstration step-by-step. JAXA envisions our space exploration as the extension from the Low Earth Orbit (LEO) to the Moon and Mars, with our international partners, in order to advance our contribution to intellectual assets.
In October last year, the Japanese government announced its decision to officially join the international space exploration, and to proceed on coordination in the several areas including sharing of data acquired from our lunar exploration missions and technologies for lunar landing site selection.

Japanese lunar exploration missions:

Regarding lunar surface robotic missions, JAXA is developing Smart Lander for Investigating the Moon (SLIM), which aims to demonstrate the high-precision landing technology. The targeted launch year is 2021. Following this SLIM mission, a lunar polar exploration mission is aimed at investigating the water ice resources in the lunar polar region. This is a collaborative mission with Indian Space Research Organisation (ISRO).

Objectives of the lunar polar exploration:

In addition to the scientific interest about the origin and concentration mechanism of the water ice, there is strong interest in using water ice (if present) as an in-situ resources. Specifically, using water ice as a propellant will significantly affect future exploration scenarios and activities because the propellant generated from the water can be used for ascent from the lunar surface.
Because of the existing limited remote-sensed data, we need to find out, by direct measurement on the lunar surface, the presence of water ice, it’ s quantity, quality (pure water or contain other phases such as CO_2 or CH_4), and usability (how deep do we need to drill or how much energy is required to get water) in order to assess if we can use it as resources. Obtaining data to understand the principle of the water distribution and concentration is necessary to estimate the quantity and quality of water across the Moon.

Status on the mission:

ISRO/JAXA are jointly conducting the conceptual design (i.e. Phase-A study) under the Implementation Arrangement (IA) for the lunar polar exploration mission, in which JAXA provides a launch vehicle and a rover while ISRO provides a lander. System Requirement Review (SRR) is scheduled for this year. JAXA selected function and specification of several instruments, which will be loaded on the rover or the lander.

Spacecraft configuration:

The spacecraft system is based on direct communication with the Earth. The target mass of the spacecraft (incl. payload and propellant) is about 6ton and the payload mass is about 350kg. After the spacecraft reaches the Moon, it is inserted into a circular orbit having a 100km altitude via a few orbital changes. During powered-descent phase, the position of the lander is estimated by landmark navigation using shadows created by the terrain. After landing, the rover is deployed on the lunar surface using ramps. The rover then prospects water ice with its observation instruments.

Landing site selection:
We are down-selecting the candidates of landing site of the lunar polar region using the following parameters as constraints:
- Continuous daytime: equal or more than 60days.
- Continuous nighttime: equal or less than 14days.
- Comm. capability: equal or more than 25%.
- Land inclination: equal or less than 10deg.

As a trial of the landing site selection, sunshine is simulated using digital elevation models to obtain the sunlight days per year and the number of continuous sunshine periods at each site. The maps of simulated communication visibility from the Earth and the slope are created.

Conclusion:
In this presentation, we will introduce current status on Japanese lunar exploration missions, focusing on a lunar polar exploration.

Keywords: lunar polar exploration, lunar water, volatile, resource availability