Current status of a Japanese lunar polar exploration mission

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Introduction:

Recently, it has been suggested that water ice might be present in the lunar polar region based on spectral measurements of artificial-impact-induced plumes in the permanently shadowed region, and remote sensing observation of the lunar surface using a neutron spectrometer [1], [2] and visible to infrared spectrometer [3]. 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 and can reduce the mass of the launched spacecraft of lunar landing missions.

However, currently it is unclear if water ice is really present in the polar region because of the currently limited available data. Therefore, we need to learn that by directly measuring on the lunar surface. If there is water ice, we also need to know it’ s quantity (how much), quality (is it pure water or does it contain other phases such as CO_2 and CH_4), and usability (how deep do we need to drill or how much energy is required to derive the water) for assessing if we can use it as resources. Therefore, JAXA is studying a lunar polar exploration mission that aims to gain the above information and to establish the technology for planetary surface exploration [4]. JAXA is also studying possibility of implementing it within the framework of international collaboration with Indian Space Research Organisation (ISRO).

Spacecraft configuration:

The spacecraft system comprises a lander system and a rover system. The system does not have a communication relay satellite but is based on direct communication with the Earth. The minimum target for the landing payload mass is several-hundred kilograms. The launch orbit is the lunar transfer orbit (LTO). 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..

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Landing site selection:

Considering the mission objectives and condition of the lunar polar region, we listed the following parameters as constraints.
- Presence of water
- Surface topography
- Communication capability
- Duration of sunshine

As a first 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. Also, slope and the simulated communication visibility map from the Earth are created. These conditions can be superimposed to select the landing site candidate.

Current status:
Recently, we finished joint mission definition review (JMDR) with ISRO, in which JAXA provide a launch rocket and a rover while ISRO provide a lander system. Related to the instruments which will be carried on the rover or the lander, JAXA selected several candidate instrument study teams for accelerating development of these instruments. In this presentation, we are going to introduce current status of the mission planning.

References:
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