LUNARNET

—— An Innovative Project for Lunar Mission

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Abstract

An innovative and feasible lunar project — **LUNARNET** is presented in the paper. It is composed of a lunar **Orbitor** and a **Lunar Probe** net, through which an information network is formed. Moreover, the detectable information and project features are described in detail.

Keyword: LUNARNET, Orbitor, Lunar Probe

Introduction

After decades dreariness, the world saw the resurgence of Lunar prospect in virtue of mini lunar explorer. The 'smaller, faster, better' aims of NASA leads the Lunar prospect into a new era of low cost, short development period, and fast technology updating. In 1994, NASA successfully executed the 'Clementine' project, which predicted the existence of solid water near the Lunar polar for the first time. The 'Lunar Prospector' project in 1998, moreover, led a big stride by proving and evaluating the water resource volume on the moon. Japan has launched its 'Muse' lunar satellite at the beginning of 1990s and ESA has also placed its own project on the agenda. At this rate, an affordable, reasonable and innovative Lunar Project is then needed in China as well.

The conventional prospect of lunar project requires high resolution telemetry payloads and can not provide the physical, chemical and geological information of the moon surface. On the other hand, the moving prospect vehicle docked on the moon can only detect limited moonscape information in a small neighborhood. Eliminating the above restrictions, **LUNARNET** is a feasible project to obtain the full field lunar data, collected by the **Lunar Probes** consecutively deployed on the moonscape.

Definition and Contents

Definition

LUNARNET is composed of a lunar **Orbitor,** an earth-to-moon **Messenger** and a **Lunar Probe** net on the moon surface. The **Lunar Probes** collect space, soil, rock and surface layer information and interact on each other directly and indirectly (via **Orbitor**), through which an information network is formed.

Contents

- Moonscape Lunar Probe Net

  Implemented in the initial deployment and with the potential of densification through subsequent deployments;
- Information Collection:

  Detection scope: Moonscape, surface layer and soil;

Field Character: The collected information is function of time and moonscape spatial coordinates, thus records the distributed and historical data of the Moon;

- Data Type

  Information from each probe consists of image, and physical (mechanical, thermal, acoustic, optical, electric, magnetic), chemical (element composition, structure) and geological data;

- Data Transfer

  Intermittently and umbrella-like data transfer. The Orbitor circles the moon in deflecting polar orbit and intermittently collects information from different Lunar Probes, through which an umbrella-like data transfer net is formed. After processed by on-board computer, the data is sent to the Messenger tracing a long elliptical orbit enclosing the earth and the moon. The information is down-linked to the ground station via one of the geo-stationary communication satellites that points to the Moon.

Formation

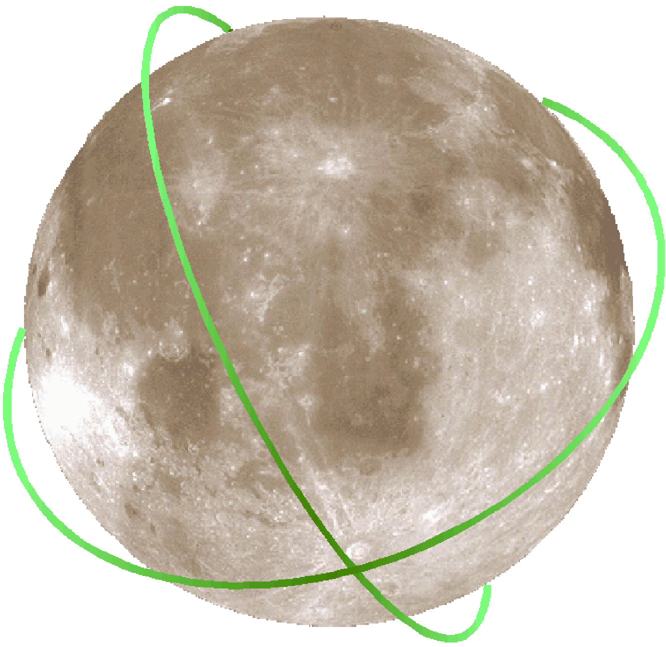

Fig 1 Schematics of **LUNARNET**

Deployment of Lunar Probes

After the Orbitor has been stablized in a 200 km LMO(Low Moon Orbit) for a certain period of time, the ground station will determine whether the deployment control program of Lunar Probe should be started. The deployment of moonscape Probe net will be implemented in two steps. Eight Lunar Probes will be deployed in each step.

The first deployment step is carried out along the polar orbit perpendicular to the orientation of lunar polar valley. The eight probes are ejected evenly along latitude one by one. The total weight of the eight probes is 42.5 Kg, including 14.5 Kg fuel for deceleration. After the ground station has verified the success of the first step, it will start up the second step of control program and deploy another eight probes along the polar orbit parallel to the lunar polar valley. The orbit braking system on each Lunar Probe will control the final landing velocity at a range between 12 m/s to 22 m/s. The attitude control system will restrict the insert angle between 45 degrees to 87 degrees.

Probe configuration and Orbitor revisit period

After the initial two deployment steps, the Moonscape Probes are deployed along two crossed polar orbits (Fig 1). The Probes are separated at intervals of 45 latitudinal degrees, that is, 4 in North and South poles (with 100% vision covering probability of the Orbitor), 4 in equator (with 58% vision covering probability) and 8 in temperate zone (with 68% vision covering probability). This probe configuration is reasonable for water detection according to the maximum ice distribution near the polar zone predicted by Lunar Prospector Project.

The network can be densified in the subsequent steps such as further probe deployment along another two transpolar orbits or at smaller intervals of latitudinal degrees. The network can also be enhanced by integrating new functional module into probe payloads.

The Orbitor revisit period depends on the probe position. Probes in two poles will be revisited as frequently as the Orbitor circles the Moon. Probes in equator will be revisited every 23 days whereas the data collection from probes in temperate zone need 22 days.

Detectable information

- **Moonscape Temperature**
  Detected by digital thermometric scale. The 16 probes measure and record the temperature variation of the moon surface along day and night and through seasons. The accumulated information provides direct data for the moonscape radiant heat, temperature field distribution and evolution research. Combined with physiognomy image, it can be used to determine the effect of moon surface fluctuation on the solar radiant heat, and examine indirectly the micro-gravity heat transfer models.
- **Light and Cosmo radiation intensity**
  The payload for light detection can also serve as solar battery. The variation of light intensity in poles, equator and temperate zones can be related with local temperature fluctuation, and consequently used to check the physical models of micro-gravity optics and optical-thermal transfer. The cosmo radiation field will be measured by a mini- device composed of different detection cells, which are sensitive to different kinds of cosmo radiation. The cosmo radiation data can provide fruitful supports for the He3 resource prediction.
- **Soil exploration**
  Detecting payload is installed at the inserting end of the Probe, exploring the moon soil instantaneously, intermittently and in long-term.
  The instantaneous exploration is accomplished during the Probe inserting process. The initial and final inserting velocities of the Probe can be used to evaluate the friction behaviour of the moon soil, and the scratch depth of the inserting end is related to the hardness of the moon soil granule. With all the above data and the soil image near the Probe, one can conjecture the meso-constitution of the moon soil. The mass frictional heat released during the inserting process may result in the evaporation of moon ice and infrared radiation, which can be also detected by sensitive elements in the Probe.
  The intermittent exploration is executed by the detecting needle fixed at the end of the Probe. The needle intermittently emits stress or electromagnetic impulses and collects the echo data, which can determine the moon soil wave transmitting speed, elastic module and geological layer construction.

Long-term exploration gives the time-variation of the mechanical behaviour of the moon soil. The long-range eroding and radiating process of the Probe end can also provide additional data for water and He3 detection.

- **He3 resource**
  He3 resource exploration on the moon is one of the major objectives of LUNARNET. Its abundant positions and reserves data can be obtained from the 16 Probes in terms of temperature, light and cosmos radiation intensity, soil infrared spectrum and long-term eroding of the inserting end.
- **Ice resource**
  The 4 Probes in two poles will be charged with the ice resource detection. The deployment of the 4 polar Probes, therefore, should be designed to touch down to the bottom of the polar valley where abundant water may exist. The active laser range finder makes the Probes adaptable to the moonscape and sensitive to the information of soil density, rigidity and inserting depth. Consequently, the existence of ice can be verified on site. The moonscape imagery near the Probe and the ice dissolution or evaporation during the inserting process can serve as further evidence.

Other kinds of detectable information are given below:

- Solar wind intensity
- Physiognomy evolution
- Soil chemical composition
- Moonquake wave: epicentre, level
- Aerolite impact wave: impact point, impact intensity
- Geological construction and fracture zone

Feature

LUNARNET has the following features:

- **Extensible**

The LUNARNET can be densified in the subsequent deployment steps and enhanced by integrating new functional module into probe payloads.

- **Low risk**

All the Lunar Probes communicate independently with the Orbitor. The failure in deploying a single Probe plays a minor role in the success of whole information network, which leads to the low risk of LUNARNET Project.

- **Complementary**

The telemetry data collected by the Orbitor is global, remote and low resolution, whereas the information detected by each Lunar Probe is local, real and high resolution. They can be mutually compensated and enhanced. For example, the imagery of the Orbitor can be improved by the orientation data and physiognomy images of Lunar Probes, using sub-pixel imagery.

Reference

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