Global Scheme of Lunar-Earth Information Network

LI Teng, XU Min and YANG Wei
(Dept. of Engineering Mechanics, Tsinghua University, Beijing 100084)

Abstract: A global scheme of Lunar-Earth Information Network is proposed in this paper. It is composed of a lunar-earth **Messenger**, a lunar **Orbiter** and a **Lunar Probe** net, through which an information collection and communication network is formed. Moreover, the triune exploration and project features are described in detail.
Keyword: LunarNet, Messenger, Orbiter, Lunar Probes

1. Introduction

In virtue of mini lunar explorer technology, the lunar prospect revived in the last decade and fairly thrived in recent years. Several leading organizations, such as NASA, ESA, have launched their own distinctive lunar exploration projects. An affordable, reasonable and innovative lunar project in China, named **LunarNet**, was proposed in our earlier paper[1]. **LunarNet** is a feasible project to obtain the full field lunar data, collected by the **Lunar Probes** consecutively deployed on the moonscape.

Based on the **LunarNet** proposal, a further innovation is presented in this paper. The scheme of **Lunar-Earth Information Network** is proposed. The adequate launching capability of China is exploited to overcome her current inadequacy in deep space communication technology.

2. Definition and Contents

2.1 Definition

Lunar-Earth Information Network is composed of a lunar-earth **Messenger,** a lunar **Orbiter** and a **Lunar Probe** net on the moon surface. The **Lunar Probes** collect space, regolith and surface layer information and interact on each other directly and indirectly (via **Orbitor**); The **Messenger** receives the detection data near perilune orbit and downloads data to ground station near perigee orbit, through which a lunar information exploration and communication network is formed.

2.2 Contents

1. Moonscape Lunar Probe Net:
   The lunar probe net may be implemented in the initial deployment and possesses the potential of densification through subsequent deployments.
2. Double flip orbit of the Messenger:
   The double flip orbit has the advantages of low fuel consumption for the orbital injection.

It enables a relatively long orbit segment near perilune for the Messenger. With the assistance of the Messenger in data collection, low power requirement for the signal transmission of the Lunar Orbiter can be accomplished.

3. Information Collection:

Detection scope: moonscape, surface layer and regolith.

Field Character: the collected information is assembled in time history and according to the moonscape spatial coordinates.

4. Data Type

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

5. Data Transfer

The data are transferred intermittently. The data transmission structure is featured by two mobile nodes (Messenger and Lunar Orbiter) with an umbrella-link to the stationary Lunar Probes. The Orbiter circles the moon in a 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 an 8-like orbit enclosing the earth and the moon. The information is down-linked to the ground station during the perigee phase of the Messenger orbit.

2. Formation

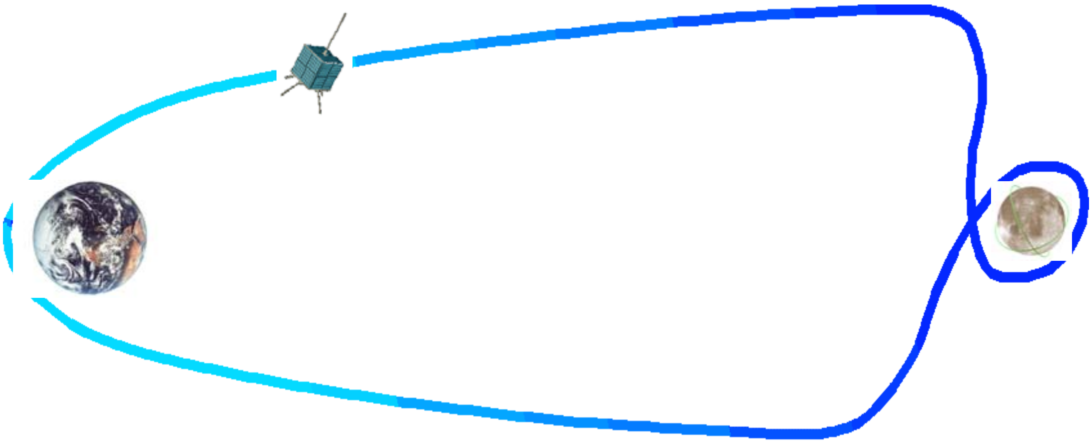

Fig 1 Schematics of **Lunar-Earth Information Network**

The Lunar-Earth Information Network will be formed through four stages:

1) After the launch, the assembled vehicle of the Messenger, the Orbiter and the Lunar Probes is projected into a geo-stationary transfer orbit.
2) The assembly is accelerated at the perigee to an accurate injection velocity of

10.90146km/s;

3) The assembly is transferred into a coast orbit approaching the moon.

4) The Orbiter with lunar probes on board is separated from the assembly and deployed near the moon. It first decelerates into a near-moon elliptic orbit and then stabilizes in a 200 circular moon orbit after the second deceleration. Meanwhile, the Messenger is accurately adjusted to stabilize in a double flip lunar-earth coast orbit, with perigee of 6578.0 km, apogee of 396547 km and cycling period of 323.4 hours.(Fig. 1)

Afterwards, the ground station will send out instruction to start the lunar probe deployment program. The Moonscape Probes net will finally be implemented along two crossed polar orbits, which was presented in detail in our former paper [1].

3. Triune exploration

During one lunar and deep space project, the following triune exploration can be applied.

3.1 Deep space environment and cosmos radiation experiment on the double flip lunar-earth orbit

The Messenger will be equipped with the payloads for cosmos radiation and micro-electronics reliability tests. When tracking on the double flip lunar-earth orbit, it will:

1) continually and in long term evaluate and record radiation environment effects ranging from background galactic cosmic rays, solar flare protons to total dose from trapped radiation;
2) measure and record micrometeoroid and sub-micron space debris environment;
3) test the reliability and thermal cycling behavior of solar cell array and data storage micro-electronics under cosmic environment.

All these experiment data will be downloaded to the ground station during the perigee orbit phase of the Messenger.

3.2 Telemetry of the Orbiter on LMO (Low Moon Orbit)

The Orbiter would finally stabilize in a 200 km LMO (Low Moon Orbit) and carry out telemetry in this deflecting polar orbit. The functional payloads include multi-band optical camera (color image, with resolution of 10~100 meters) and single band optical camera (monochrome image, with high resolution of 3 meter on the 200 km LMO). The image resolution can also be enhanced by sub-pixel technology as well as by mutually associated moon surface image. Furthermore, the Orbiter will evaluate on-board payloads reliability and fatigue behavior under cosmic environment and transfer the data to the Messenger. The optical payload jitter/pointing accuracy evaluation will also be fed back.

3.3 Field data collection by LunarNet

The lunar probes along two crossed polar orbits will be in charge of the field data collection. Locally optical detection can be used to analysis typical selenographs; high resolution images can improve the localization accuracy of remote sensing; long term observation can provide favorable data for microcosmic theory of selenograph evolution. The moonscape heat, light as well as cosmo radiation will be cumulatively recorded. They can be consequently applied to check the physical models of micro-gravity optics and optical-thermal transfer. Vibration sensors on the lunar probes can detect the moonquake and aerolite impact wave, through which the moon's geological construction and fracture zone can be predicted. Other important exploration aim focuses on the He3 and water resource, which play a significant role in the exploitation of the moon.

4. Feature

The Lunar-Earth Information Network has the following features:

1) Low energy cost

The detection data by LunarNet will be collected and transferred by the Messenger. As a result, the Orbiter power requirement of the signal transmission will be reduced to a great extent. The double flip coast orbit will cut down the launch fuel consumption and cost only a little for orbit maintenance. Furthermore, the double flip orbit has longer near-moon circling period, which is favorable for decreasing the error level of data uploading and increasing the data communication capacity.

2) Extensible

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

3) Low risk

All the Lunar Probes communicate independently with the Orbiter. 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 whole project.

4) Complementary

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

REFERENCE

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