AGILITY AND TRACTION FOR A LUNAR ROUGH TERRAIN EXPLORATION ROVER

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ABSTRACT: So far, exploration rovers on moon and mars limited there traverses to mostly flat and “easy” surfaces. On the other hand, there is Opportunity or the Mars Exploration Rover-B (MER-B) getting stuck in a 30 cm sand-dune on April 26, 2005. It took until June 4, 2005 for the rover to reach firm ground again. However, many important areas to be explored on mars and moon will require a rover to travel through uneven terrain covered with rocks, craters, and crevices. This paper presents the results of preliminary work in designing and testing a locomotion system offering high agility and wheels for the Extreme Rough Terrain Lunar Exploration Rover (ERTLER).

The goal of the ERTLER is to position itself on top of lava tubes or steep crater walls, to install a drill-rig, to drill and extract a sample from inside a closed section of a tube. The locomotion concept is based on wheels mounted on six individually articulated legs. To add further agility, the head section can be separately articulated around three axis. Similar to a scraper, ERTLER is capable to make tight turns. Having each wheel individually powered and articulated will allow it to overcome steep slopes, cross crevices or inchworm itself out of difficult situations.

The paper will present the tests of the first prototype in a mock lunar surfaces consisting of lunar soil simulant, craters, and rocks. A special section will focus on the design and testing of a rough-terrain wheel.

Keywords: *Planetary Exploration, Exploration Rover, Rover Wheel, Locomotion, Lunar Soil Simulant*

1. INTRODUCTION

On July 14, 2004 President George W. Bush unveiled the newest ambitious plan to return Americans to the Moon by 2020 and use the mission as a steppingstone for future manned trips to Mars and beyond. Saying “the desire to explore and understand is part of our character,” [O’Brien et al., 2004]. After Bush Congress has committed a multigenerational effort to explore the Moon and Mars 14 other space agencies are coordinating on space exploration based on the Global Exploration Strategy (GES). Now the world is investing on space exploration and planning manned/unmanned space exploration missions. For the first step Japan’s SELENE and China’s Chang’e 1 is remote sensing the Moon. NASA and other space agencies are developing crew capabilities for a lunar surface mission by 2020. On 2009 the first Korea launching vehicle (KSLV-1) is launched and it is in the initiative stage of space exploration coordinating with other countries. And Korea is willing to join the Moon and Mars manned exploration.

One critical aspect of success in exploring Moon, Mars and the Solar System is we have to learn about its past and how to "live off the land". Both goals depend on knowing about the history of its existence provided by planetary science. In turn, such scientific efforts depend on the access to planets, such as our Moon, to collect media samples that have survived millions of years and will be able to allow us to understand the many mysteries of the universe. This paper presents the results of preliminary work in designing and testing a locomotion system offering high agility and wheels for the Extreme Rough Terrain Lunar Exploration Rover (ERTLER).

2. RESEARCH NEEDS

So far, exploration rovers on moon and mars limited there traverses to mostly flat and "easy" surfaces. On the other hand, there is Opportunity or the Mars Exploration Rover-B (MER-B) getting stuck in a 30 cm sand-dune on April 26, 2005. It took until June 4, 2005 for the rover to reach firm ground again. However, many important areas to be explored on mars and moon will require a rover to travel through uneven terrain covered with rocks, craters, and crevices.

While the next generation lunar explorer will undoubtedly be based on the use of a flexible carrier able to be outfitted with a large set of tools, each for a different purpose, the exploration missions will become ever more difficult. Table 1 summarizes the key abilities that will be necessary to achieve what planetary scientists and engineers feel is necessary to move from the first into the second generation exploration stage.

Table 1 Key abilities of second generation rover

Chief Capabilities	Enabling Technologies
- Climbing over large obstacles - Reaching of high ledge - Crossing of large crevice - Traversing area with deep soft regolith - Descend and ascend vertical crater walls	- Flexible locomotion across obstacles - Climbing near vertical wall to reach ledge - Launching across open space - Overcoming large rolling resistance - High traction in regolith - Robotic use of climbing ropes, track cables and tethers in 1⁄6 g

3. ERTLER CONCEPT

Concept of the second generation exploration rover the ERTLER has been designed. Next are the key characteristics of the ERTLER which are differed from the previous planetary exploration rovers.

1. Actively controlled legs
2. Doubly articulated 'neck' joint
3. Detachable head
4. Turreted anchoring and drilling mechanism

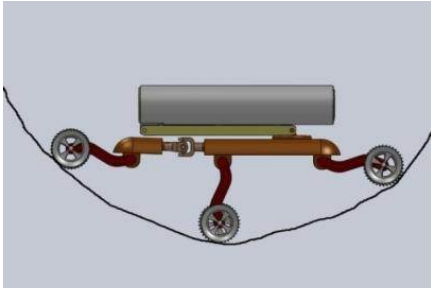

Figure 1 Concept design of ERTLER

4. ERTLER PROTOTYPE-1

ERTLER prototype-1 is developed and it is now on testing of simple locomotion to check the new type active system. Test bed to test the ERTLER prototype-1 has been developed by our own lunar soil simulant KOHLS-1. Extreme rough terrain as loose soil, crater, and steep slopes are simulated. Specifications of the lunar soil simulant and the test bed will be presented on the conference presentation.

5. FUTURE TESTS

As lunar soil has a unique characteristic compare to terrestrial soil, it would be hard to expect the wheel interaction with the lunar soil based on terrestrial theories on wheels. Depending on the unique situation ERTLER may need a totally new type of wheel which will be developed free from earth bound thinking. Thus the future work will develop several types of new wheel for ERTLER and include investigation of wheel traction testing on lunar analogue test bed. The results will be present at the conference presentation.

6. AKNWOLEDGEMENT

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