Intelligent Exploration by Planetary Rovers

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***Abstract*— Exploration Robotics Group of ISAS/JAXA has studied lunar or planetary exploration. Some rovers have been developed for the future planetary surface exploration. This paper presents the current status of research on lunar or planetary exploration robots. The detail will be presented in ICRA2013 workshop.**

I. Introduction

Some missions to explore the moon or Mars by unmanned mobile robots have been studied and proposed are being for scientific observation. Recently, so many researchers have studied and developed lunar or planetary rovers for unmanned surface and subsurface exploration of planets. Such rovers have performed long traverses on rough terrain, reliable navigation and science instrument control. The rovers carried some science instruments and obtained a lot of scientific results on Mars. NASA is currently performing scientific exploration on Mars by using a new bigger robotic laboratory in MSL mission in 2012 and 2013.

Japanese researchers have studied new lunar or planetary exploration missions including landers and rovers earnestly Those missions follow up SELENE (SELenoligical Engineering Explorer), a lunar global remote sensing mission. One of main missions for lunar robotics exploration in post SELENE missions is to demonstrate the technologies for lunar or planetary surface exploration and human activities on the moon in the near future. The following top science will also be conducted in the robotics mission.

In Japan, the working group has studied Japanese Mars exploration since 2008. In the preliminary study, unique explorer spacecrafts cooperatively explore Martian surface. Some explorers, such as surface exploration rovers, wide area exploration airplane, sub-surface exploration robots mole functions are under study.

This paper firstly describes robotic exploration plans for future lunar or planetary in Japan. Then this paper presents the design and implementation of test-bed rovers for the future planetary missions requiring long traverses and rover-based observation. This paper also discusses an intelligent navigation and guidance scheme for long distance traverse. Finally this paper shows the field tests by developed experimental rovers.

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II. Developed Experimental Rovers

A new test-beds, which is called Micro6 has been developed with capability to carry out a variety of the novel mission sequences. Micro6 is not designed for the mission specific, but for pushing the technology advance. Figure 1 shows the first design of Micro6. The Micro6 has the novel suspension system called HEXUS, which has failure tolerant feature. Wheel design must be done for mission oriented, because its performance is seriously affected by surface condition. The Micro6 installed a smart manipulator system for detailed surface exploration. The key technologies of Micro6 project are to develop intelligent software architecture, to develop intelligent navigation including path planning, and to develop the exploration strategy by scientific instruments.

III. Intelligent Navigation

Conventional tele-operation methods cause the behavior called “Move & Wait” to a movement of an explorer. An explorer has to wait for commands while the operator’s planning the path, and as a consequence, that is time consuming. Moreover, to avoid collision between the waypoint path and obstacles, a rover requests the operator to regenerate its waypoint path, which causes further delay until new path data are received. Therefore, an advanced navigation scheme is necessary for efficient and safe exploration by the rover for planetary explorations.

For corresponding to an unknown obstacle, a conventional autonomous path-planning algorithm is a solution, and it can be applied for short range path planning between each waypoint. On the other hand, a rover is continuously updating the environment data set. The original path may result the rover to follow a trajectory that might cause a collision to obstacles. Therefore, it is required to compensate waypoints by using the latest measurement data.

Some field tests are conducted to investigate the effectiveness of the proposed navigation scheme by the developed rover. The results of field test are presented and discussed in detail.

Figure 1. Developed exploration rover: Micro6