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A Small Lunar Rover for Reconnaissance in the Framework of ExoGeoLab Project, System Level Design

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Scientific research is based on accurate measurement and so depends on the possibilities of accurate instruments. In planetary science and exploration it is often difficult or even impossible in some cases to gather accurate and direct information from a specified target. It is important to gather as much information as possible to be able to analyze and extract scientific data from them. One possibility to do so is to send equipments to the target and perform the measurements locally. The measurement data is then sent to base station for further analysis. To send measurement instruments to measurement point it is important to have a good estimation of the environmental situation there. This information can be collected by sending a pilot rover to the area of interest to collect visual information. The aim of this work is to develop a tele-operated small rover, Google Lunar X-Prize (GLXP) class, which is capable of surviving in the Moon environment and perform reconnaissance to provide visual information to base station of ExoGeoLab project of ESA/ESTEC. Using the state of the art developments in electronics, software and communication technologies allows us to achieve increase in accuracy while reducing size and power consumption.

Target mass of the rover is lees than 5 kg and its target dimension is 300 x 60 x 80 mm^3. The small size of the rover gives the possibility of accessing places which are normally out of reach. The required power for operation and the cost of launch is considerably reduced compared to large rovers which makes the mission more cost effective.

The mission of the rover is to capture high resolution images and transmit them to base station. Data link between lover and base station is wireless and rover should supply its own energy. The base station can be either a habitat or a relay station. The navigation of the rover is controlled by an operator in a habitat who has a view from the stereo camera on the rover. This stereo camera gives image information to the base and gives the possibility for future autonomous navigation by using three-dimensional image recognition software. As the navigation view should have minimum delay, the resolution of stereo camera is not very high.

The rover design is divided into four work packages. These work packages are remote imaging, remote manual navigation, locomotion and structure, and power system. Remote imaging work package is responsible for capturing high resolution images, transmitting image data to base station via wireless link and store the data for further processing. Remote manual navigation is handling the tele-operation. It collects stereo images and navigation sensor readouts, transmits stereo images and navigation data to base station via wireless link, displays the image and sensor status in a real-time fashion on operator's monitor, receives command from operator's joystick, transfers navigation commands to rover via wireless link, and operates the actuators accordingly. Locomotion and structure takes care of designing the body structure and locomotion system based on the Moon environment specifications. The target specifications of rover locomotion system are maximum speed of 200 m/h, maximum acceleration of 0.554 m/s^2, and maximum slope angle of 20°. The power system for the rover includes the solar panel, batteries and power electronics mounted on the rover. The energy storage in the rover should be able to survive for minimum 500 m movement on the moon. Subsequently, it should provide energy for other sub-systems to communicate, navigate and transmit the data.

Considering the harsh environmental issues on the Moon such as dust, temperature range and radiation, it is vital

for the mission that these issues are considered in the design to correctly dimension reliability and if necessary redundancy. Corrosion resistive material should be used to ensure the survival of mechanical structure, moving parts and other sensitive parts such as electronics. High temperature variation should be considered in the design of structure and electronics and finally electronics should be radiation protected.