Return to the Moon (02)
Concepts for Robotic and Human Missions to the Moon (3)

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GOAL ORIENTED AUTONOMOUS ARCHITECTURE FOR LUNAR EXPLORERS

Abstract

The paper discusses the design of goal oriented autonomous architecture aimed to harmonize high level decision making processes and uncertainties facing to better simulate the human reasoning. A Multi Attribute Decision Making trade-off analysis is performed by the higher level for the generation of a feasible and sound set of scientific goals, based on weight functions that model the environment's sensed data and the characteristics of the synthetic lunar exploration rover. A planner/scheduler intermediate level, based on the classical planning graph technique, is applied to allows the translation of the activated goal into a system user-defined activities, modeled in terms of consumable/inconsumable resource allocation, causal relations and activating-time constraints. The lower level of the presented architecture is a made of a naïve module that splits each activity, part of the computed feasible plan, into a set of system directed control commands.

The architecture has been tested by means of a simulated Lunar environment and a synthetic explorer. The synthetic environment allows to generate visual sensors inputs whereas the physics and subsystems modules support different mission scenarios or planet to simulate both vehicle interaction with the environment and planned activities. As a consequence, design choices both at subsystem and system level can be cross checked in terms of effectiveness, robustness and flexibility of the vehicle. Customizable options include type and properties of soil, surface geometry and atmosphere as well as their dependencies from time (daily and seasonal variations). An orbital mechanics module is included too, to let the user obtain the visibility windows for communications between the vehicle and either an orbiting spacecraft or a set of selected ground stations.

Preliminary results for both nominal and anomalous scenarios are reported for a lunar surface explorer. Results, even if based on simplified problems to capture the goal generation level and hybrid architecture performance and limitations without marginal details, showed promising results and proved soundness of the proposed architecture.