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THE BRIGHT SIDE OF THE MOON: MULTI-CONSTRAINED OPTIMIZED MAPS IN SUPPORT OF FUTURE MISSION PLANNING

Abstract

The discovery of natural resources on (and beneath) the lunar surface has renewed in the last years a strong interest on the Moon exploration, that is emerging as one of the next global strategic priorities in space exploration. In this domain, it is expected that a huge number of assets (i.e. robots, sensors, beacon, autonomous intelligent devices, etc.) will be deployed over the lunar surface.

The identification of optimal multi-constrained site over the lunar surface for the asset deployment is a fundamental task. In particular, the most relevant constraints to be considered for the deployment of the assets of the future lunar infrastructures are the solar irradiance, the Earth visibility and the Moon morphology.

The huge availability of raw data from existing in-place sensors (mostly, in-orbit) enables the execution of analysis and simulations, giving the chance to determine and solve, already during the mission definition phase, the optimal asset deployment problem with respect to these constrains.

To this end, many environmental requirements need to be analysed for the correct positioning and dimensioning of those devices. Most of these assets will be powered with batteries and solar panels, for which information about the distribution and length of the shadowing periods on the deployment site is a critical design constrain. The analysis of this aspect becomes necessary especially on the Moon, where nights can last from few hours to tens of terrestrial days. The solar irradiance over long time periods will be also an important constrain for solar panel design and, consequently, for battery autonomy sizing.

Multi-constrained optimization maps can be used to perform the system dimensioning and to identify the optimal deployment strategy. Moreover these maps can be used for the optimization of the routes of the autonomous vehicles. Proximity from the envisioned lunar villages (nowadays expected around the Shackleton Craters) and morphological peculiarities are other constrains to be taken into account. Earth visibility could be also a relevant constrain in the domain of antennas positioning for navigation, observation and communication.

The scope of this paper is to report the main results of the analysis performed by Thales Alenia Space Italia in defining the optimal multi-constrained location maps in support of future missions on the lunar South Pole. The methodology used and the results obtained by a simulation-based approach conducted

with a software platform based on STK and Matlab integrating the 3D maps of the Lunar surface will be shown.