IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

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DEPLOYMENT OF A COMMUNICATIONS NETWORK TO EXPLORE A LUNAR CAVE

Abstract

Lunar caves are subterranean wide and long tubes that could potentially host a human base. These caves are expected to be stable, with small temperature variations and they can protect the base from micrometeorites. The entrance, known as pit or skylight, to these tubes is a small collapse with cliff-like vertical walls.

In this work, the deployment of a communication network is developed: from the pit to the unexplored zone inside the cave. An ad hoc communication network with multiple nodes is foreseen. This network shall maximize the coverage distance of the communication link, while remaining a total data rate greater than 25 Mbps. It must be taken into account that with each hop between nodes, a decrease in data rate occurs.

From the geomorphological data, the key positions where the robots-relays should be placed have been identified. These robots shall seek an elevated position to reduce non-line of sight zones. These robots will maintain the connection between the base station on the Moon surface and the explorer fleet. That is, a coordination between relays and exploring robots is mandatory.

The requirements for the network card and antennas of the robot have been proposed taking into account the expected morphology of the cave. A Wi-Fi 4 network based, or a more advanced version, can meet these requirements. On the other hand, omnidirectional circular polarized antennas will contribute to maintain a stable link whatever the terrain.

In order to estimate the data rate of the total communication link, a propagation model has been developed, considering ground, walls and roof echoes. This model has been experimentally validated in Earth lava caves in Lanzarote (Spain), for different ground roughness. The measurement campaign has demonstrated that an increment of some meters of the antenna height can increase the link distance up to 200m, due to the positive interference of the ground echo. Moreover, non-line of sites scenarios, like bends and small slopes has been analysed to estimate the increment of the propagation losses. The conclusion of this work is that is that a medium data rate communications link is feasible from the inside of the cave to the outside, with three hops (four nodes) to avoid different expected but unknown obstacles inherent to the morphology of the cave. The location of the nodes has to be defined during the exploring mission itself.