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

Author: Mr. Robert Pöhlmann
German Aerospace Center (DLR), Germany

Dr. Emanuel Staudinger
German Aerospace Center (DLR), Germany
Dr. Siwei Zhang
German Aerospace Center (DLR), Germany
Dr. Armin Dammann
German Aerospace Center (DLR), Germany

COOPERATIVE RADIO NAVIGATION FOR LUNAR EXPLORATION - EXPERIMENTAL RESULTS

Abstract

In future exploration missions to the lunar south pole, autonomous robotic systems will play a crucial role. Teams of robots shall collaborate to perform exploration tasks. Autonomous operation of robotic systems requires robust communication and a reliable navigation solution. The positions of the robots are required by exploration algorithms, but also to reference scientific measurements. The orientations of the robots are required for control and to pinpoint the direction of scientific instruments. Thus, a navigation system shall provide means to estimate the position and orientation of the robots. With ESA's Moonlight initiative, a satellite communication and navigation system is planned. However, due to the limited number of satellites and the currently foreseen real-time positioning accuracy, there will most likely be no continuous coverage and the accuracy will not reach meter or sub-meter level.

We thus propose a local communication and radio-navigation system. The system is complimentary to satellite-based solutions and is designed as a joint system for cooperative radio navigation and high rate local communications. To avoid a central point of failure, the system is implemented in a decentralized fashion. It can handle a flexible number of radio nodes, e.g. a lander, static payload boxes with scientific instruments and mobile robotic systems. The system is designed as a flexible framework to enable singleport and multiport antennas. With a singleport antenna, e.g. a dipole, communication and position estimation are possible. A multiport antenna, e.g. an antenna array or a multi-mode antenna, offers the possibility to additionally estimate the orientation of the node and enables the possibility to determine the position of a neighboring node, which has only a single radio link.

In this paper, we look on cooperative radio navigation with a multiport antenna. Specifically, we will focus on two aspects. Firstly, we will evaluate orientation estimation by a multiport antenna, and compare the achieved performance to alternative approaches. Secondly, we will investigate positioning for the special case where a node has only a single radio link to another entity. For both aspects, we will present experimental results obtained in the framework of the ARCHES space-analogue mission. The experiments will feature multiple robotic rovers and multiple payload boxes. The ARCHES space-analogue mission will take place in June and July 2022 at a Moon-analogue site on the volcano Mt. Etna on Sicily, Italy.