IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

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COOPERATIVE RADIO-NAVIGATION FOR ROVERS, DRONES, AND INSTRUMENT PACKAGES IN THE POLAR EXPLORER MISSION – RESULTS FROM A SPACE-ANALOGUE MISSION

Abstract

The Polar Explorer mission aims at landing scientific instruments, rovers, and technology demonstrator payloads on the lunar surface to explore for example permanently shadowed regions. The current architecture foresees rovers as prospecting elements, deployed instrument packages with scientific instruments, and a drone for exploration. Communication, localization, and navigation is required to interconnect such a network, provide accurate positional information of deployed instruments, and enable safe robotic exploration. Infrastructure for communication and radio-navigation will be available through Moonlight LCNS, though availability, and in particular the foreseen real-time positioning accuracy of 30m to 100m, are not sufficient for rapid robotic exploration.

We propose a wireless system simultaneously enabling high-rate communication and accurate real-time radio-navigation. It is specifically designed to interconnect robots and sensors on the lunar surface in a decentralized fashion. For communication, we use state of the art modulation techniques as known from 802.11 Wi-Fi or 4G, and perform time-based round-trip ranging among all entities. By sharing ranging information within the network, we obtain a decentralized estimate of relative positions. Estimated positions can then be used for further sensor-fusion in rovers, navigation, and to pin-point scientific instrument locations. In addition, such a wireless system can complement Moonlight LCNS technologies to obtain a robust and global real-time navigation solution.

In this paper, we will provide details about our wireless navigation system, and present results of this system from a space-analogue mission. Within the ARCHES (Autonomous Robotic Networks to Help Modern Societies) project, we will demonstrate real-time cooperative radio-navigation on Mt. Etna, Sicily, in June 2022. We will show the obtained ranging and positioning accuracy of the localized rovers and instrument packages. Based on the demonstration results, we will discuss the feasibility for future space missions. In addition, we will provide an outlook on how our concept as complementary system can be combined with Moonlight LCNS.