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Moon Exploration – Part 3 (2C)

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COOPERATIVE RADIO-NAVIGATION FOR ROVERS, DRONES, AND INSTRUMENT PACKAGES FOR LUNAR EXPLORATION - RESULTS FROM A SPACE-ANALOGUE MISSION ON MT. ETNA

Abstract

Future lunar exploration missions aim at landing multiple scientific instruments, rovers, and technology demonstrator payloads on the lunar surface to explore for example permanently shadowed regions. Current architectures foresee 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.

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, for 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 with permanent availability.

In this paper, we will provide details about our wireless navigation system, and present results of this system from a space-analogue mission. We executed this space-analogue mission over the course of four weeks on Mt. Etna, Sicily, in June 2022. We show the obtained ranging and positioning accuracy of the localized rovers, instrument packages, and drone. 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 can be combined with Moonlight LCNS.