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RADIO-LOCALIZATION AND MULTI-ROBOT TECHNOLOGIES FOR LOW-FREQUENCY RADIO
ARRAYS: RESULTS FROM A SPACE ANALOGUE CAMPAIGN ON MT. ETNA

Abstract

A forward-looking vision of astronomers worldwide is the operation of a large-scale radio-telescope on the far side of the Moon to observe the sky in the radio-frequency (RF) range of few Megahertz with unprecedented quality. Observations in this frequency range, free of interference from Earth's ionosphere and human-made RF sources, enable insights into the dark ages of the universe, the magnetospheres, and space environments of possibly habitable exoplanets and our solar system.

Numerous concepts for lunar radio-telescopes have been proposed, and are mostly involving tethered antennas robotically deployed around a lander. In contrast to these concepts, we propose a distributed untethered array to potentially span the array over a larger area, and to reconfigure array geometry. Key technologies to achieve this goal are precise localization and synchronization of array antennas and robotic manipulation capabilities for autonomous deployments and reconfiguration. The ARCHES (Autonomous Robotic Networks to Help Modern Societies) project focuses on the development and validation of these technologies.

In this work, we present our radio-localization system providing precise relative localization of array antennas as well as multi-robot technologies for array deployment. The array is referred to as low-frequency radio arrays, and comprises multiple distributed antennas realized in payload boxes. These shoe-box sized payload boxes can be transported and manipulated by our Lightweight Rover Units (LRUs), prototypes of small and agile exploration rovers featuring a high degree of on-board autonomy. These technologies will be demonstrated in a space-analogue field campaign on the volcano Mt. Etna, Sicily, Italy, in June 2022. We give insights into this field campaign with this experiment, and show results and performance comparisons of our demonstrated technologies. Furthermore, we give an outlook on future developments and future usage of these technologies.