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# AUTONOMOUS MISSION PLANNING FOR OLFAR: A SATELLITE SWARM IN LUNAR ORBIT FOR RADIO ASTRONOMY

**Abstract**

Earth-based radio astronomy has provided novel information on celestial objects at radio frequencies for over half a century, which complement the information at other frequencies. However, the cosmic signals in the frequencies between 0.3-30 MHz have remained unexplored because of the non-transparency of the Earth ionosphere below 10 MHz and man-made Radio Frequency Interference (RFI).

The OLFAR (Orbiting Low-Frequency Antenna for Radio Astronomy) project aims to reveal the mystery for radio astronomy between 0.3-30 MHz. A satellite swarm of nanosatellites is planned to operate in lunar orbit reaching at maximum 100 km baseline while minimising RFI exploiting the Earth eclipse on the far side of the Moon. Over the past decade, significant progress has been made in designing the various satellite subsystems to realise the OLFAR swarm. However, unlike the space segment, little attention has been given to the ground segment which plays a key role in the post-launch operations, e.g., mission planning, commanding and telemetry processing, and orbit manoeuvring.

This paper proposes an autonomous Mission Planning (MP) strategy for OLFAR. First, the MP problem is formulated, which consists of subsystems' tasks (e.g. collecting radio waves), resources (e.g. battery energy), and constraints (e.g. maximum data rate). Then, a two-stage MP algorithm is developed, where the first-stage is of long-term MP for one month, and the second-stage is of short-term MP for three days, corresponding to the 24 orbital periods. In this paper, a priority-based greedy algorithm is developed, which examines if each task is conflict-free with the pre-assigned tasks and constraints, in descending order from the highest priority task. For each orbit, a payload observation task is first assigned, followed by associated tasks to pre-process and correlate the observed data, and a swarm-to-earth downlink task when the ground station is available, which occurs in approximately 2-3 orbits per day (i.e., per eight orbital periods).

Numerical simulations demonstrate the proposed MP performance for the three-day planning horizon. The simulation results demonstrate that the swarm satellites' science data can be successfully transmitted to the ground station despite the limited contact period and data rate in far-range communication. It is expected that the current and on-going MP study will be one of the stepping-stones to enable the deployment of a satellite swarm in lunar orbit for radio astronomy.