Paper ID: 58437
oral
student

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

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COMMUNICATION-BASED PATH PLANNING FOR COORDINATED PLANETARY SURFACE ROVERS

Abstract

Path planning and navigation is a fundamental challenge to coordinate a multi-rover system in order to achieve a desired collective behavior while exploring as a swarm. A very strong assumption is that communication is available among all agents by default. However, it is essential to apply a reliable communication architecture that enables the moving rovers to maintain connectivity and share information in a decentralized fashion with each other when navigating through unknown environments. A communication-aware path planning extends the capabilities of mobile robotic swarms operating in complex environments such as on the surface of the Moon or Mars. A suitable RF propagation model in combination with communication link prediction is a mandatory prerequisite for wireless communication-based path planning. In this paper, we have modeled the RF communication links for a multi-rovers system at every instant of the exploration path and created a map of received signal strength determining the waypoints for optimal communication. The constraints such as surface absorption, reflection and scattering of waves, line-of-sight blockage and Fresnel zone between the communicating agents, antenna types and carrier frequency, are taken into account for the propagation modeling. A motion planning algorithm is implemented to navigate these waypoints that ensures exchanging messages containing positional information and successfully completes the coverage of the target area. A distributed coordination algorithm is applied to avoid inter-robot path conflicts and repeated coverage of the same locations. The proposed technique is validated within a ROS-framework-based simulation for 3 rovers in a lunar-like environment, and also on simple hardware platforms, CLOVER robots developed at the Space Robotics Laboratory.