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AUTONOMOUS NAVIGATION APPLIED TO THE IGLUNA LUNAR ANALOGUE MISSION ON COLLABORATIVE ROBOTIC SYSTEMS

Abstract

The desire of bringing back the man on the Moon is pushing forward the research of the autonomous systems that will help humans establish a permanent lunar base. Space agencies, companies, and universities accept the challenge of studying solutions to enable human exploration of the cosmos.

This paper illustrates the work performed during the IGLUNA analogue mission, a testbed to demonstrate technologies for future lunar explorations. The CoRoDro team was in charge to build an exploration system for the lunar lava tubes, a possible shelter for humans in the equatorial zone of the Moon. In the lava tubes, the main challenge is the impossibility for humans to visually track and communicate with robotic systems. Two earth analogues were used to demonstrate a lunar rover's and a thruster propelled hopper's autonomous navigation operation: a small rover and a drone performing short flights to simulate the hopper. In the lava tube, the two systems will collaborate to analyze and provide a map of its internal structure. The hopper will provide a map thanks to its propelled flights to the rover that will avoid obstacles in the lava tube to reach high-interest areas for analyzing.

This concept has been proved during the IGLUNA field campaign that occurred on top of Mount Pilatus (Switzerland). This paper is focusing on presenting the path planning and SLAM (Simultaneous Localization And Mapping) algorithms implemented on both robots. The drone relies on path planning algorithms to explore the unknown environment while the SLAM algorithms generate the map. Path-planning on the drone acquires the boundaries and establishes the covering path of the exploration area. The SLAM algorithms contain several modules that take into consideration the mobility capabilities of the rover to create a map that mentions obstacles and reachable areas for the rover. The map is shared with the rover and used to reach identified targets by the drone. Taking into account obstacles, targets, risks and rewards, an optimum global path is generated. SLAM and path planning algorithms on the rover permit it to update the map along its path, and to adjust locally its path if new obstacles, unseen by the drone, are detected.

This work has been reviewed by experts from ESA, Space Innovation, Airbus; an analysis of its performance is presented in this paper. It has shown the interest of fully autonomous robotic missions in extreme and remote conditions, encountered both in space and on Earth.