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CANADA'S SPACE EXPLORATION ROVERS: GN&C FIELD TRIAL RESULTS

Abstract

For the last decade, MDA has been developing and field testing Guidance, Navigation and Control (GNC) capabilities that enable rover long-range, fully autonomous navigation in planetary analogue environments. The maturity and robustness of these technologies have been greatly accelerated through multiple field tests. This paper presents the results from recent GNC field trials in a hard rock quarry near Granby, Quebec, and comments on GNC performance during CSA's Mars Sample Return Analogue Deployment in Hanksville, Utah. It also contains discussions on the lessons learned from these field trials, as well as future development towards flight missions.

MDA's GNC is an end-to-end system that is able to incorporate information from onboard sensors to autonomously navigate long distances within a single command cycle. Navigation entails assessing the surrounding terrain, estimating relative localization, and planning and tracking safe paths to avoid obstacles and reach goals. A coarse-resolution a priori map (if available) can be used for global planning and absolute localization, and the system can enlarge and refine the map using local sensor data.

In 2015, the Lunar Exploration Light Rover (LELR) was taken to a previously unknown hard rock quarry where it was commanded to autonomously traverse 2.8 km through waypoints of increasing difficulty. The commands were carried out within a 400 x 400 m area using a global DEM of 1m resolution. The LELR worked "out-of-the-box" – it successfully navigated to the waypoints, and with visual odometry errors averaging 1.7% of the distance travelled over the wide types of scenes encountered.

In 2016, during a Mars Sample Return mission emulation in the Utah desert, the CSA-owned Mars Exploration Science Rover (MESR) was tele-commanded from CSA Headquarters in Saint-Hubert, Quebec, to execute flight-like mission operations. The MESR also performed out-of-the-box, reliably and autonomously traversing 1 km by establishing its own routes and avoiding obstacles to reach its destinations. On several occasions, the communication between the operations team and the rover was lost, but the rover reliably pursued and reached its targets without human intervention.