SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 2 (2B)

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AN INTEGRATED SCIENCE-CLASS AN INTEGRATED SCIENCE-CLASS PLANETARY ROVER PROTOTYPE

Abstract

This paper describes the recent development and field-testing of a science-class exploration rover prototype. The integrated prototype is a fusion of two programs funded by the Canadian Space Agency (CSA); a planetary-represtative science-class mobility platform (CBR) and an advanced autonomous guidance, navigation control system (AIRGNC). The integration of these two projects culminated in a fully autonomous san analogue field deployment to test the combined system in Mars-like conditions.

The Canadian Breadboard Rover (CBR) is a six wheeled planetary rover prototype capable of supporting a range of payload elements on representative terrain in a variety of science-class Analogue Moon and Mars mission scenarios. The 21 degree-of-freedom vehicle design is based on a ruggedized version of the Phase B1 ExoMars rover breadboard design previously developed by MDA for the European Space Agency. Testing on Mars-like terrain at the University of Toronto Mars Dome in Toronto, Canada demonstrated strong flight-representative vehicle performance, from traverse speeds, slope capability and obstacle negotiation to lander stowability and deployment capability.

The Autonomous, Intelligent, and Robust Guidance, Navigation, and Control for Planetary Rovers (AIR-GNC) system has features that include: optimal use of features from stereo images as visual landmarks, use of visual motion estimation (VME) as feedback to close the path tracking loop, and use of a long-range/wide-field-of-view active 3D sensor to extract fixed landmarks for enabling VME observability, thereby improving accuracy. Field testing in Mars-like terrains in the Mojave Desert, under highly variable lighting conditions, demonstrated strong average localization. Moreover, Enhanced IMU-corrected odometry proved reliable and showed good accuracy in all test locations, including loose sand dunes, during total traverse distance of 7km, under both fully autonomous and tele-operated control.

The integrated CBR and AIR-GNC systems were recently tested together under a Planetary Sample Return scenario near SP Crater in Arizona, USA. The integrated system was operated remotely from the CSA in Montreal, Canada using both tele-operation and autonomous control under the direction of a remote science team led by the University of Western Ontario. CBR ensured the required mobility over the rugged terrain while AIR-GNC provided situational awareness, 3D modeling for target selection and science image acquisition.

Continued and future work includes an interface upgrade for compatibility with future Canadian developments and exciting new CSA-funded development programs for Mars and Moon analogue rover systems to demonstrate end-to-end mission operations including science, in-situ resource prospecting and crewed exploration.