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LOCALIZATION SYSTEM OF THE LUNAR ANALOGUE ROVER "ARTEMIS JR."

Abstract

Accurate localization – the knowledge of one's position – is crucial in enabling a rover to explore an extraterrestrial world. A rover needs this capability to plan and follow paths, perform systematic searches of its surroundings, and return to known points of interest.

This paper describes the localization system of the Artemis rover, developed by Neptec Design Group and its partner companies NGC Aerospace and ProtoInnovations, for the Canadian Space Agency. This team has developed a sophisticated localization system that can allow Artemis to perform accurate relative and absolute localization using only either its own sensors or surface assets that can reasonably expected to be part of a future mission.

Artemis uses its on-board sensors and software to achieve accurate relative localization – knowing its position relative to a particular starting point. A chassis-mounted inertial measurement unit (IMU) measures relative angular motion, and is complemented by an inclinometer and Sun-sensing camera for preventing angular drift. Distance travelled is measured by wheel odometers and two complementary visual odometer processes – one working with mast-mounted stereo navigation cameras, and the other working with downward-facing stereo odometry cameras. This information is converted in real-time to an estimated rover position and orientation by an Extended Kalman Filter (EKF).

Given the presence of unique surface assets or other identifiable information, Artemis can also perform absolute localization, i.e. finding its longitude/latitude. If a Digital Elevation Map (DEM) is available for the surroundings (e.g. from an orbiting satellite), Artemis can localize itself by comparing the map to 3D data gathered by its LiDAR sensor. As well, Artemis can localize itself in the vicinity of a "lander", if the lander is equipped with a range and angle laser scanner.

Testing of the Artemis rover was conducted at the Mars Emulation Terrain at the Canadian Space Agency, and at Neptec's indoor lunar terrain simulation facility. Experimental results presented in the paper show Artemis' relative and absolute localization capabilities in a variety of terrains, at various speeds, and in both teleoperation and autonomous modes.