On-suit Navigation Information System for Manned Lunar Landing Missions

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The effects of spatial disorientation impose serious health risks to exploring astronauts, compromising their ability to successfully explore the planet surface and return safely to Earth. Spatial disorientation factors include unfamiliarity with the terrain and a lack of known landmarks, unknown distances to distant objects, and lower gravity, which make it impossible for astronauts to estimate the distance they travel with each stride. This paper presents the development of a Lunar Astronaut Spatial Orientation and Information System (LAOSIS) at The Ohio State University for addressing lunar astronaut navigation challenges through an integrated sensor network.

The LASOIS integrated sensor-network incorporates data from orbital, on-suit, and ground-based sensors. Orbital sensors include high-resolution imaging sensors onboard the Lunar Reconnaissance Orbiter capable of providing long-range views of the Lunar surface. On-suit sensors include IMUs (Inertial Measurement Units), foot-mounted pressure sensors, and stereo-vision cameras. Ground-based sensors will be extended to include transmitters mounted on a beacon network and receivers mounted on the astronauts' suits. Observations from these sensors are integrated through an Extended Kalman Filter. The Zero Velocity Update technique is used to compensate for IMU distance errors. Vision data are used to compensate for any IMU gyro drift. The spatial information generated will be provided to astronauts through a wrist-mounted OLED (Organic Light-Emitting Diode interface).

Interim results for this NASA NSBRI-funded project from field experiments conducted in a Lunar-like environment show that this multi-sensor approach can achieve a meter-level of accuracy for traverses within one kilometre, and has the potential of being further improved.