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Laser Imaging Detection and Ranging Performance in a High-Fidelity Lunar Terrain Field

Project Manager(s)/Lead(s)

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Sponsoring Program(s)

Marshall Space Flight Center/Center Management and Operations
Technology Investment Program

Project Description

The prime objective of this project is to evaluate Laser Imaging Detection and Ranging (LIDAR) systems and compare their performance for hazard avoidance when tested at the NASA Marshall Space Flight Center's (MSFC's) lunar high-fidelity terrain field (see fig. 1). Hazard avoidance is the ability to avoid boulders, holes, or slopes that would jeopardize a safe landing and the deployment of scientific payloads. This capability is critical for any sample return mission intending to land in challenging terrain. Since challenging terrain is frequently where the most scientifically attractive targets are, hazard avoidance will be among the highest priorities for future robotic exploration missions. The maturation of hazard avoidance sensing addressed in this project directly supports the MSFC Tier I priority of sample return.

Possible sources for the LIDAR sensor itself are Ibeo LIDAR contributed by Auburn University, commercial Faro LIDAR, commercial Leica LIDAR, and LIDAR sensor packages and software contributed by Astrobotic and Moon Express. We will evaluate how well these sensors are able to identify hazards and produce 3D maps. Strengths and weaknesses of each system will be documented and compared.

Figure 1: MSFC's lunar high-fidelity terrain field.

Anticipated Benefits

Some of the anticipated benefits include supporting the MSFC Tier I priority of sample returns, connecting with commercial providers of space landers and rovers, providing a platform technology for spacecraft landing and rover navigation testing at MSFC, bring in FTEs to the Center, and add value competencies to the Center through hands-on experience with the LIDAR hardware.

Potential Applications

Hazard avoidance technology using LIDAR by this project is important to sample return and other autonomous space landing missions because, without it, landing sites have to be relatively free of hazards. As with all previous unmanned missions, a landing site can be selected in a broad flat area. High-value scientific targets, however, are often in areas with hazards. These 'challenging' landing sites include landing near an outcrop or in a crater. In a Monte Carlo analysis for a lunar landing, the probability of a safe landing without hazard avoidance is 23% and 99% with a LIDAR-based hazard avoidance system.

Notable Accomplishments

The project team has successfully completed four LIDAR tests at the MSFC high-fidelity lunar terrain field with Ibeo, Faro, and Leica LIDAR. The first test used four balloons to lift the LIDAR package above the terrain field (see fig. 2). The package included an Ibeo LIDAR, Advantech processor, lithium battery, and GPS/INS system. Four balloons provided about 60 lb of lift force to the LIDAR package. Four internal LIDAR mirrors were pointing downward to scan the terrain field while the package was ascended to about 150 feet and descended to the ground. The second test transferred the LIDAR package to a pipe that mounted to the fork of a bucket truck. By moving the arm up and down and by adding a weight to the side of the package, the LIDAR was pointed to the ground with various scan angles. The third test was jointly conducted with a Faro contractor to obtain a truth model of the terrain field (see fig. 3) and the fourth test used a Leica LIDAR to map a truth model of the field.

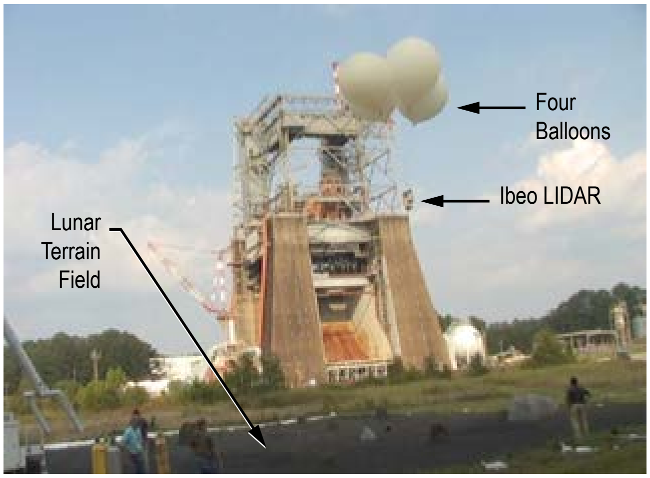

Figure 2: Ibeo LIDAR balloon test.

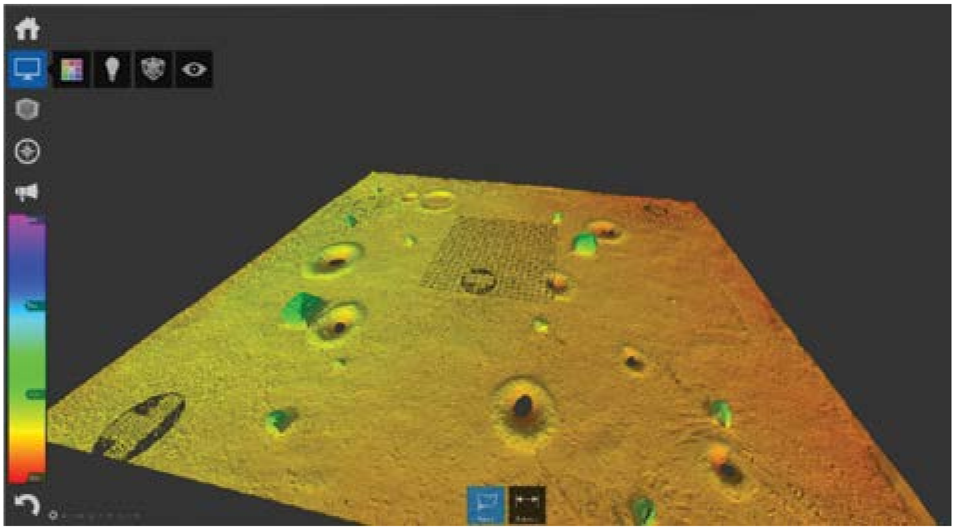

Figure 3: Faro LIDAR mapping.