IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 1 (2A)

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VALIDATION OF THE PILOT HAZARD DETECTION AND AVOIDANCE FUNCTION FOR MOON EXPLORATION

Abstract

PILOT is a suite of advanced landing technologies aiming at providing global access to the lunar surface, precisely and safely. It includes Visual Navigation and Hazard Detection & Avoidance (HDA) functions to be integrated onboard the spacecraft. The PILOT subsystem consists of landing cameras, a 3D-imaging scanning Lidar and a Landing Processing Unit implementing the Visual Navigation and HDA software functions. A first flight opportunity has been identified in the frame of the ESA-Roscosmos co-operation on lunar exploration. The PILOT system is developed by Airbus Defence and Space (Germany, France) as prime contractor, in partnership with GMV (Spain, Romania), Neptec (UK), OIP (Belgium) and NGC Aerospace (Canada). The industrial consortium is now completing phase B of the programme.

The main objective of the HDA function is to detect surface slope, roughness and shadow hazards on the surface during the descent based on Lidar and camera measurements and to designate the coordinates of the safest landing sites. The HDA software is composed of functions dedicated to command the Lidar, process the raw Lidar measurements, perform motion compensation, reconstruct the surface topography,

process the raw camera images, ground-reference the resulting Lidar and camera images, compute hazard maps and then designate the safe landing site coordinates on the surface. Two of the most important challenges for the HDA function are to 1) reconstruct the terrain topography from Lidar scans despite Lander translational and attitude motion and 2) process Lidar and camera information in a limited amount of time to provide a safe site recommendation to the Lander platform within the allocated time.

In the context of the Phase B of the PILOT programme, the performance of the HDA function of the PILOT system has been validated in a high fidelity closed-loop software simulation environment and in a Hardware-in-the-Loop (HWIL) dynamic laboratory environment with a PILOT Lidar development model. Dynamic HWIL testing has successfully demonstrated one of the critical function, which is the capability of the system to compensate for the expected Lander motion during the scanning phases. This requires real-time adaptation of the Lidar scan pattern based on the estimated states to maintain the desired resolution and coverage, and real-time ground-referencing of the measurements to reconstruct the terrain topography.

The paper will detail the status of the HDA function development and discuss the most recent simulation and dynamic test results demonstrating the feasibility of the HDA concept.