

Helicopter Field Testing of NASA's Autonomous Landing and Hazard Avoidance Technology (ALHAT) System fully integrated with the Morpheus Vertical Test Bed Avionics.

The Autonomous Landing Hazard Avoidance Technology (ALHAT) Project was chartered to develop and mature to a Technology Readiness Level (TRL) of six an autonomous system combining guidance, navigation and control with real-time terrain sensing and recognition functions for crewed, cargo, and robotic planetary landing vehicles. The ALHAT System must be capable of identifying and avoiding surface hazards to enable a safe and accurate landing to within tens of meters of designated and certified landing sites anywhere on a planetary surface under any lighting conditions. This is accomplished with the core sensing functions of the ALHAT system: Terrain Relative Navigation (TRN), Hazard Detection and Avoidance (HDA), and Hazard Relative Navigation (HRN). The NASA plan for the ALHAT technology is to perform the TRL6 closed loop demonstration on the Morpheus Vertical Test Bed (VTB). The first Morpheus vehicle was lost in August of 2012 during free-flight testing at Kennedy Space Center (KSC), so the decision was made to perform a helicopter test of the integrated ALHAT System with the Morpheus avionics over the ALHAT planetary hazard field at KSC. The KSC helicopter tests included flight profiles approximating planetary approaches, with the entire ALHAT system interfaced with all appropriate Morpheus subsystems and operated in real-time. During these helicopter flights, the ALHAT system imaged the simulated lunar terrain constructed in FY2012 to support ALHAT/Morpheus testing at KSC. To the best of our knowledge, this represents the highest fidelity testing of a system of this kind to date. During this helicopter testing, two new Morpheus landers were under construction at the Johnson Space Center to support the objective of an integrated ALHAT/Morpheus free-flight demonstration. This paper provides an overview of this helicopter flight test activity, including results and lessons learned, and also provides an overview of recent integrated testing of ALHAT on the second Morpheus vehicle.