SPACE EXPLORATION SYMPOSIUM (A3)
Space Exploration Overview (1)

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AUTONOMOUS SAFE PRECISION LANDING TECHNOLOGY: ESA ACHIEVEMENTS AND CHALLENGES

Abstract

Autonomous safe and precision landing is an important capability required to ensure mission success for future automated landers targeting the polar regions of the Moon. The lander will be able to automatically identify the location of the desired landing site while detecting hazardous terrain features within it during the final powered descent to the surface, to designate an alternate safe landing site, and to maneuver to the selected safe site. Moreover, the lander will be able to autonomously estimate its inertial position during the descent phase and subsequently update onboard the reference optimal trajectory in order to access restricted illuminated areas at the lunar poles allowing surface operations of several lunar days. In this respect, the European Space Agency (ESA) has supported for many years the preparation of European solutions for autonomous safe precision landing technologies. These technologies are presently at different maturity level and are relevant to others space exploration missions.

The paper discusses the major design drivers of future automated lunar landers and provides the current status of the autonomous safe precision landing technologies developed in the ESA Aurora Core Programme. The emphasis is on autonomous optical terrain relative and absolute navigation technologies: optical camera breadboard, image processing and navigation algorithms, guidance and control systems encompassing onboard capabilities for hazard risk detection, safe landing site selection and re-designation. The incremental model-based development and validation approach, including high fidelity simulation platform (EAGLE), synthetic terrain image generation software tool (PANGU), specialized performance analysis tools, flight representative avionics testbed and ground dynamics test facilities, and associated technical challenges are discussed. Finally, the paper concludes with an overview of the landing site risk analysis software framework (LandSAfe) that is used for the certification of safe landing sites.