

SPACE EXPLORATION SYMPOSIUM (A3)  
Moon Exploration – Part 2 (2B)

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GUIDANCE, NAVIGATION, AND CONTROL SYSTEMS FOR THE EXPLORATION OF THE MOON

**Abstract**

This paper describes the current state of the art and the future developments of Guidance, Navigation, and Control (GNC) systems for the exploration of the Moon by the European Space Agency ESA.

Robotics and human space exploration space missions have brought astonishing accomplishments till date (e.g. 12 humans actually walking on the lunar surface). The ESA roadmaps of GNC technology for the exploration of the Solar System have been designed to set the goal of fostering robotics exploration with the final aim to support human exploration.

This talk provides a wide overview of the current technology programs and activities in the area of guidance, navigation, and control systems. Within those technology roadmaps, vision-based navigation techniques and technologies play a special and remarkable role in the area of precise and pinpoint navigation for landing.

The paper describes also the commonalities of the GNC systems for Moon exploration with other developments including GNC technologies for mission to asteroids (AIM), Phobos sample return, and Mars sample return mission preparations.

The paper highlights for the navigation function the need of active and passive systems, absolute and relative navigation, as well as verification, and validation techniques to complete the closed loop control system of the complete GNC chain. For the guidance function, the paper explains the technology efforts on how to generate optimal trajectories both off-line and in real-time. For the control function, the paper explains the techniques and technologies of advanced and robust control methodologies.