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

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A ROVER VISION-BASED RELATIVE LOCALISATION SYSTEM FOR THE RESOLVE MOON EXPLORATION MISSION

Abstract

Accurate relative localisation is a critical aspect for future rover planetary exploration missions. In previous work, NGC Aerospace and Neptec Design Group have developed, implemented and tested a generic and robust vision-based pose estimation system for the lunar exploration rover prototype "Artemis". This system was implemented and tested in the context of a lunar exploration rover prototype design activity sponsored by the Canadian Space Agency. This rover prototype, initially designed for Earth-bound demonstration, is now being considered as the vehicle to carry and operate the NASA RESOLVE payload for an In-Situ Resource Utilisation (ISRU) experiment mission at the South Pole of the Moon. This paper describes how the Artemis relative localisation system design can be adapted to the baseline RESOLVE mission, taking into account the constraints of a Moon South Pole exploration mission, and what level of performance is expected.

The proposed rover relative localisation system relies on images from two stereo cameras, measurements from an inertial measurement unit, a star tracker and wheel odometry. It also optionally processes absolute position measurement inputs from a Lander-relative position measurement system. The system performs processing of the images and fuses the sensor measurements into an Extended Kalman Filter. The system is specifically designed to handle issues such as:

- sensor outage due to variations in operating conditions
- measurement delays introduced by the measurement processing time and communication links
- sensor failure and sporadic measurement outliers

In 2012, the system performance and robustness were demonstrated through software simulations, laboratory experiments and finally long-range field-testing. The field testing confirmed the expected high level of accuracy and system robustness in challenging dynamical conditions.

In this paper, the applicability to the RESOLVE mission of this design and the expected level of performance will be discussed. The RESOLVE mission requires a reduced level of autonomy and reduced operational speed compared with the baseline Artemis mission, but different mission constraints will contribute in degrading the original system performance. In particular, the challenging lighting conditions at the Lunar South Pole require an illuminator, which will affect vision-based navigation performance. In addition, the limited available processing power will affect the cycle execution time, thus influencing the trade-off between image processing accuracy and computational load requirements. Another issue to be presented is the rover-to-ground bandwidth limitations, reducing the amount of data which can be reported back to the ground and limiting visibility over the software execution.