IAF SPACE SYSTEMS SYMPOSIUM (D1)
Technologies that Enable Space Systems (2)

Author: Dr. Thierry GERMA
Magellium, France

Mr. Loïc Le Cabec
Magellium, France
Mr. Vincent Delort
Magellium, France
Mr. Philemon Fieschi
Magellium, France
Ms. Emma Villanueva-Rourera
Magellium, France

ALPER: VISION BASED ABSOLUTE LOCALISATION FOR PLANETARY EXPLORATION ROVERS - STATISTICAL ANALYSIS OF COMPLEMENTARY APPROACHES

Abstract

Future planetary robotic missions, like sample returns or planetary base construction, underscore the necessity for GNC systems with advanced capabilities in extended autonomous traverses. Current mission systems rely on relative localization techniques, which, by iteratively estimating the rover's current pose based on previous pose estimates, are accurate over short distances but prone to error accumulation during extended traverses. Hence, the development of absolute localisation algorithms which, akin to GNSS measurements on Earth, provide rover pose corrections independant to past post estimates, is of primary importance.

In the Martian exploration context, HiRISE imagery, with a ground resolution of 0.3m, offers an unprecedented capability to visualize the rover's operating area from an overhead perspective. Capitalizing on this opportunity, the ALPER project undertaken by Magellium under the ESA's GSTP program, designed and implemented three absolute localisation algorithms employing complementary strategies for matching orbital and rover data. These algorithms, characterized by increasing degrees of autonomy, are: 1) TPT: Operator-guided visual tie-point tracking; 2) CM: Constellation matching through rock detection on rover DEM; 3) DICOR: Dense image co-registration of local ortho-mosaics with orbital orthoimages.

The operational capabilities of these solutions were statistically evaluated through a comprehensive Monte Carlo campaign conducted on various simulated and real world terrain characteristics, illumination conditions and noise levels. Additionally, their practical application was demonstrated in field trials conducted in the Bardenas Reales in July 2023. The primary algorithm loops were ported onto the LEON4 board, demonstrating remarkable computational efficiency on representative target hardware.

The CM and DICOR algorithms exhibited robustness against both noise and terrain conditions, providing dependable and frequent localisation estimation with an accuracy of less than 5 HiRISE pixels with a success rate exceeding 98

Ongoing studies are investigating the performance and adaptation of these methods in a lunar context, characterized by harsh illumination conditions.