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Author: Mr. Takuto Oikawa
Tohoku University, Japan, oikawa@astro.mech.tohoku.ac.jp

Ms. Jasmin Bröhan
Germany, jasmin.broehan@tuhh.de
Mr. Gabriel Dubernet
Ecole Nationale Supérieure des Sciences Appliquées et de Technologie de Lannion, France,
dubernet.g.e@gmail.com
Prof.Dr. Kazuya Yoshida
Tohoku University, Japan, yoshida@astro.mech.tohoku.ac.jp

ROVER ORIENTATION ESTIMATION USING SUN SENSORS FOR LUNAR AND PLANETARY EXPLORATION

Abstract

For space exploration rovers, knowing the exact local orientation is difficult due to the absence of Global Position System. From the global information (landing site) and the rover's images, the operator can make a rough estimation of its current position. Although this approach requires an active operator at all time, it is a very simple way of obtaining a position estimation. While the rover is in motion, wheel slippage is considered as it can be a source of heading error and diverge away from the intended motion plan. This problem is approached by tuning the wheel rotation speed based on the slip condition from terrestrial testing by mimicking the target environment. This method would be sufficient if the rover is landing at a pre-explored region such as the Apollo mission site. However, the above practice does not work when the rover travels to a previously unexplored area as the tuning parameters will not necessarily be optimal. Therefore, we need a robust system that can track the rover's absolute orientation regardless of terrain conditions.

In this paper, we will present an approach using commercial off-the-shelf photodiodes as sun sensors. Arrays of diodes are added onto the rover; each installed on a different surface to measure all necessary directions. The calibration process is initially performed in a controlled environment with a single artificial sunlight emitter to measure the sensor's functionality. The test results are then compared with the outdoor condition to measure errors such as environmental noise from surface albedo. As a final validation process, a field test is conducted to show the rover's local orientation based on the sun heading. The rover's yaw estimation is during spot turn operations, and the deviation is compared to the angle derived from the ground truth. Finally, we will determine the solar elevation angle based on the sensor information and compare with the global solar orientation.