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INS/ST/OPTICAL SENSOR INTEGRATED ALGORITHM WITH WEIGHTED MULTI-OBSERVATION

Abstract

The optical navigation is one of the most widely used navigation approaches for the deep space missions, which the support of the Global Navigation Satellite System (GNSS) cannot be provided. It used to capture landmarks on the surface of the targeted planet, such as craters, valleys or large mountains. These captured landmarks are compared to existing databases to compensate the error of inertial measurement unit. In the database, mainly stored information is an absolute position of landmarks. Thus, once the landmarks are matched from the optical sensor, the spacecraft is able to determine its position by utilizing the prior information. However, database is not always available. There are places where a database is not yet created when approaching an unknown planet, and database accuracy is so low that it may be unreliable. In this case, spacecraft can get relative measurement with respect to captured landmarks that it is impossible to not only eliminate initial error, but determine current absolute position of spacecraft. This research focuses on demonstrating the navigation system which can improve robustness and accuracy without prior information in approaching phase of planet. Craters are targeted landmarks for optical sensor since the success of Near Earth Asteroid Rendezvous (NEAR) mission during the approaching phase to the asteroid Eros 433. If circle is lying on plane, normal vector of the plane can be calculated from coefficient matrix of the circle. Despite of craters are known to be ellipsed-shaped landmarks that exist on the surface of the planets, approximately 5% of all kilometer-sized craters formed on Mars, Venus, and the Moon have elliptical shapes. So the approaching phase, normal vector is obtained from craters and it is integrated with star tracker measurement. The integrated measurement includes an horizontal information of absolute position. To mitigate the error from elliptical crater, quality value of each measurement is calculated with parity vector which is often used in Fault Detection and Isolation(FDI). The elliptical craters are considered as fault that its error level is measured via p-value test using parity vector. Finally, the performance of the proposed method is verified through numerical simulation. To verify that how well the algorithm estimates horizontal position and performance is compared with and without quality value.