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REAL-TIME SPACECRAFT POSE ESTIMATION USING TERRESTRIAL ILLUMINATION MATCHING

Abstract

An algorithm to conduct real-time air or space craft position and attitude (pose) estimation via terrestrial illumination matching (TIM) is presented consisting of a novel method that uses terrestrial lights as a surrogate for star fields. Although star sensors and the Global Positioning System (GPS) represent a highly accurate means of attitude determination and position, respectively, TIM provides a potentially viable alternative. In the event of star sensor or GPS malfunction or performance degradation, an aerospace vehicle with a camera on board could do the job. In an era where satellites are getting smaller and smaller, the market for dual-purpose sensors to replace traditional ones is also rising. The work will present TIM as a collection of mapping and image processing techniques in a real-time scenario to conduct pose estimation as a viable attitude determination method comparable to the accuracy and speed of star trackers. The research uses the OpenCV framework found in Python, specifically the Scale Invariant Feature Transform (SIFT) and the Random Sample Consensus (RANSAC). The simulation for a city lights field is built in MATLAB using an orbit propagator and NASA's Black Marble image, a consolidation of 365 days of city lights observation from the Suomi National Polar-Orbiting Partnership (NPP). The simulated orbit images, taken every five minutes, are then run through the state-of-the-art OpenCV algorithm to estimate the Pose, which is a matrix of position change and attitude with a scaling factor, of Suomi NPP. The algorithm determined 89