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Image-Based Star Detection and Centroid Estimation: Initial Exploration of Lunar Navigation Systems

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Abstract

Accurate star detection and centroiding are critical for attitude determination in space missions, especially under challenging environments like the lunar surface. This study presents an enhanced centroiding algorithm designed to improve robustness and accuracy in the presence of noise. The method incorporates thresholding and intensity-weighted centroid calculations, optimized through testing on synthetic star images affected by Salt-and-Pepper and Gaussian noise. Validation is conducted via affine transformation and star matching with a known star catalogue. The proposed algorithm is benchmarked against conventional Centre of Mass (COM) and Sieve Search Algorithm (SSA) techniques, showing superior performance in terms of Euclidean distance and computational efficiency. The results show accurate detection by visual validation and the detected stars are within 1 to 3 pixels Euclidian distances from the actual stars input. The proposed method demonstrates high accuracy and strong noise resilience, compared to benchmark methods, making it suitable for future lunar missions.

Keywords

Author Keywords: [star detection](#); [centroiding algorithm](#); [attitude determination](#); [noise reduction](#); [lunar mission](#)

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