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# A DIFFERENTIAL ENCODING-BASED METHOD FOR SPACE DEBRIS DETECTION IN LOW SIGNAL-TO-NOISE RATIO ENVIRONMENTS

**Abstract**

With the increasing amount of space debris, traditional space debris detection and tracking methods face significant challenges, especially in the extraction of faint targets under low signal-to-noise ratio (SNR) conditions. In this paper, we propose an efficient starpoint extraction algorithm based on differential encoding, aiming to improve the detection and characterization of space debris and non-cooperative targets, particularly in low SNR environments. The proposed method combines wavelet transform-based image denoising, differential encoding, and Levenshtein distance matching to precisely extract starpoints, demonstrating the ability to detect even fainter targets in star sensor images.

Through experiments with star images from a star sensor capturing 6th magnitude stars, the results show that the method enables the extraction of 8th magnitude stars, significantly enhancing the detection capability for dimmer targets. This ability to extract weaker signals directly contributes to the enhancement of space debris monitoring, extending the observational range and improving the detection of non-cooperative targets in space.

This method provides a new technical approach to space situational awareness and space debris detection, reducing reliance on high-performance hardware. It enhances the ability to monitor space debris and non-cooperative targets at greater distances, offering substantial improvements in the real-time tracking and early warning capabilities of space debris.