Paper ID: 71663
student

20th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 20th IAA SYMPOSIUM ON SPACE DEBRIS (IP)

Author: Mr. Jinfeng Li
School of Aerospace Engineering, Beijing Institute of Technology, China, lijinfeng@bit.edu.cn

Dr. Dantong Ge
School of Aerospace Engineering, Beijing Institute of Technology, China, gedt@bit.edu.cn

IMAGE RECOGNITION AND MOTION ESTIMATION METHOD WITH INTERCLASS VARIANCE OPTIMIZATION FOR SPACE TARGETS

Abstract

Accurate estimation of the space debris' motion is of great significance for space situation awareness and space collision avoidance. As a typical non-cooperative target, the imaging size, the intensity of brightness, the trajectory and velocity of the space debris are uncertain. When the target brightness and signal-noise ratio (SNR) are low, the imaging obtained in-orbit is relatively faint. Therefore, the target is easily submerged in the background, which makes the detection and extraction work extremely difficult. Increasing the exposure time is usually adopted to improve the detection ability of space debris of low brightness, which will improve the SNR to a certain extent. In this case, the target appears as a line segment or a curve in the image.

In order to solve the problem of target omission or misidentification due to inappropriate selection of gray level threshold and unknown target motion in the process of target recognition from long-exposure images, this paper proposes a new space target recognition and motion estimation method. By maximizing the interclass variance of the pixels' gray level, a superior target detection effect is achieved compared to the traditional identification method based on fixed threshold, and the relative motion estimation of the non-cooperative target is realized by piecewise curve fitting of the detected target trajectory. First, based on the preprocessing results of image filtering and gray level thresholding, the image pixels are roughly divided into target and background by using the line segment template matching method. The interclass variance is calculated according to the mean values of the two regions' gray level, and the optimal initial classification of the pixels is determined by maximizing the interclass variance. Then, the segmented curve fitting is performed on the target area with the endpoint of the initially identified line segment as the segmented point. The accurate identification of the spatial target is realized by searching for the target trajectory fitting curve parameters that make the interclass variance get the maximum value. Furthermore, combining the optimal fitting trajectory and the target observation sequence images, the motion of the target in the imaging plane is estimated. Finally, a point diffusion model is used to generate the imaging of a spatial target, and numerical simulations are conducted to verify the effectiveness of the proposed method for accurate target recognition and motion estimation in long-exposure images.