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IMAGE-BASED MULTI-TARGET TRACKING FOR ASTEROID AND DEBRIS AFTER A KINETIC IMPACT

Abstract

Near-Earth asteroid (NEA) impacts are a major catastrophic threat to human society. In the case of short warning time, using kinetic impact to destroy the asteroid can be more effective than deflecting the orbit of the asteroid to eliminate the impact threat to the Earth. Due to the composition of the asteroid, the impact effect is different. To evaluate the impact effect, it is necessary to recognize and track the asteroid and residual debris after the impact. Debris recognition and tracking has two problems. First, due to the large number of residual debris and different movement directions after impact under no prior information, it is difficult to track multiple targets. Second, the residual debris vary in size and have occlusion during movement, resulting in frequent disappearance and recurrence in the field of view, which greatly increases the difficulty of tracking the number and location of debris.

Aiming at the evaluation of NEA disposal results, an image-based method for residual debris recognition and tracking after impact is proposed in this paper. Firstly, an improved motion detection algorithm is proposed, and a mask is designed to divide the current image into background and foreground. The preliminary recognition results of residual debris are obtained by Hough transform to reduce the background disturbance and illumination effects. Then, a PHD update method based on target grayscale measurements under random finite sets is proposed. Finally, an improved particle filter is used to track the residual debris. In addition, to solve the debris occlusion, the transform detection mechanism of target contour architecture is proposed, and the robust game detection of target is integrated into the updating step of particle filter.

Simulation results show that the proposed method can improve the recognition accuracy of target number and reduce the tracking error of target position. In addition, the proposed method can solve the problem of distinguishing targets under partial occlusion and reconstructing targets under complete occlusion. Therefore, the proposed method can be used to recognize and track residual debris of near-Earth asteroids after impact.