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SPACE DEBRIS SYMPOSIUM (A6)
Measurements (1)

Author: Dr. Koki Fujita
Kyushu University, Japan, fuji@aero.kyushu-u.ac.jp

Dr. Naoyuki Ichimura
National Institute of Advanced Industrial Science of Technology (AIST), Japan, nic@ni.aist.go.jp

DETECTING GEO DEBRIS IMAGES VIA VOTING OF MOTION TRAJECTORY FEATURES

Abstract

In this work, we propose a novel technique to detect and track images of debris on Geosynchronous Earth Orbit (GEO). Although ground-based observations using high-resolution CCD cameras have been conducted for the GEO region and some effective techniques to detect or track the debris images have been proposed in the past studies, most of them treat stepwise processes which include preprocessing, such as binarization and noise reduction based on the shapes of irrelevant stellar images. However, such preprocessing algorithms sometimes need heavy computational load and have possibility to remove the debris images which are faint and smaller than the other stellar images. Aiming at more directly estimating debris trajectories from the original time-series imagery, we derive a detecting method for the debris images based on voting algorithm. Focusing on a search observation approach, a series of observation images are taken for the same area with a telescope fixed in a topocentric equatorial coordinate system. Since most of the images of the stars and the debris on GEO appear to be point-like in the image frames and the trajectories of them are approximated to be line segments between the different image frames for relatively short time slot, they can be detected as various lines in the spatiotemporal domain. On the other hand, between the two sequential image frames, the stars seem to move at a specific displacement in the same direction while the other moving objects on GEO move at relatively shorter displacements in various directions. Considering the above characteristic motion of the objects seen in the observation image sequence, the line segments caused from the star images which could be main reason for false detections are effectively removed by histogram voting for the directions of the linear trajectories and the displacements of the object locations on the same line, which are detected in the original image sequence. Also, by statistically analyzing the displacements of the debris candidate images between sequential image frames, the performance to detect exact debris is improved. The effectiveness of the proposed method is validated through analyzing real image sequences obtained at JAXA's Mt. Nyukasa optical observation facility in Japan.