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Space Debris Detection, Tracking and Characterization (1)

Author: Mrs. Natalia Zavialova
Russian Federation, zavialova.na@mipt.ru

Dr. Alexander Rodin
Moscow Institute of Physics and Technology, Russian Federation, alexander.rodin@phystech.edu
Dr. Sergei Negodiaev
Moscow Institute of Physics and Technology (MIPT), Russian Federation, snegod@mail.ru
Mr. Ilia Perepechkin
Moscow Institute of Physics and Technology (MIPT), Russian Federation, perepechkin@phystech.edu
Mr. Pavel Grishin
Moscow Institute of Physics and Technology (MIPT), Russian Federation, grishin.pa@mipt.ru

METHODS FOR DETECTING SUBTLE SPACE DEBRIS USING INFORMATION FROM OPTICAL TELESCOPES

Abstract

Optical telescopes can be successfully used for registration of space debris. They help to detect even relatively small objects. In order to more accurately determine the orbits of space objects, as many optical telescopes are necessary. Not always, they have a sufficient level of sensitivity for the explicit detection of objects, this error must be compensated by the processing algorithms for the resulting images.

Initially, images are considered in the work, where the signal-to-noise ratio is about 1.

As a rule, at the images the stars are already determined, broken pixels are also easy to identified as not changing on a series of shots. But noise is a value that depends on the state of the atmosphere, the illumination of the telescope, the presence of foreign objects, such as clouds, in the frame. And the worst, the noise at different telescopes is different. These phenomena impose a significant restriction on the use of modern methods of image recognition based on neural networks. If during training one type of noise is encountered, and when another is in real task the solution will be unstable and will not be obtainned. Therefore, for cases of dim objects, it is preferable to use deterministic algorithms.

All space objects can be divided into 2 large categories. The first objects with a low angular velocity, usually similar to blurred points. The second category is objects with a high angular velocity, leaving straight line segments on images. The algorithms used to register such objects have a similar detail the need integral mathematical transformations.

For the case of point objects, the object appears on series of snapshots, so we can analyze the entire sequence. Images are specially prepared and then transformed by a method similar to a convolution with a two-dimensional wavelet. After that, taking into account the dynamics of the object, it can be detected by a series of snapshots.

For the case of extended objects, after the preparation of the image, transformations are carried out, consisting in the accumulation of information along the curves, including those along with the curve of interest. After them, objects are identified uniquely.

For bright objects, the assessment of the adequacy of the algorithms was carried out on real images and the algorithms showed their viability. To check the detection of barely visible objects, data from the image generator were used and a good degree of accuracy was also obtained.