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Space Debris Detection, Tracking and Characterization (1)

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NEAR REAL TIME SPACE-BASED SPACE DEBRIS DETECTION BASED ON PARALLEL IMAGE PROCESSING PIPELINE

Abstract

The space debris environment is one of the main issues in present and future space missions in Earth orbit. The threat posed by these objects to operational satellites is getting more and more severe due to their increasing number, which determines, as consequence, an increase in the risk of potential accidental collisions. Some orbits are of particular interest for many applications and then more exposed to the space debris threat. The possibility to prevent space collisions through monitoring activities is a crucial aspect for agencies and companies that operates satellites in these orbits.

Usually, the estimation of the orbital collisions are based on orbital propagation of space debris performed using real data acquired by optical ground-based systems. Complementary to, and not competitive with the ground-based systems, are the optical space-based observations. The space-based systems are able to target specific portions of the debris surveillance network, which is unfeasible, or at least very difficult and expensive, from the ground. The detection of space debris from space-based systems are usually performed by background subtraction methods. These methods process two successive exposures and detect space debris moving relative to the star background performing a frames subtraction. The present paper proposes an innovative space-based system, which performs a nearly continuous scanning of the sky. The core of the system is the automatic image-processing pipeline able to detect space debris in optical data. The algorithm recognizes the features present in the image allowing its usage in both sidereal and object tracking observation modes. The space debris extraction is performed using a single frame; the computation process does not use neither information about the image, such as the observed zone and orbital regime of the observed object, nor the star catalogue to perform stars subtraction for detect the streaks in the image. The test of the pipeline has been performed with ground-based images taken by Italian observatories among which: Mid-latitude ITalian Observatory settled in Rome and EQUatorial Observatory in Malindi. Considering the nearly continuous scanning, we also examine the advantages of increasing the performance exploiting parallelism by means of the Jetson TK1 embedded platform equipped with a NVIDIA General Purpose Graphics Processing Units (GPGPU). The parallelism applied on thousands of threads allows to process images with a lower time. These advantages impose certain

limitations and add implementation complexity, both of which shall be taken into account to achieve an effective system.