17th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Space Debris Detection, Tracking and Characterization (1)

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OPTICAL DETECTION OF GEOSTATIONARY OBJECTS USING END-TO-END DEEP LEARNING

Abstract

A persistent source of difficulty in the optical detection of man-made objects in space lies in the significant amount of clutter (background stars, atmospheric effects, etc.) in the recorded measurements (images). Coupled with the dimness of the target objects relative to other celestial bodies, detection techniques often spend an inordinate amount of effort to discount or suppress the influence of the non-targets. Second, current algorithmic pipelines to process the images often rest upon the correct tuning of a multitude of parameters, which are usually done manually to fit a particular operational setting. There is thus interest to investigate new detection techniques that can alleviate the above shortcomings.

We report results on using deep neural networks to detect man-made objects a sequence of images observed under region tracking in geostationary orbit (GEO). Different to existing approaches, the deep network conducts "end-to-end learning", in that the sequence of operations starting from a raw stack of input images to final detection outputs are trained using a learning algorithm on a set of labelled data. This obviates manual guesstimation of parameters required in a conventional pipeline. In addition, since deep neural networks can now be conveniently trained and executed on graphical processing units (GPUs), the proposed approach is able to very efficiently process multiple high resolution images, thus enabling relatively dim objects to be detected without much difficulty.

The proposed approach has been tested on real images and compared against state-of-the-art non-machine learning techniques. The results point to the promise of deep learning for GEO object detection.