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A MULTI-TASK DEEP LEARNING APPROACH FOR IDENTIFYING AND ANALYZING ORBITAL DEBRIS IN TELESCOPIC IMAGES

Abstract

Space debris refers to a collection of natural micrometeoroids and man-made objects revolving around the planet. The man-made constituent of space debris comprises dead satellites, rocket fragments, and other remnants jettisoned by spacecraft. Nearly 5,500 satellites circle the globe with another 58,000 possible by 2030. Approximately 3,000 are dead or inactive. Space debris represents an increased risk to active satellites and space missions, and new technologies need to be discovered for efficient detection and tracking.

Conventional detection methods are challenged by the faint, streaky behavior of debris in captured telescopic frames. Deep learning, specifically, was an effective counter to the limitations. The research introduces a new way to integrate DL approaches into SST systems to effectively address the challenge posed by the growing number of space debris.

Our new approach employs a deep learning framework that employs a multi-task Convolutional Neural Network (CNN) for the holistic characterization of space debris. The approach exceeds mere detection, attempting to classify debris objects by size, shape, and even material composition, if possible, within a single CNN framework. Traditional methods adopt multiple processing stages for detection, size and shape classification, and material characterization. This multi-task CNN accelerates the process, enabling the network to learn all these tasks simultaneously. Our multitasking approach exploits the shared nature of activities and significantly enhances the efficiency and effectiveness of debris analysis as a whole.

In conclusion, the paper presents a new multi-task convolutional neural network (CNN) for end-to-end space debris analysis. Besides detection, this deep learning technique provides a further understanding of the space debris environment. This is information important to the sustainable future of space activity, as it opens up avenues for further advancements in research and encourages the use of new technologies to make outer space safer.