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IMAGE ENHANCEMENT FOR SPACE SURVEILLANCE AND TRACKING

Abstract

Images generated in space with monocular camera payloads suffer degradations that hinder their utility in precision tracking applications including debris identification and removal, and in-orbit refueling. To address the substandard quality of images captured in space and make them more reliable in space object tracking applications, several image enhancement techniques are investigated in this work. Two novel space image enhancement methods were developed. The first method called REVEAL, relies upon the application of more traditional image processing enhancement techniques and assumes a Retinex image formation model. A subsequent method, based on a UNet Deep Learning model was also developed. Image degradations addressed include blurring, exposure issues, poor contrast, and noise. The shortage of space-generated data suitable for supervised deep learning is also addressed. A comparison of both techniques developed was conducted and compared against the current state-of-the-art in Deep Learning image enhancement techniques relevant to images captured in extreme lighting conditions. A visual comparison of the developed against the competing methods that demonstrates their viability is provided. It is also determined that both the REVEAL and UNet-based Deep Learning solutions developed are well suited to correct for the image degradations most often found in space images. In addition, it has been found that enhancing images in a pre-processing stage facilitates the subsequent extraction of object contours and metrics. By extracting information through image metrics, object properties such as size and orientation are easily determined which enable more precise space object tracking.