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USING DEEP LEARNING FOR AUTOMATED SATELLITE MANEUVER PROCESSING

Abstract

This paper explores the use of various deep learning architectures to equip an automated process with the ability to solve for maneuvers with limited data extracted from optical telescopes. This work was motivated by the increasing need for Space Domain Awareness (SDA) and space sustainability in the presence of an exponentially-increasing number of actively maneuvering spacecraft. With objects in orbit moving at high velocities, it's important to have a strong understanding of the dynamics of the object in question to propagate an estimation.

The non-cooperative detection, characterization, processing, and refinement of frequent maneuvers is challenging, particularly where low-thrust maneuvering is performed and observational and positional data is limited. While maneuvers with a single in-track, cross-track, or radial component are relatively easy to autonomously solve, many spacecraft and their operators employ canted thrust vectors, and these can be much more difficult, oftentimes requiring skilled operators to solve for them based upon experience and intuition. This resource-intensive process is inefficient and can cause operational gaps and lower confidence.

Machine learning (ML) models are often capable of identifying trends in data that humans and other computational methods cannot. Such an ML model requires truth data, so high fidelity simulated data and real measurements with spacecraft operator data were used to train and test the models.

This paper describes a novel method that has been devised and implemented to automate the estimation of spacecraft maneuvers, reduce SDA operator levels-of-effort, and improve the efficiency and accuracy of existing methods. Results from employing this ML architecture and tool shown that such a model can non-cooperatively estimate maneuvers more accurately than SSA system operators and can allow for efficient automation of maneuver processing.