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MULTI-SOURCE RESIDENT SPACE OBJECT DATA CURATION AND FUSION TECHNIQUES

Abstract

The growth of resident space object (RSO) population is rapidly accelerating due in large part to mega-constellations planned by various companies (e.g. SpaceX, Planet, OneWeb, Telesat, Blue Origin, etc) over the next several years. In addition to this population growth, the number of data providers (from raw observations of RSOs to RSO state information to derived data such as maneuver detection and conjunction assessment) is also growing swiftly. These sources of information are not guaranteed to be consistent and oftentimes present conflicting evidence and ambiguity. This creates an urgent need to properly "orient" and fuse multi-source, multi-phenomenology data to increase solution reliability and ultimately drive confident decision making. This paper presents work that expands on previous research which leveraged machine learning to fuse multi-source RSO state data whilst reconciling individual information source and propagation errors. Additionally, this work explores a so-called consensus filter. Consensus filters are not new, but they all process physics-based inputs and are cast in a Bayesian framework (i.e. probabilistic). This assumes that the nature of the inherent errors are driven by randomness that can be precisely characterized. This is also known as Aleatory uncertainty. The credibilistic consensus filter leverages previous work in Outer Probability Measures (OPMs) to fuse disparate multi-source data that can represent both aleatory (random) and epistemic (systematic) uncertainty, even when the representation of uncertainty is unknown but bounded. The proliferation of data providers also creates a challenge in that it is impractical (or at the very least, exclusionary) to impose exacting specification, verification, and validation on the data being provided. This creates the obvious need for automatic data curation. We explore methods to analyze multi-source RSO data to identify and exploit signatures extracted from multi-source residuals, finding the source of errors that could plausibly cause the signatures and providing real-time corrections. Ultimately, data curation and fusion techniques enable more reliable and accurate down-stream information (including maneuver detection and prediction, conjunction assessment and avoidance, and radio frequency interference identification and mitigation, to name a few) resulting in more confident decision making.