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RECONSTRUCTION OF NON-COOPERATIVE SPACECRAFT MANEUVERS DURING OBSERVATION GAPS FROM ANGLES-ONLY MEASUREMENTS USING MACHINE LEARNING

Abstract

Maneuver reconstruction techniques are constantly evolving to keep up with growing space situational awareness needs. Currently, there are two accepted methods that are most prevalent. The optimal control-based estimator approach is unique in that it requires no a priori information about the spacecraft's maneuver strategy. However, it can only solve for fuel-optimal maneuvers – making it ineffective against many non-cooperative spacecraft. Interacting multiple models are different in that they can solve for sub-optimal maneuvers, but require a priori information about the maneuver. In addition, both have difficulty converging when performed from angles-only measurements. Consequently, little research has yet to be published demonstrating maneuver reconstruction from angles-only observations. This paper presents a new method for reconstructing non-cooperative spacecraft maneuvers that relies on deep neural networks. The posed machine learning approach is unique in that it can both reconstruct non-cooperative maneuvers in real time during measurement collection and also reconstruct single impulse maneuvers that occur during observation gaps. In addition, though the neural network requires new training for different nominal orbits, no a priori information is required on the maneuvers themselves. This results in a method for reconstructing non-cooperative spacecraft maneuvers in real time that is valid for all measurement data types and provides at least comparable performance to modern techniques while requiring less a priori data and incurring less computational cost.