Paper ID: 98591
oral
student

23rd IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Orbit Determination and Propagation - SST (9)

Author: Mr. Francisco Caldas
Faculdade de Ciências e Tecnologia - UNL, Portugal

Mr. Giovanni Granato
GMV Innovating Solutions, Spain
Mr. David Vázquez Enríquez
GMV Aerospace & Defence SAU, Spain, Spain
Mr. Borja Lecue Cires
GMV Aerospace & Defence SAU, Spain, Spain
Prof. Claudia Soares
FCT-UNL, Portugal

DEEP EXTENDED KALMAN FILTER FOR STATE ESTIMATION FOR SATELLITE CONSTELLATIONS

Abstract

Accurate state estimation of satellites in Low-Earth Orbit (LEO) is crucial for monitoring, collision avoidance, and communication. The Extended Kalman filtering techniques currently used rely on numerical physics-based models for state prediction, which may be computationally expensive and challenging to derive for large and complex systems. In this work, we propose a Deep Extended Kalman Filter (DEKF) for state estimation, which replaces the conventional physics-based prediction step with a neural network while preserving the correction step of the Extended Kalman Filter. This hybrid approach leverages the computational efficiency and expressiveness of neural networks for fast state propagation while ensuring robustness and uncertainty quantification through Kalman-based updates, and to increase performance, uses ground station state information coupled with relative state estimation from other satellites in the constellation. The proposed framework allows for: (i) data-driven nonlinear dynamics in LEO, (ii) masked or missing information, and (iii) time-varying topologies. We demonstrate the effectiveness of DEKF on simulated datasets, representative of the Starlink and OneWeb constellations, showcasing improvements in computational efficiency while maintaining accurate and consistent state estimation.