Spacecraft Collision Avoidance using Deep Learning algorithms[☆]

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Abstract

Since the beginning of the space era, the humankind has not ceased his activity to exploit the potential of the near-Earth space environment. The lack of strict global regulations has lead to a consistent increase of the space density (aggravated by recent collisions in orbit and new megaconstellations of satellites) with Artificial Space Objects (ASOs) which poses a serious threat not only to the sustainability of the space activity as we know nowadays but also causes a severe environmental damage.

This increment of space density increases the risk of collisions in orbit which create additional debris triggering a chain reaction, a phenomena commonly known as the *Kessler syndrome*[1]. In an attempt to mitigate this problem, space organizations worldwide have developed Space Situational Awareness (SSA) programmes with integrated Conjunction Assessment systems that rely on processing iteratively space data coming from international Data Sharing schemes and Space Surveillance Tracking systems[2][3] to identify conjunctions with high risk of collisions. While this approach is still effective, the potential increase of ASOs in orbit expected in the next decade will put any spacecraft collision avoidance system under severe stress if the current technologies used do not evolve fast enough.

This research project focuses on the data-processing side of the Conjunction Assessment systems' workflow by optimizing the identification and prediction of high collision risk conjunctions by means of Time Series Forecasting (TSF) Deep Learning models. In particular, *Transformer* networks constitute the core of the research for their capability to selectively weight important information from the past[4]. Additionally a Synthetic Data Generation (SDG) method is proposed to create additional CDM virtual data that can be used for Deep Learning.

Keywords: Spacecraft Collision Avoidance, Artificial Intelligence, Deep Learning, Transformers, Python

References

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