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DEEP-LEARNING OPTIMIZATION OF A TIME-CRITICAL MULTISPACECRAFT SWARM NEO DEFLECTION APPROACH

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ABSTRACT

We hereby present results of the analysis of a multispacecraft swarm NEO deflection simulation using deep learning techniques. Spacecraft could be simpler and operate longer and farther only if their computational capabilities could be transferred to a network. However, in tasks that are time-critical such as the uncommon situation of the deflection of a NEO object, whether this delegation of "intelligence" could be operational in practical terms is still a matter of research.

A multispacecraft swarm of spacecraft should be able to operate and react with a very small latency delay. A multi-agent system has been proposed in a variety of similar applications such as Low-Complexity UAVs[1]. In these situations preserving low complexity and low latency for computational data transmission is essential in order for the system to undertake automatic and reliable decisions quickly. Furthermore, a multi-agent system also preserves energy consumption. On the other side, larger swarms may fail to provide reliable full connectivity.

An architecture of signal processing techniques is proposed for a swarm multispacecraft network intended to deflect a NEO object. The operations involve:
i) tracking the object to be deflected, ii) cooperative guidance for the multispacecraft swarm and iii) a multiple impact deflection on the target.

A computational complexity analysis has been performed. A real scenario with a NEO object has been simulated afterwards with different swarm architecture configurations. We analyse in particular the localization impact accuracy versus different approach velocities and spacecraft swarm number. Optimization of different parameters has been conducted with a deep learning analysis. Parameters include: approach velocity, distance to target, spacecraft number, NEO diameter, computational capability and spacecraft variability. Based on the simulation results, a metric is proposed as a measure of the swarm proficiency. As a conclusion, an hybrid approach in terms of sensing and fast communication capabilities, depending on the particular characteristics of the target, offers the best solution for optimizing this original deflection system capabilities.

[1]A. Guerra, F. Guidi, "Networks of UAVs of Low complexity for Time-Critical Localization", *IEEE Aerospace and Electronic Systems*, vol. 37, 10, 22-38.

Comments: *Poster Presentation*