23rd IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 23rd IAA SYMPOSIUM ON SPACE DEBRIS (IP)

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ENHANCING SPACE SITUATIONAL AWARENESS (SSA) WITH OPTIMIZED TRAILING SATELLITE FORMATION AND CONJUNCTION ANALYSIS FOR EARTH'S COVERAGE IN LEO.

Abstract

As space traffic increases, the crucial role of Space Situational Awareness (SSA) with effective satellite constellations becomes significant in sustainable space operations. However, the rate at which satellites are being launched may create challenges with the current SSA issues by raising the possibility of collisions. Thus, this research presents a novel method for designing satellite constellations, including an optimal trailing configuration of satellites for conjunction avoidance and global coverage which can also join the forces for monitoring the earth's surface for disaster management, environmental monitoring, agriculture, global climate studies, and disaster response. Designed to offer continuous worldwide surveillance of the LEO region, this constellation is based on Walker's constellation of satellites. The suggested formation's capacity to track debris in real-time and predict conjunctions will increase the precision of collision avoidance decisions.

To accomplish these goals, this research integrates an in-house Cesium and Python integrated kit for visualizing all the space objects in real-time, along with the Systems Tool Kit (STK). Cesium and Python will be used as the design and simulation tools for integrating SSA algorithms into cesium while STK will be used for validating the trailing formation for interference management and conjunction prediction. As part of this study, an algorithm for the suggested formation will be initialized, and the possibility of worldwide coverage, with the detection of close objects in the LEO orbital regime, will be examined. The results provide an overview of the total percentage of the area satisfied/covered by the constellation by an illustrative report. Followed by the percentage satisfied report, the conjunction analysis report gives an overview of all the space objects, their probability of conjunction, and the time of impact with all the satellites in the constellation. In conclusion, the trailing constellation can achieve almost entire global coverage which could provide continuous services that can advance society, providing real-time data on risk assessment for natural calamities, disaster management, disaster response, global climate studies, and more. Optimized trailing satellite constellations do offer a very promising way to enhance SSA and enable safer, more effective, and more robust satellite operations.