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FAST CHARACTERIZATION OF IN-ORBIT FRAGMENTATIONS

Abstract

In [1] an index, named Fragmentation Environmental Index (FEI), to quantify and visualize the medium term effects on the environment of a fragmentation in Low Earth Orbit (LEO) was derived. The main effort with FEI was to devise a simple analytical index to catch, also visually, the impact of an in-orbit fragmentation on the space environment and its evolution in a given time frame, typically limited to several months after the event. The FEI was derived, based on the CSI (Criticality of Spacecraft Index) and the shell indexes developed in the previous years [2][3][4].

The FEI was developed having in mind the effects on a space surveillance network (SST) of an event creating a large number of fragments. Most of these fragments will be below the detection threshold of the SST sensors, making these mm and cm-sized objects even more lethal since they won't be trackable and, therefore, not avoidable by active spacecraft. With this purpose, a multiplicative weight w_{tr} was introduced in the expression of the FEI to enhance the importance of the non-trackable objects on its computation.

To improve FEI, different weighting factors for specific applications of the index were devised, in particular to characterize the impact of a fragmentation on a specific surveillance sensor, based on the Signal to Noise Ratio equations for a telescope or a radar.

The aim is to allow the use of the index to quickly point out regions of space and span of times where a sensor, and the related chain of services (such as collision avoidance), could be stressed by a fragmentation. Moreover, the dynamical evolution of the cloud of fragments and its possible interaction with specific assets in nearby orbital regions are quantified by a novel indicator based on the known evolution of the angular argument (under the J2 perturbation) and the overall distribution of objects in space.

Proper normalizing factors were devised in order to produce a time cumulated index over a specific time span to directly classify and rank different fragmentation events on various regions of LEO.

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References

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