Fragdet

FRAGMENTATION DETECTION AND ANALYSIS SOFTWARE

GMV's **Fragdet** COTS software is a software application for **detecting in-orbit fragmentations** of objects orbiting the Earth. It is able to detect two different types of fragmentations: a fragmentation due to a **collision** between two objects or the **explosion** of an object itself. The fragmentation detection process is assessed trying to group newly detected objects into potential fragmentations events and assigning the parent (explosion) or parents (collision) to each fragmentation.

The **in-orbit fragmentation detection process** performed by **Fragdet** consists of the following steps:

- **Detection of fragmentations** through a **short-term analysis** based on whether several newly detected objects coincide in space and time in the recent past
- Characterisation of fragmentation as **explosion or collision**
- Identification of **progenitor/s**
- Use of **long-term statistical methods** to include newly detected objects as **new fragments of an existing fragmentation** cloud

- **Fragmentation simulation** with NASA break-up model for generation of expected increase in space debris spatial density (below observable size) as well as the estimated percentage of objects detected
- **Fragmentation plots** generation (evolution of number of fragments over time, Gabbard diagram)

The process of **in-orbit fragmentation detection** consists of the following steps:

- Backward propagation of orbital information of newly detected
- Detection of conjunctions in the past among newly detected objects and also past objects
- Grouping of newly detected objects in fragmentations based on their participation in conjunctions in the past among them
- Computation of time and location of fragmentation based on the conjunctions in the past involving the fragments of a detected fragmentation
- Identification of progenitor objects of each fragmentation based on the detection of conjunctions between existing objects and newly detected objects

Additionally, **Fragdet** counts with a fragmentation simulation component able to generate a cloud of fragments generated in a collision or explosion together with the corresponding orbital information. This feature is very useful for fragmentation simulation and validation/testing purposes.

In terms of processing experience, **Fragdet** has been used in the following operational scenarios:

- **GMV** for in-house analyses of several real fragmentations (e.g. recent Indian Anti-Satellite test), as for instance, in the frame of its participation in Global Sentinel events through the Spanish Army
- **EU-SatCen** for the generation of testing data of the EUSST SatCen Web Portal

In terms of run-time performance, **Fragdet** is able to perform a fragmentation analysis of a fragmentation with 500 new objects on top of a background population of 10000 objects in less than 45 minutes running in a single modern core

As end user products, **Fragdet** generates the following products:

- **Fragmentation data** file, containing all the information of the fragmentation in the form of a CCSDS-like fragmentation warning message in XML format

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```xml
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Figure 1: Example of CCSDS-like fragmentation warning message generated by *Fragdet*

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