A method to develop mission critical data processing systems for satellite based instruments. The spinning mode case.

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1. Introduction

Modern satellite based experiments are often very complex real-time systems, composed by flight and ground segments, that have challenging resource related constraints, in terms of size, weight, power, requirements for real-time response, fault tolerance, and specialized input/output hardware-software, and they must be certified to high levels of performance or to pull degraded hardware to maintain satisfactory features. We'll show real-life examples describing a system, processing the data of a X-Ray detector on satellite-based mission in spinning mode.

2. Description of the Algorithm

The software algorithm we are describing is named SPInning Pipeline (SPIPI), and is based on the concept that measurement data recorded by a detection system mounted on a spinning satellite contain data related to different portions of the field of view that cyclically return to be pointed. For our example the satellite is spinning around his axis with an angular velocity of 0.8° per second. The total measurement data set is divided both in a temporary grid and in a spatial grid. The spatial grid is composed by slices, of square shape each of them with the angular dimension of some degrees in the field of view (e.g. 6°). The data related on a given slice is considered during the (short) time intervals where the pointing is relatively stable, and then merged into temporary event lists related to each given slice. For every eventlist related to a given slice of the grid, the attitude correction procedure is applied, and then all the imaging procedure is performed.

3. Reliability issues and used standards

We designed and implemented The SPIPI software system to analyse data acquired by an instrument in spinning mode; the SuperAGILE instrument (SA) of the Italian Space Agency AGILE mission, although the instrument was mainly designed and optimized to work in pointing mode, with the nominal Attitude Control System (ACS) that could maintain attitude stability better than 0.1 degrees/s (see [5]). The AGILE ACS went out of order in autumn 2009 due to a failure of the momentum wheel. All time related data is represented following the ISO 8601 standard (see [1]), for the software requirements specifications we used the format suggested by the IEEE Standard 830-199 (see [2]). All the log messages generated by the SPIPI software are handled using the syslog standard utilities, this opens a lot of possible counteractions to logged events [8].

4. Input/Output, scheduling and Archiviation

The SASPIN procedures was developed to handle the I/O for the SPIPI software and to allow processing to be run interactively by scientific users and to be automatically scheduled by processing work stations. Specifically is possible to run the software in source/field mode, run daily/weekly ... dataset integrations, log all the events and errors. All processing steps, scheduling events, processing status and the final detection infos are saved on a mysql database.

5. Software Summary

- What does the SPIPI analysis software take as input?
Satellite attitude data, satellite ephemerides data, photons event lists;
- What the program does?
Extract images of the sky to detect sources, dividing the field of view in a grid where the pointing can be acceptable for analysis;
- What does the program produce as output?
Tables and maps of the detected sky sources, with their positions (RA, DEC) and flux [erg/cm²/s].

6. Conclusions and future development

The main results due to the analysis of SA data products generated by the SPIPI software are mainly reported in [1]. A future improvement can be to rewrite some procedures in a way to output data lists directly on socket streams in order to pipe most of them without using temporary files, and complete the error control system with more recovery functionalities.

7. References

1. Del Monte E. et al, proceedings of SPIE 2010

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Fig. 1 SPIPI software activity diagram (flow chart)

Fig. 2 List of sources detected processing the weekly dataset in the time interval (2010-03-04T17:10:17, 2010-03-13T23:50:32)