Paper ID: 47351
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IAF EARTH OBSERVATION SYMPOSIUM (B1)
Interactive Presentations - IAF EARTH OBSERVATION SYMPOSIUM (IP)

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AUTONOMOUS SATELLITE DATA MONITORING TECHNIQUES APPLIED TO DELFI-C3 TELEMETRY

Abstract

The pursuit of trends extraction and valuable information mining from a set of big data is currently one of the hottest topic in the society. An ever-growing number of companies and agencies are trying to stay up to date with this digital revolution and even the space sector is performing significant research on this topic. With the size of constellations constantly growing, there is an increasing need to automatize satellite data analysis to limit the size of the operation teams: this paper shows a preliminary analysis of these techniques applied to the telemetry of Delfi-C3 through the deployment of machine learning algorithms. Delfi-C3 is the first TU Delft CubeSat, launched on 2008, which is still providing telemetry (to date almost 10 GB of data has been received): this vast amount of available data allows to perform an extended analysis over the operational lifetime of the spacecraft. Accordingly, a proper data distribution and processing architecture has been designed to safely store raw data and subsequently process them. The system is based on standard "Big Data" applications that are suited to archive and process in near-real time enormous amounts of data, also performing higher level tasks like autonomous outlier detection, model fitting and data mining. From the raw data, level 1 data is extracted, e.g. engineering values like temperatures and currents are obtained. A first processing is carried out to discard outliers and skewed data from housekeeping data through autonomous clustering techniques. Then, the cleaned data available undergoes another process: given the vast amount of data spread over almost 10 years window, focusing on a restricted time window, a model of selected parameters is fitted and then extended and compared to the whole available data set. By doing so, spikes and abnormal patterns can be isolated, filtered and eventually predicted. This strategy can also be applied in real-time to new data, thanks to the integration of the data collection and processing systems. Thanks to the availability of historical data, an extended analysis could find the impact of operative external environment, such as incoming radiation, on onboard systems, trying to find a correlation between the long-term evolution of specific parameters due to ageing effects. In this paper we will present this analysis for few selected parameters related to the electrical sub-system to prove that this technique (and the architecture that was developed to operate it) provides great advantages for satellite operations.