IAF SPACE OPERATIONS SYMPOSIUM (B6)
Large Constellations & Fleet Operations (5)

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IMPROVING CONSTELLATIONS HEALTH STATUS MONITORING AND FAULT PREVENTION

Abstract

Any kind of complex systems pose demanding tasks to operating personnel in charge of their performance checking. The assessment of the health status of satellites during operations is one of the major tasks of Satellites Controllers (SCs) who continuously check satellites telemetries to detect symptoms of potential anomalies. The continuous assessment of satellites health status requires knowledge of the system in order to focus the attention on the subset of the hundreds or thousands of telemetries, depending on the mission, that are known to be relevant and that can be practically monitored by a human operator. Automatic alerting systems are proposed to help supervising satellites operations, reported to use also methods based on Artificial Intelligence algorithms. However, most of them, while are able to detect the present status of a satellite, are still lacking reliable failure prediction capability or the remaining useful life (RUL) at subsystem or components level, taking into account that different contexts of operation may determine different normal behaviour patterns that must be distinguished in order to reliably identify anomalies and predict failures. Often this can hardly be assessed by operators, unless a repeated behaviour is observed in the telemetries, associated to known failure modes. To address the above points, advanced predictive diagnostics systems are necessary. By providing support to operators raising early alerts and providing estimates of RUL, they ultimately represent the key enabling technologies for the enhancement of missions duration and service availability, as well as for both ground operations costs reduction and on-board autonomy. This paper describes the approach and the typical results obtainable by a set of algorithms resulting from two decades of RD and application experience by SATE, implemented as a suite of software components, referred to as Diagnostic Kernel Modules (DKM). They are now the core of a number of diagnostic applications being proven for space satellites constellations, industrial vehicle fleets and hydrocarbons production facilities. The advantage of DKM is that they implement a fully context sensitive, interpretable data-driven approach, which is fundamental for the understanding of the reasons of a detected anomaly and hardly covered by State-of-the-Art Deep Learning. An example of application of these technologies is provided with reference to a real anomaly occurred on a flying mission, showing how these techniques could have allowed operators identify incipient faults well before the moment in which they actually detected them.