IAF SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Architectures (2)

Author: Ms. Silvana Radu
Rhea for ESA, The Netherlands

Dr. Angelo Cervone
Delft University of Technology (TU Delft), The Netherlands
Dr. Francesco Topputo
Politecnico di Milano, Italy

THE CHALLENGES OF FAULT DETECTION ISOLATION AND RECOVERY FOR LUNAR CUBESATS

Abstract

The constant advancement of technology for spacecraft components naturally inspires more complex and ambitious missions. On the other hand, cost is one of the main driving factors in designing a mission, with a clear aim of reducing mission costs as much as possible. This clearly justifies the recent popularity of spacecraft miniaturization, with the very well-known example of CubeSats. CubeSats have been flourishing in the past 15 years, allowing for dramatic reductions of the costs of missions in Low Earth Orbit. Recently, the space community has started to express a strong interest in using such platforms also for interplanetary missions, which however raise a need for ensuring autonomy, reliability and safety of the spacecraft, especially considering the communication limitations, orbital manoeuvres complexity and reduced redundancy in CubeSat deep space missions. The Fault Detection Isolation and Recovery (FDIR) system represent a key to this respect. In order to design it, a very detailed step-by-step mission scenario needs to be defined for identifying potential risky situations. At every step of the mission, failure cases shall be determined and detailed, to understand what actions are needed for avoidance and/or recovery. When autonomy is desired, redundant components are added to the design. In this context, TU Delft has recently been involved in a number of case studies related to interplanetary CubeSat missions. One of them is LUMIO, a 12U Lunar CubeSat expected to be released in Moon orbit and autonomously transfer to a halo orbit around the Moon-Earth L2 point, aiming to characterize over a one-year period the micro-meteoroid impacts on the Lunar far side. TU Delft is a key member of the LUMIO consortium and has conducted detailed studies on the FDIR requirements of the mission during its Phase 0. This paper presents an extensive overview of the potential scenarios and recovery actions for the FDIR system design of a typical Lunar CubeSat mission. The LUMIO mission will be presented as study case: internal (hardware, software), external (background radiation, thermal environment) and human failures (e.g. wrong parameters inserted) will be analysed and discussed. Additionally, the paper presents a preliminary design of the proposed FDIR system, considering the current information and development stage. Recommendations are provided for further improving the proposed architecture and design a more robust FDIR system, aiming at providing maintainability for fully autonomous, miniaturized, standardized deep-space CubeSat platforms with limited Earth communication opportunities.