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IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems Verification and In-Flight Experimentation (6)

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STRATOSPHERIC VALIDATION FOR TRL ELEVATION OF HYBRID NAVIGATION SYSTEMS, TWO-PHASE COOLING SYSTEMS AND AI-ASSISTED ATTITUDE DETERMINATION FOR LAUNCH VEHICLES.

Abstract

The research and application of innovative technologies represents the basis for progress in the field of space exploration. However, the testing of these novel technologies in a space environment presents challenges, primarily due to the high costs associated with launching dedicated missions. For this reason, different solutions may be exploited to assess the implementation of new technologies as an alternative means to increase their Technology Readiness Level. Stratospheric balloons represent a possible platform able to deliver a harsh flight environment in which an experiment can prove its functionality and provide invaluable data. In this context, students from the S5Lab at Sapienza University of Rome are currently developing the RETINA (Real time Experiment for Thermal management Inertial Navigation and Attitude) stratospheric balloon experiment, aimed at performing four innovative experiments to increase their TRL for future space applications. The experiments on board will test the implementation of Artificial Intelligence (AI) algorithms for attitude determination using IMU data, data fusion algorithms for navigation using measurements from an array of low cost IMUs and the implementation of a miniaturized two-phase mechanically pumped loop cooling system. Furthermore, the first in flight demonstration of a Flexible Time Triggered Ethernet network for communication between on board devices will be performed. The data fusion and FTT-Ethernet experiments are developed by the Sapienza S5Lab and DIET within the NIBBIO research project coordinated by the Italian Space Agency (ASI) for the study and prototyping of hybrid-distributed navigation systems for launchers. The RETINA mission is set to fly in October 2024 within the context of the REXUS/BEXUS program on BEXUS 34. The project is jointly sponsored and supported by SNSA (Swedish National Space Agency), DLR (German Aerospace Centre) and ESA (European Space Agency). This paper discusses the implementation of the four experiments, highlighting challenges faced and design choices taken to ensure mission success, along with considerations on the system engineer's role in such projects, illustrating the work done to produce a robust design ensuring the compatibility and integration of different experiments in a single module with stringent weight and space constraints. Focus will also be given to the necessary risk mitigation strategies against critical interdependencies between experiments and a general analysis of all functional aspects of the mission. Tackling these challenges allows for an alternative solution for the validation of new technologies in relevant environments, elevating their Technology Readiness Level and paving the way for future use in space applications.