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STARSIM: A STAND-ALONE TOOL FOR "IN THE LOOP" VERIFICATION

Abstract

In the last decades, systems have strongly increased remarking the importance of defining methods and tools that improve the design, verification and validation of the system process: effectiveness and costs reduction without loss of confidence in the final product are the objectives that have to be pursued. Within the System Engineering context, the modern Model and Simulation Based Approach is a promising strategy because it reduces the wasted resources with respect to the traditional methods. Considering a wild range of simulations architectures and methods, crucial stages are defined by algorithm in the loop (AIL), software in the loop (SIL), hardware in the loop (HIL). This paper presents an in-house tool, developed at Politecnico di Torino, able to perform different simulation sessions in any phase of the space product life-cycle using a unique and self-contained platform, called StarSim: Modularity, flexibility, real time operation, fidelity with real world, ease of data management, effectiveness and congruence of the outputs with respect to the inputs are StarSim sought-after features. The main issue is to guarantee the possibility to verify the behavior of the system under test thanks to virtual models, that substitute all those elements not yet available and all the non-reproducible dynamics and environmental conditions. Progressively, pieces of the on board software and hardware can be introduced without stopping the process of design and verification, avoiding delays and loss of resources. StarSim has been applied for the first time on the e-st@r-II Cubesat, developed the "CubeSat Team Polito" within the ESA Education Office initiative called "Fly Your Satellite". StarSim has been mainly used for the payload development, an Active Attitude Determination and Control System, but StarSim's capabilities have also been updated to evaluate functionalities, operations and performances of the entire satellite. AIL, SIL, HIL simulations have been constantly performed, successfully verifying a great number of functional and operational requirements. In particular, attitude determination algorithms, control laws, modes of operation have been selected and verified; software has been developed step by step and the bugs-free executable files have been loaded on the micro-controller. Actuators, logic and electrical circuits have been designed, built and tested and sensors calibrated. Problems such as real time and synchronization have been solved, allowing, at the end of the process, a complete hardware in the loop simulation test for the entire satellite. The case study has allowed the successfully validation of the first release of StarSim.