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THE HIGH PERFORMANCE SATELLITE DYNAMICS SIMULATOR (HPS): A MODULAR MATLAB/SIMULINK-BASED SIMULATION LIBRARY FOR GNC SYSTEMS DEVELOPMENT

Abstract

The development and verification of Guidance, Navigation, and Control (GNC) systems demands the simulation of the system dynamics of space vehicles, their sensors and actuators as well as the prevalent environmental conditions and disturbances. The development and validation of such simulations can require a significant effort because of the technical and emergent complexity. Sustainable, reusable, and reliable simulation software is a key factor for time- and cost-effective project handling and for the conservation of expert knowledge.

The Department of Guidance, Navigation and Control Systems of the DLR Institute of Space Systems and the Center of Applied Space Technology and Microgravity (ZARM) at the University of Bremen are jointly developing the *High Performance Satellite Dynamics Simulator* (HPS). The HPS is a MATLAB/Simulink-based library of simulation models and tools for the simulation of space GNC systems and consists of more than 90 interconnected modules, which are steadily used and improved throughout the DLR and ZARM projects. One major application focus of these modules are science missions with a high demand for measurement and control accuracy. It has recently been used for modeling and simulation of MICROSCOPE, a satellite mission for testing the Equivalence Principle in space, and the development of the attitude control system for the life science satellite Eu:CROPIS.

Most parts of the HPS are planned to be released as open source software to the scientific community in the near future. The development of HPS modules is subject to a quality assurance process, which also comprises a comprehensive module documentation, the verification of modules with unit tests as well as their validation with real flight data, as far as possible. Selected modules are already prepared to be used in hardware-in-the-loop applications and automatic code generation scenarios, whereas enabling these capabilities for all other modules is envisaged. The HPS is not simply a collection of simulation models, it also provides a framework for an automated, platform-independent, modular build, execution, test, and verification environment for space simulation models that seamlessly integrates into MATLAB/Simulink.

This framework has also been developed to support plug & play functionality, which enables interchangeability of technically complex simulation scenarios.

This paper presents the general concept of the HPS Core, which is establishing the development and run-time environment for all scientific modules, describes the development process, the currently available simulation modules, and how simulations of GNC systems are built based on the example of a recent space mission.