IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Technologies for Future Space Transportation Systems (5)

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PRELIMINARY VERIFICATION STRATEGY FOR HYBRID NAVIGATION SYSTEMS (HNS) FOR REUSABLE SPACE TRANSPORTATION SYSTEMS

Abstract

The Department of Guidance, Navigation and Control Systems of the DLR Institute of Space Systems in Bremen is developing novel, autonomous Hybrid Navigation Systems (HNS), which overcome the limitations of conventional navigation systems by combining measurements of inertial and non-inertial sensors by methods of data fusion. They provide a long-term accurate navigation solution suitable for guidance and control purposes for reusable space transportation systems. HNSs are currently being developed in the frame of two Reusable Launch Vehicle (RLV) missions with different landing approaches: ReFEx (Reusability Flight Experiment), which is a DLR technology demonstrator for the development of key technologies for winged Vertical Takeoff, Horizontal Landing (VTHL) RLV, and CALLISTO (Cooperative Action Leading to Launcher Innovation for Stage Tossback Operation), a joint project of the French National Center for Space Studies (CNES), DLR, and the Japan Aerospace Exploration Agency (JAXA) for the development of a Vertical Takeoff, Vertical Landing (VTVL) RLV. The core technology is shared across these developments, but the specifically chosen sensor suite deviates significantly between the two

HNSs due to major differences of the mission requirements. The selected sensor suites comprise Global Navigation Satellite System (GNSS) receivers, a differential GNSS-based augmentation approach, Sun sensors, laser and radar altimeters, and Flush Airdata Sensing (FADS) systems as non-inertial sensors along with partially self-built Inertial Measurement Units (IMU).

This paper shortly introduces the current baseline design of the two HNSs under development and then focuses on a discussion of the desired global verification strategy for the entire subsystem and specific strategies for selected components in the following. The discussion is based on the verification plan established for the subsystem Preliminary Design Review (PDR) for both missions and provides an overview of the verification needs and applied verification methods on algorithmic, software, hardware, integrated system and system level as well as the identified verification constraints. We will also elaborate on the custom tools and testbeds specifically in development for testing and verification of these systems. The paper closes with a synthesis of the first verification results for some components and with an outlook on the planned verification program.