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DEVELOPMENT OF LAUNCH VEHICLE FLIGHT SIMULATION SOFTWARE TO VERIFY GUIDANCE AND CONTROL FOR HILS(HARDWARE-IN-THE-LOOP SIMULATION) TESTING

Abstract

Throughout the entire lifecycle of launch vehicle development, the flight simulation software plays a pivotal role, serving as a critical tool for system and component validation. It is employed in the Verification Validation process to assess the conformance of mission requirements to the performance specifications of the developed product and to evaluate the impact of mission specifications on the product's performance. This paper introduces **KARIMS**(**K**SLV-II **A**nalysis of dynamics, **R**eal-time environment for **I**ntegration, **M**odeling and **S**imulation)—a launch vehicle flight simulation software for attitude control verification and integrated simulation applications in the Korean launch vehicle development project—and proposes a direction for the development of next-generation flight simulation software to respond to future launch vehicle development needs. The development of launch vehicle flight simulation software entails the fulfillment of numerous requirements, including flight stability, computational performance, model fidelity etc. As a design tool, it is essential to facilitate precise evaluation of pivotal design indicators, such as guidance/control algorithm. In addition, as a verification tool, it must be equipped with requirements such as optimized computing performance, high model fidelity, and user convenience to ensure that product performance specifications and flight suitability evaluation process for the developed product can proceed smoothly. From these requirements, the Korea Aerospace Research Institute (KARI) has developed KARIMS Software for NURI(KSLV-II - the medium-lifted launch vehicle). The primary objectives of KARIMS are integrated software/hardware verification with guidance control, post-processing analysis of flight test results, and HILS test operation. This paper presents the simulation structure based on KARIMS software requirements, a high-fidelity numerical model, and the model configuration and simulation results for HILS testing. KARIMS software is utilized during the design process to evaluate flight control controllability and stability. Additionally, it is employed during the development process to verify the specifications of attitude control actuators. The software's functionality encompasses software simulation analysis that considers design parameter fluctuations in the performance specification and verification process. In the 2000s, the world's entry into the New-Space Era coincided with a call for reduced launch costs, reduced development and production costs, and the development of diverse future launch vehicles to ensure competitiveness in the space transportation sector. In support of these goals, KARI plans to enhance the use of flight simulation by expanding the capabilities of KARIMS to provide an integrated flight performance evaluation simulation environment capable of meeting diverse future launch vehicle requirements.