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A PARALLEL SIMULATION SYSTEM FOR SPACE OPERATIONS

Abstract

Parallel simulation is a significant application method, which takes the simulation system as an artificial system, and operates cooperatively with the actual system, interacts with reality, evolves together, and controls each other. It can be adopted to certify the mission design index as well as technical feasibility, and it relates to complex system simulation methods such as multidisciplinary coupling, multi-programming language modeling and spacecraft dynamic simulation etc.

Space operations, such as non-cooperative target capture, on-orbit maintenance and in-space assembly are the focus of the current research in recent years. This paper presents the design of a parallel simulation system for space operations mission verification. The designed system has the advantages of high generality and extensibility, being easy to build up new task and high fidelity of operations simulation. It is composed of spacecraft dynamic simulation system, space situation simulation system, visual display system and task management system. Functional Mockup Interface (FMI) Standard is used to achieve multidisciplinary models coupling and interactivity among the different modeling tools or programming languages. The system can be communicated with ground TTC system through network communication module and could receive on-orbit spacecraft TTC data as its operation parameters to do simulation experiments for on-orbit missions. It also has interface to access real-time data of physical experimental platform to build up a hardware-in-loop simulation. The task management system which loads, configures, and controls the simulation task process either in automatic or in manual mode, is the master control unit. The task process could be encoded with scripting languages (Python/C) and uploaded to the parallel simulation system to concurrently run with other FMUs (Functional Mockup Units) and control the FMUs through parameterize or access FMU interface. Unity3D/OpenSceneGraph is adopted to implement the visual display system which includes space environment display, flight trace display and space operation display. With this system, space mission sceneries could be built efficiently by defining composition of spacecraft, parameterize space environment, scripting mission procession, and configuring visual scene. The final

section of the paper took a typical space operation mission about a dual-arm space robot capturing an on-orbit target to demonstrate the functions of the parallel simulation system.