A Real-time HWIL Simulation Control System Architecture for Implementing Evaluation Environment of Complex Embedded Systems

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Abstract— the complex embedded systems used in aircraft and guided weapon systems have complex tasks and diverse I/O interfaces for controlling the interconnected slave systems. Some complex systems consist of many embedded systems which are closely cooperated each other to perform designated mission. Hardware-in-the-Loop(HWIL) simulation system of complex embedded system suppose to be implemented as a complex system, which has a complex software architecture and hardware configuration, because it needs to support real-time computation of complex embedded system models within a strictly constrained time interval and real-time I/O interfaces. With the HWIL simulation system, the users may run HWIL simulation on the various test scenarios and may implement many sorts of software in accordance with the test scenarios. Therefore, it should have the well-designed software architecture to provide convenient way for developing HWIL simulation environment and support real-time control environment. It also should support interactive simulation control and real-time data acquisition capabilities to provide simulation state control and data analyzing environment. This paper suggests layered HWIL simulation control system architecture, which comprises I/O device driver, I/O library, HWIL Simulation control executive, and application, for building evaluation environment of the complex embedded system. In this architecture, real-time control mechanism using internal CPU timer is included. It, also, suggests two protocols, named Command Processing Protocol (CPP) and Multi-rate Data Acquisition Protocol(MDAP), for interactive simulation control and real-time simulation data acquisition. The proposed architecture is implemented as tasks based on the Commercial Off-The-Shelf (COTS) real-time operating system which runs on the computing processor installed on VME bus platform.

Keywords— HWIL Simulation, Real-time Control, Software Architecture, Data Acquisition, Embedded System