

REAL-TIME SOFTWARE-IN-THE-LOOP SIMULATION FOR CONTROL EDUCATION

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ABSTRACT. *This paper suggests a real-time implementation method for software-in-the-loop (SIL) simulation for control systems, primarily for control education. The SIL simulation is carried out by using a PC for the controllers, a PC for the plant, an open network, and a general-purpose computer-aided control system design (CACSD) package. Specially, Ethernet network is investigated in terms of control issues such as sampling interval, network-induced time-delay, use with many I/O points and data synchronization. A performance evaluation of software-in-the-loop simulation is made with respect to a computation delay and a sampling interval. To reduce the effects of the time-delay, particularly for fast plants, we introduce a time-scaling method that leads to a slow motion. It is demonstrated that this real-time SIL simulation will be very useful, particularly for control education.*

Keywords: Software-in-the-loop simulation, Control education, Computer-aided control system design (CACSD)

1. Introduction. The design and analysis of control systems require algebraic or numerical computations, various plots, and commonly used mathematical algorithms to satisfy given performance specifications. Many computer-aided control system design (CACSD) packages have been developed for the design and analysis of control systems, and have emerged as indispensable tools [27-30]. They are widely used at universities and research centers for control education and research [1-8].

In real control systems, the controller and plant are located apart from each other and exchange, in real-time, several analog signals for continuous variables and a few digital signals for event variables. However, most CACSD packages run in a single personal computer (PC), where a plant and a controller are simulated together and hence some practical problems from their connection or communication cannot be simulated. These existing packages are not real timed and far from reality.

An approach to simulate real control systems is to provide some systems in which the simulated plant and the simulated controller can be connected to each other and run in two personal computers in real-time. We call the method software-in-the-loop (SIL) simulation compared with the hardware-in-the-simulation [9-11], because only software exists in the control loop. A SIL simulation is particularly useful for control education because real control experiment systems are too expensive for large classes in big universities.