Hardware-in-the-loop testing using 20-Sim 4C

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Figure 1: Drill string compensator (20m tall)

Introduction

The manufacturers in the offshore drilling industry are faced with an increased level of automation and shorter deadlines for project completion. The majority of the equipment is special purpose machines made in small quantities. This results in limited time for testing before the equipment is handed over to the customer. In addition, there are high financial risks associated with these complex machines. The harsh environment the equipment has to be operational in makes it important to have durable and well tested systems.

HiL simulation

The University of Agder in Norway, together with the industry partner Aker Solutions, have developed a Hardware-in-the-Loop (HiL) testing environment for a typical machine, the drill string compensator, shown in Figure 1.

The dynamic behavior of the machine is simulated in real-time, and the actual control system to be used on the rig can be developed and tested even before the machine is built. Tests which are too expensive or dangerous to perform with the real machine can be simulated.

The software architecture used for the HiL test is illustrated in Figure 2, where 20-Sim 4C is used for communication between the modelling software running on Windows and the hard, real-time system running on a Linux operating system. The real-time operating system finally communicates with a Siemens PLC through TCP/IP communication.
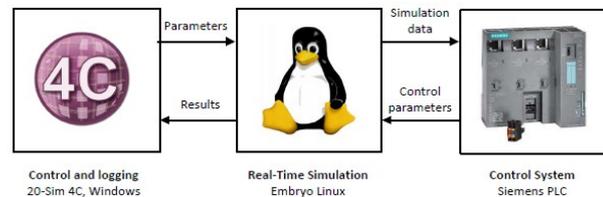

Figure 2: Software architecture for the HiL system.

Results

The results of the HiL test are illustrated in Figure 1.. The system is capable of keeping the crown block of the compensator stationary within ±5cm. The external wave-induced motion of the platform in the simulations equals a multi-frequency sine-wave with an amplitude of 1.75m. The pressure on the seabed has been kept within the specified limitations. The overall model contains 20 states and the simulation model accounts for less than 10% of the CPU load at 1ms sampling rate on a standard desktop computer.
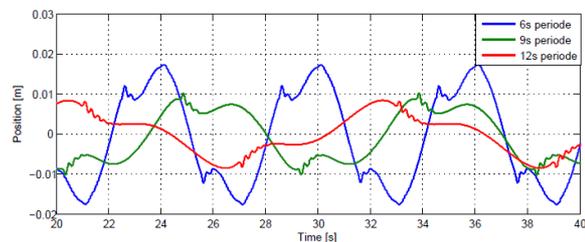

Figure 3: HiL test results.

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