Hardware in the Loop Testing of DP Systems

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Abstract

Systematic testing of DP system functionality, performance, and failure handling is increasingly important as the software and hardware complexity of DP system installations grow. Hardware-in-the-loop (HIL) simulation testing is widely used in other industries in order to test the hardware and software of computer-based control units. This paper reports on a pilot study on HIL testing of DP systems. A DP-HIL vessel simulator is a real-time simulator which is directly interfaced to a DP computer system. It calculates the vessel motion in response to simulated environmental conditions, failure modes injected by the user, and thruster commands received from the DP computer system. Based on the calculated motion of the simulated vessel, it also simulates on-board systems and equipment such as the power system, thrusters, sensors and position reference systems and transmits the corresponding sensor and status signals back to the DP computers. Compared to a built-in training simulator, a DP-HIL vessel simulator is distinguished by capability of significantly more detailed simulation of failure modes. The benefit of such as test setup is that the DP control system can operate in closed loop during Factory Acceptance Test (FAT) and commissioning. The level of DP computer system testing at FAT and commissioning will therefore be comparable to a sea trial as the DP control system will be exposed to a wide range of operational modes, complex failure modes and sea states already at FAT.   A hardware-in-the-loop FMEA simulator can be interfaced to the DP computer system installed on-board the vessel, in order to test failure handling and alarm functions of the integrated DP system. During a dock or sea trial, the FMEA simulator can modify the original signals and insert dirty signals at the input or output of the DP computers. The benefit of this test setup is that systematic Failure Mode and Effect Analysis (FMEA) of a wide range of integrated software and hardware functions can be tested efficiently with increased test coverage and with non-destructive and complex hardware failure simulation. The CyberSea Simulator is an advanced integrated system simulator for HIL testing of DP systems (DP-HIL). The real-time vessel simulator is based on state-of-the-art models of hydrodynamics, thrusters, power system, sensors, and position reference systems, including more than one thousand of single point failure modes in addition to common mode and multiple failures. This paper present the new DP-HIL simulator concept and technology, and reports how practical testing of DP computer system hardware and software can be carried out.

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