ODIM Launch and Recovery System simulator

Rolls-Royce Marine

Introduction

For companies developing and supplying equipment to the offshore industry, the degree of success is highly dependent on the reliability of delivered systems in operation. This comprises both operability and safety functions, and hence control systems need to go through extensive testing before being installed on new or existing systems. The possibility for testing a system in full scale before it is installed at the work site is often limited, and thus extensive testing is required on-board a vessel or a rig. Limiting the scope of work and time used for testing is important in such cases, due to limited access and cost of on-site testing.
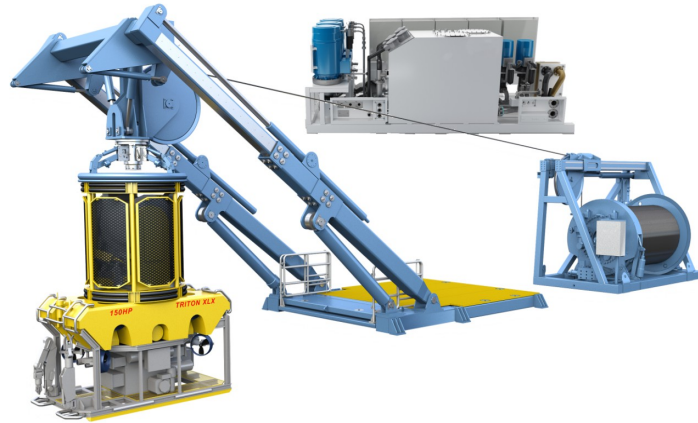

Figure 1: The ODIM Launch and Recovery System for remotely operated vehicles.

Two Master students at the Aalesund University College, in cooperation with Rolls-Royce Marine, have developed a simulator replacing a full scale launch and recovery system. The purpose of this thesis was to come up with a concept for a simulator which could be used for testing control system hardware and software for a launch and recovery system. This is a system used on vessels during subsea operations for handling remotely operated vehicles from deck to working depth, mainly consisting of a hydraulic power unit, a winch and a handling unit; typically an A-frame. These components were to be replaced by a simulator.

Concept

Through the work of a pre-study, an idea of how to build a simulator to fit this purpose was developed as illustrated in figure 2. A numeric model of the launch and recovery system was to be made using 20-sim and implemented on a Bachmann M1 controller for real-time simulation. The simulator would be interfaced with the existing control system and accept commands and provide feedback representing the response of the launch and recovery system.
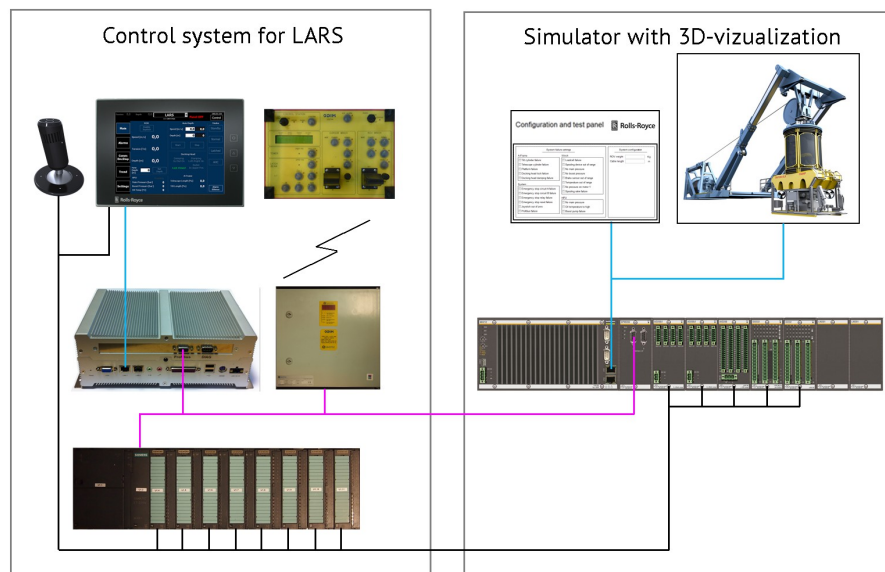

Figure 2: The simulator concept.

20-sim model

A numeric model was developed for the system including a hydraulic power unit, winch and A-frame, as illustrated in figure 3. The numeric model comprised the hydraulic and mechanical dynamics of the system, and in addition an interface to the control system was implemented. For the mechanical domain, models representing a remotely operated vehicle and the umbilical connecting it to the winch were also created.
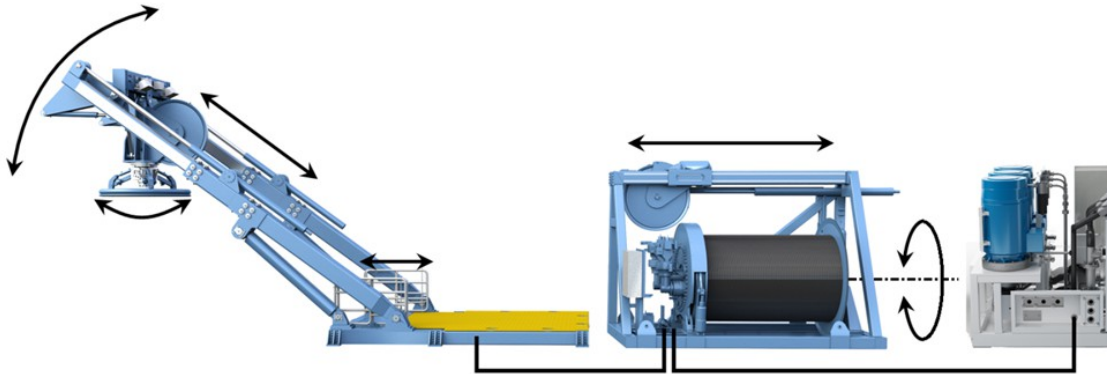

Figure 3: The modelled system.

The numeric models were implemented with bond graphs by means of the 20-sim software from Controllab. Bond graph modelling is a method to graphically describe the dynamics of a physical system. It is based on modelling energy flows, and allows an easy adaptation of the level of detail appropriate to the model's purpose. This was crucial as the model was required to simulate system behavior in real time.

Simulator hardware

An embedded hardware solution running the simulator and control system as a stand-alone unit was built to test if the concept would work as intended. To keep the interface to the simulator as equal as possible to the real system, all interface components used in the existing control system were maintained. This was done to maximize the validity of the results when using the simulator for control system testing. To reduce the physical size of the control system hardware, some signals normally transmitted by means of conventional IO were transferred to ProfiBus. By this approach, the differences between the control system software used for the real system and the simulator came down to mapping of signals between conventional IO and the ProfiBus interface. As both mentioned technologies for signal transmitting were already used in the existing control system this provided for a flexible solution for testing, as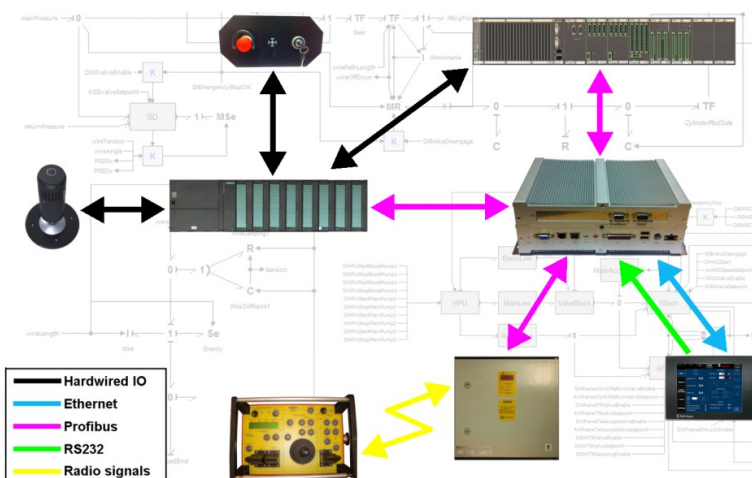 which signals are transmitted through the different communication methods could easily be changed. The operator interface consisting of a radio remote and an operation control panel including a graphical user interface was kept unchanged and connected to the control system. The simulator hardware topology is illustrated in figure 4. Disregarding the requirement for mapping of IOs, no changes were needed to the control system software. This is important when using the simulator for control system testing, as changes made to the software after testing it in a simulator environment before implementing it on a real system is a potential root for failure.

Figure 4: The Control system topology.

Visualization in 20-sim 4C

Observing the system is the most important source of feedback to the operator when handling a remotely operated vehicle, and to cover up for this visualization of the numeric model was required. The 20-sim software includes a 3D animation feature which was used to build up a graphical model of the launch and recovery system from STL-files, which can be exported from most 3D CAD tools. 20-sim 4C was used to link data from the numeric model to the graphical model during run-time, providing for real time motion of the latter during simulation. 20-sim 4C was also used to export the numeric model from 20-sim to the Bachmann M1 controller and to set up mapping between model variables and the simulator IO interface.
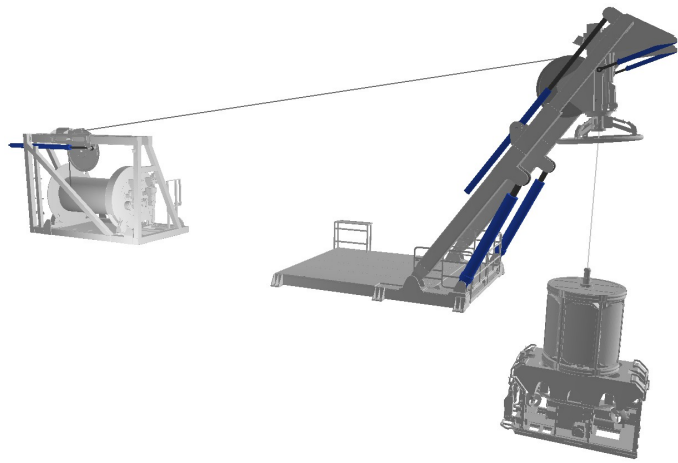

Figure 5: Graphical representation of the simulated system.

Results

Several tests were performed to check if the developed solution was fit for purpose. The results from testing the simulator concept verified that it can be used for control system testing with respect to both hardware and software. Data logged during testing showed it can be also used for benchmarking as regards to system performance, as results from simulation corresponded well to previously measured performance of the real system in operation at sea. En example of data logged by the simulator during an active heave compensation performance test is shown in figure 6.
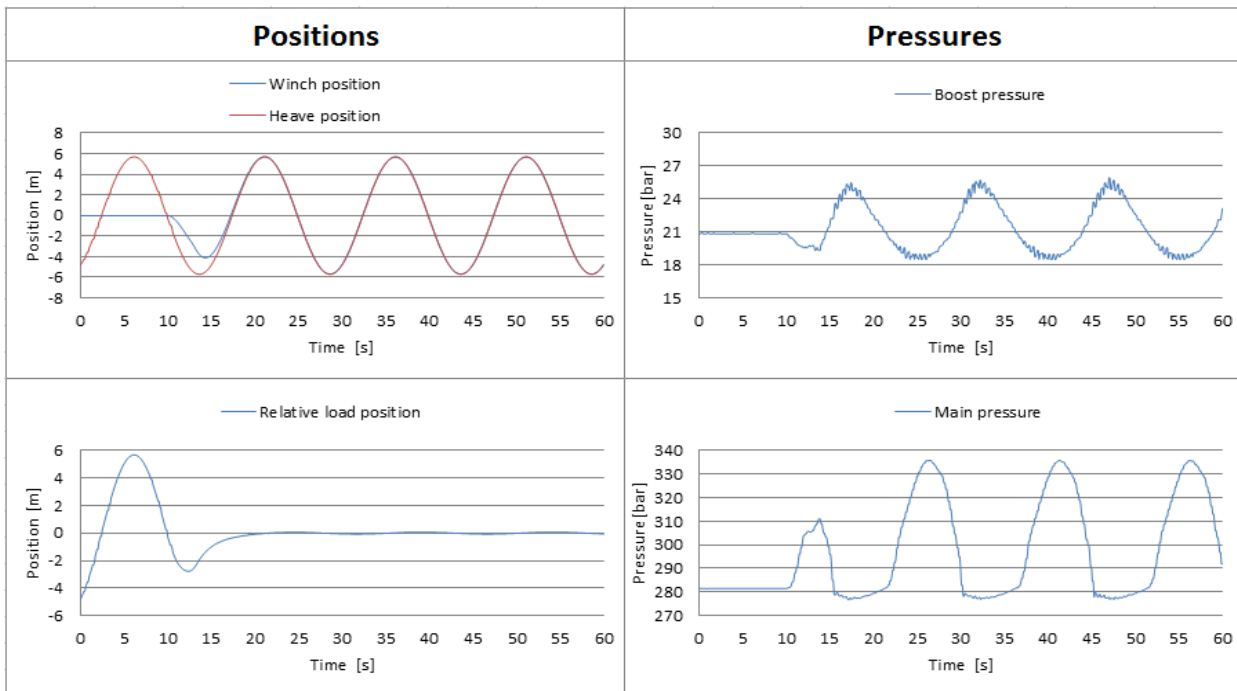

Figure 6: Active heave compensation performance test.