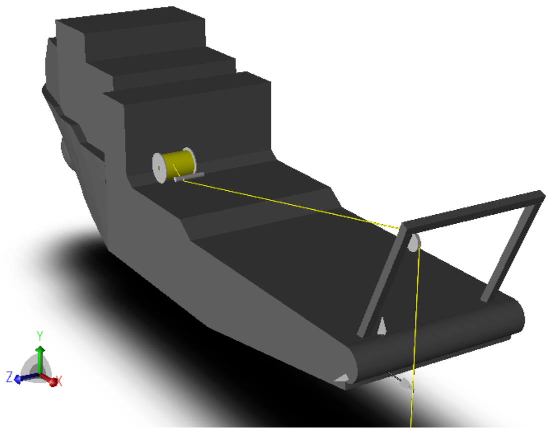
1. Introduction

SimulationX® is graphically based software for modeling and simulation of dynamic systems. The software is developed by ITI GmbH in Germany and has been well received in the offshore industry because of its extensive library, simple user interface and high flexibility. This article describes a simulation model of a hydraulic actuated winch system in SimulationX® 3.5 using a combination of libraries available in the software. The winch system is set to work within a specific load range controlled by hydraulic valves.



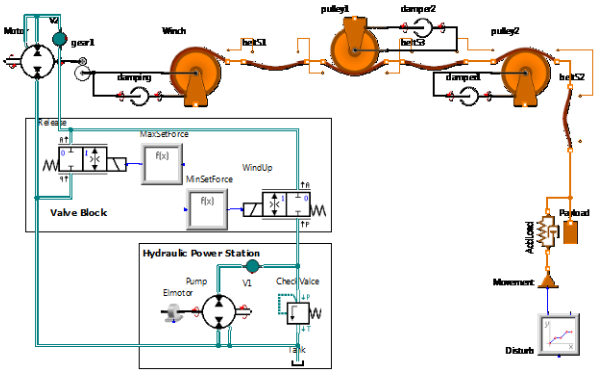
Both hydraulic and electrical actuated winches are widely used on ships and in the offshore industry; such as, anchor winches, towing winches, trawl winches, etc.

The figure above shows a three dimensional simulation model in SimulationX® of a typically constant tension system guided by an A-frame. The winch is holding a payload in the sea. In this example the winch shall supply a force on the wire within a given range. See animation here.

Even though this is a quite simple mechanical system it poses some challenges in dimensioning the hydraulic (or electrical) drive system and developing control algorithms especially for systems with more advanced control like heave compensation.

2. SimulationX® Model

A system model of the winch system, including the hydraulic drive, in SimulationX® is shown below.

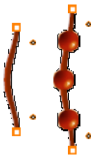


The model contains a combination of elements from the Hydraulic, 1D Rotational Mechanics, 2D Planar Mechanics, 3D MBS Mechanics and Belt Drives libraries together with control signal boxes. The winch is connected through a gearbox to a hydraulic motor. The two valves are controlled by a sensor measuring the torque on the winch and they either bypass the motor or supply oil to wind-in the winch.

The libraries in SimulationX® allow the user to develop interdisciplinary simulation models fast and efficient. The Belt Drives library includes elements for modeling wire systems and belt drives. Some of them are briefly described here.

The winch element can be parameterized with a mass, moment of inertia and a drum diameter. The wind-in kinematics is formulated so that the relation between rotational speed and the winding velocity correlates to the drum diameter, wire thickness, number of windings per layer and the length of the already wound-in wire. The winch can be driven by any rotation motor element in SimulationX®.

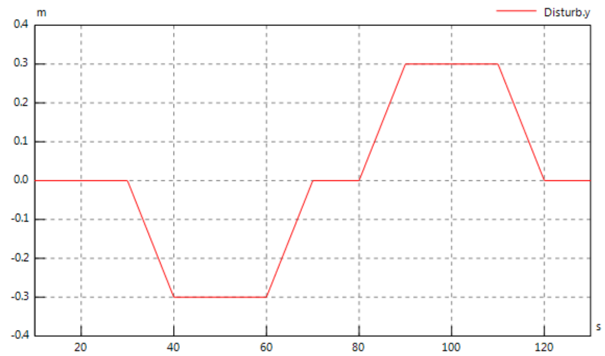
The sheave element can be parameterized by inertia properties and diameter. In addition there is an option to include slip between sheave and wire. For both winch and sheave it is possible to introduce damping or friction by connecting the two black lines through a damper or friction element from the Rotational Mechanics library.



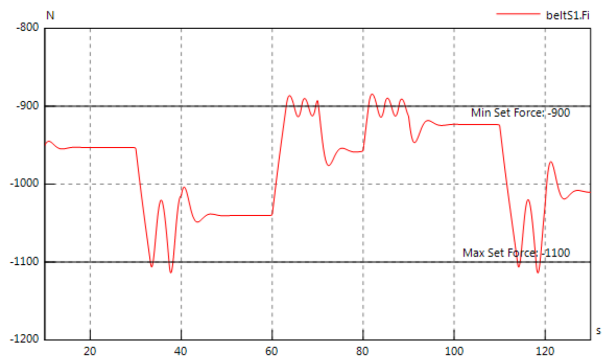
Two kinds of wire exist in the library. The first is a mass less wire specified by a stiffness constant (E-modulus times cross section area) and a damping factor. The second is furthermore specified by a distributed density (mass per length). The length of each wire section is calculated automatically and continuously updated during simulation if the sheaves are moving relative to each other. Hence, all kinematic relations including compliance of the wires are handled by SimulationX®.

3. The system analysis

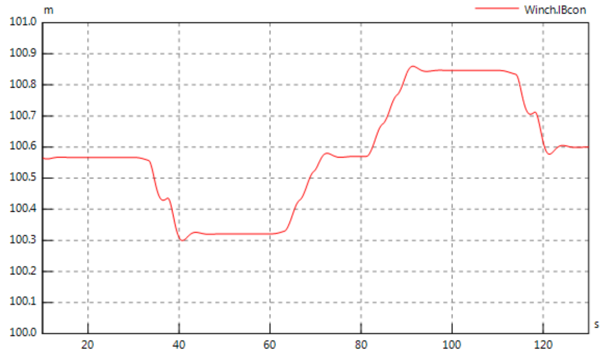
In this example the winch is holding a payload subsea. Due to subsea operation the payload is moving relative to the A-frame on the boat which is shown in figure below.



This results in force variation through the wire and into the winch. The hydraulic valves are adjusted to keep a range between 900kN and 1100kN. If the wire force during operation goes below or above the range the valve will either wind-in the drum or release more wire. The figure below shows the force variation in the wire and the range is marked by the black lines.



On the figure below the length of the wound-in wire is plotted during the operation. Due to activation of the valves wire is released or wound-in.



It is here demonstrated how SimulationX® can be applied for simulating winch systems. The model can easily be changed and expanded to i.e. a electrical drive instead. And more complex control algorithms can be tested through simulation.

SimulationX® simplifies the modeling and simulation and makes this technique available for more engineers. The systems can be virtually tested and the system limits can be identified without the risk of damage and the high cost of physical tests. SimulationX® facilitates a variety of co-simulation and code export opportunities; MATLAB/Simulink, SIMPACK, SCALE-RT, dSPACE, NI VeriStand, NI LabView, Modelisar FMI, etc. Hence, the user has all kind of possibilities to interface with other simulation software or to interface with i.e. controller hardware. SimulationX® can then be used in pilot studies as well as the hardware test of i.e. controllers.

It is important to remember that no software can ever be so good that system knowledge is no longer necessary. If SimulationX® is used together with good system knowledge in the design process; it will give the end user better and more stable systems and also more optimized systems for the system producers regarding cost/performance.

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