An Object-oriented Hybrid Approach to ARGESIM Comparison "C13 Crane and Embedded Control" with AnyLogic

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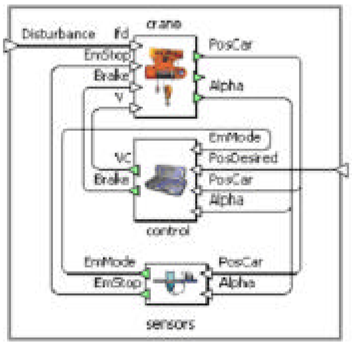
Simulator: AnyLogic (www.xjtek.com) is a general-purpose simulation environment for discrete, continuous and hybrid systems. It employs UML-RT structure diagrams for building hierarchical models in object-oriented way and *hybrid statecharts* for behaviour specification. The generated model is Java and can be extended with user's Java code. The simulation engine handles discrete events and dynamically changing sets of algebraic-differential equations. It automatically detects "change" (or "state") events. Debugging and visualization facilities are present.

Model: The model was intuitively decomposed into the following blocks: crane, control and sensors.

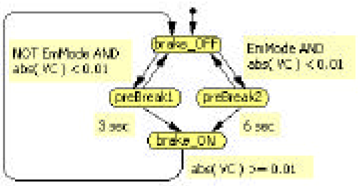


The **crane** object consists of the crane- mechanics and the DC-motor. The mechanics of linear and nonlinear systems, as well as the DC-motor were implemented plainly using given equations. The **control** block generates voltage for the motor and switches on/off brakes, whereby discretisation is implemented by triggering the block with the sampling time. This object receives information about **car status** and **car desired** position. The **sensors** object implements checking and control of any emergency modes.

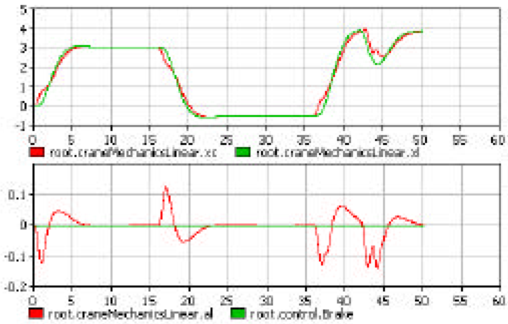
Task a: Comparison of uncontrolled nonlinear and linear model. The following table shows the differences of linear and nonlinear model in X_L:

Disturbance	-750	-850	-800
ΔX_L	-150	-265	-389

Task b: Simulation of the controlled system. Brake control was implemented in the control block using statechart notation (see figure left). If the condition for activating the brake is true it switches to the **preBrake** state.



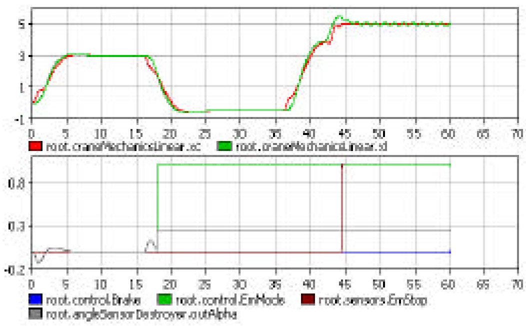
If condition will be true for the specified time it will pass to the **brake_ON** state, activating the brakes.



The above figure shows the diagrams for the variables **PosCar**, **PosLoad**, **Angle** and **Brake**. As follows from the diagram the brakes are not activated during operation. Thus the brakes activating condition may be too strict.

Task c: Simulation of controlled system with sensor diagnosis. Diagnosis was implemented as follows: imagine a status function F of the sensor: F = 0 then sensor is valid, F = 1 otherwise. Let integrate this function for a 100 ms time window (it is possible to integrate a difference of F and 100 ms delayed F). The result will be a total time when the sensor status was invalid during 100 ms. An EmergencyMode will be switched on if the result is greater than 50.

The following figure shows the transient diagrams for **PosCar**, **PosLoad**, **Angle**, and states the time instants of break-on, emergency-mode and emergency-stop events. The system switches to Emergency-Mode at t = 18.05 and Emergency Stop is triggered at t = 44.4798.



C13 Classification: Object-oriented / Hybrid Approach

Simulator: Anylogic V.4.5