A Classic CNS - Solution to ARGESIM Comparison "C13 Crane and Embedded Control" using MATLAB

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Simulator: MATLAB is a widely used software tool based on numerical vector and matrix manipulation. Simulink is a graphical extension for block oriented simulation. S-functions provide a mechanism for extending the capabilities of Simulink by adding user defined blocks. The functionality of these blocks is written in an m-file or other programming languages like C, FORTRAN or Ada.

Model: SIMULINK was used to implement the DC-motor and the mechanics of the linear and the nonlinear system. It was forced to use a fixed step algorithm (Euler) with a step wide of 0.0001 for numerical integration. The goal was to get a comparison between the results obtained by a more sophisticated solver (ODE23s: see SNE 31). The main problem for the SIMULINK model in task b and task c is based on the different sampling times, managed by classical `zero-order hold` and `unit delay` blocks.

Task a: Comparison of uncontrolled linear and nonlinear model. The implicit nonlinear model was transformed to a simplified explicit model. The next table shows the position differences for different loads.

Disturbance	-750	-800	-850
Difference	-145	-246	-356

Task b: Simulation of the controlled system. For the controller the Discrete-State-Space – block was used and 'zero-order hold' and 'unit delay' blocks were implemented (fig. 1)
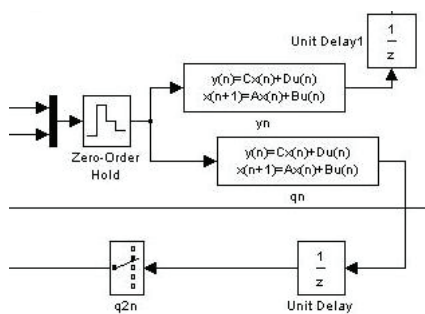

Fig. 1: SIMULINK model for discrete control

The reason was to compensate the slower sample time of the controller (0.01). Fig. 2 shows position of the car and the load, activation times of the brake (t = 15.34, 31.7 and 56.7 sec) and the angle of the cable
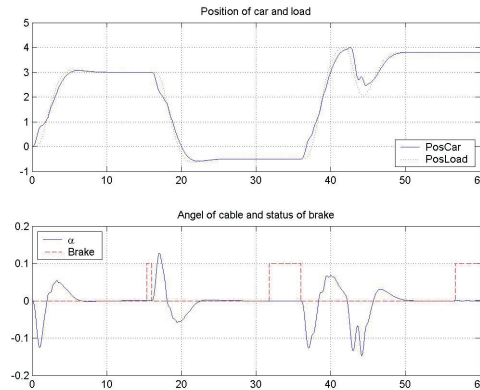

Fig. 2: Results controlled movement with brake action

Task c: Simulation of controlled system with sensor diagnostics. Brake control and sensor diagnosis were modelled by two s-functions, the latter one called every 2 ms. the status of the angle sensor is stored in a vector. Each call fills one cell of this vector with a 1 and updates it with the current status of the sensor. If the sum of ones is greater than 25, Emergency Mode is triggered.

The whole system goes into Emergency Mode at t = 18.00, brake was switched on at t = 15.34 and 34.93 and Emergency Stop is triggered at t = 44.44. Fig. 3 shows the results graphically.
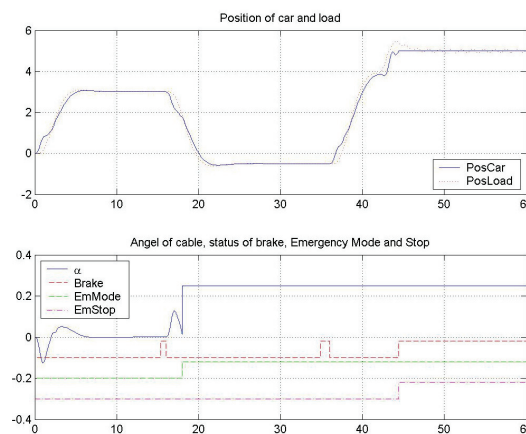

Fig. 3: Results controlled movement with sensor diagnosis

C13 Classification: Classical CNS Approach
Simulator: MATLAB / SIMULINK Rel. 13, 2003