REPORT
ME2400 Simulink Project

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Introduction

The task was to simulate the generalized axis model for a cnc machine using the information and data given in the paper "Identification of 5-Axis Machine Tools Feed Drive Systems for Contouring Simulation".

From the paper, the equation of the model obtained is:

$$(s^2 + a_1 * s + a_2 + a_3/s) * x(s) = (b_0 * s^2 + b_1 s + b_2 + a_3/s) * x_r(s) - \text{sgn}(dx/dt) * d_c$$

Where a_1, a_2, a_3, b_0, b_1, b_2, b_3 and d_c are the model parameters. Actual Values of which are provided in the paper.

Model Parameters	Actual	PSO Estimate
a_1	238.4335	226.94681
a_2	48421.5859	49915.0545
a_3	2.487140.30	2778130.868
b_0	0	-0.05340
b_1	117.5424	104.366781
b_2	37258.9796	37446.2295
d_c	2.6815	585.31

Closed loop transfer function obtained between commanded (x_r mm) and actual position (x mm) is:

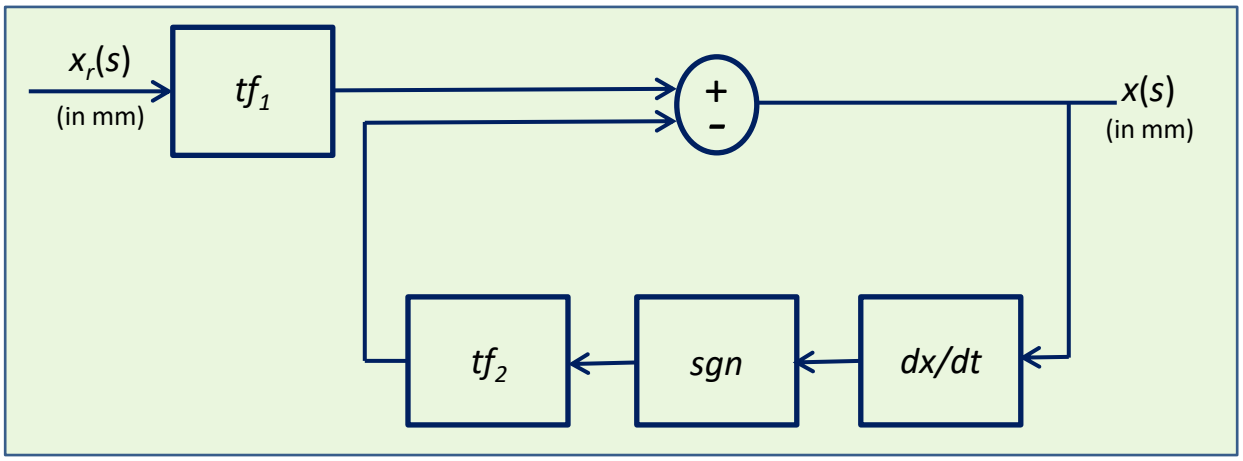
$$x(s) = \underbrace{\frac{(b_0 * s^2 + b_1 s + b_2 + a_3/s)}{(s^2 + a_1 * s + a_2 + a_3/s)}}_{tf_1\ \{G_{track}(s)\}} * x_r(s) - \underbrace{\frac{1}{(s^2 + a_1 * s + a_2 + a_3/s)}}_{tf_2} * \text{sgn}(dx/dt) * d_c$$

------ equation(1)

This function is used to simulate the model in Simulink.

Simulation

Block diagram for simulations:



The model parameters are stored in model workspace in Simulink file and is used in tf_1 and tf_2 blocks.

Steps in simulation:

The input signal (commanded axis position) x_r is obtained in the form of ramp block. It is then passed through the transfer fcn block, which multiplies x_r with tf_1. Thus we obtain the first part of RHS of the equation 1.

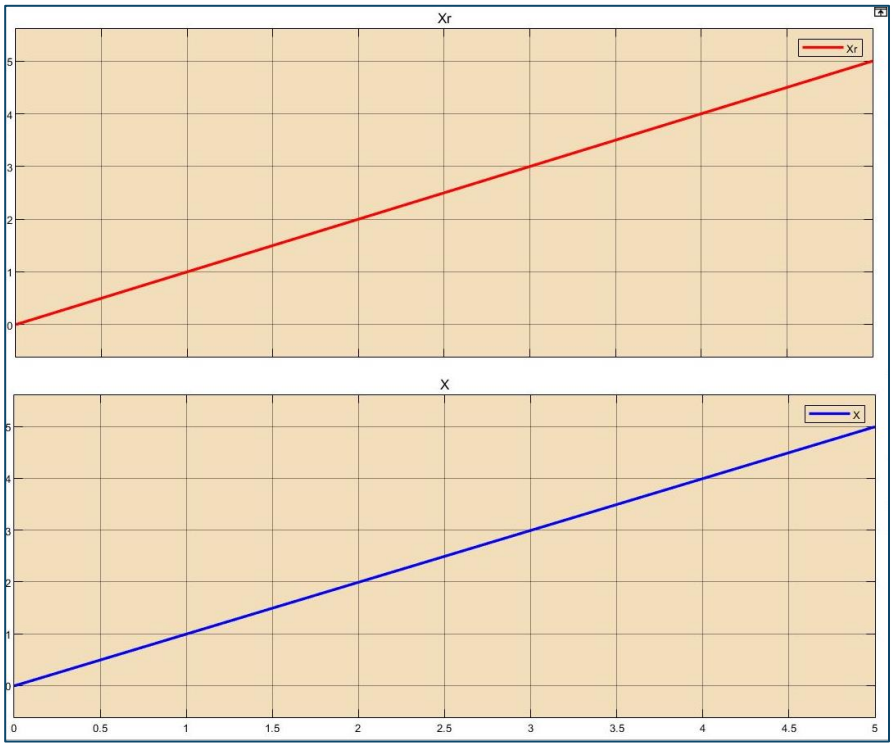
This modified x_r signal is then passed via sum block (sign of 2nd terminal changed for subtraction). The output obtained from this block is the x signal (actual axis position).

A branch of the x signal is passed via derivative block (Dx/Dt) to obtain x_dot. It is then passed via signum block (Sgn) and transfer fcn block (tf_2) to obtain the second part of RHS of the equation 1. This obtained signal is connected to the negative terminal of sum block to complete the loop.

The output signal x and input signal xr is then compared using scope block.

Results & Conclusion

Equation 1 is simulated using Simulink, where a ramp of slope 1 is used as input. Simulation time was limited to 5s. The following result is obtained from scope.
x_r is the input and x output.



The generalized axis model for a cnc machine is simulated and the results are obtained. From the results, the commanded and the actual axis positions are identical.