Integration Project Systems and Control (SC42035)
Container Crane Experiment

Description

Figure 1 shows a schematic drawing of an overhead crane. A trolley with mass M is driven by a DC motor with input u such that it travels in the lateral direction on a rail. The trolley carries a container of mass m. The container is attached to the trolley by a cable of variable length l. A second DC motor drives the hoist system.

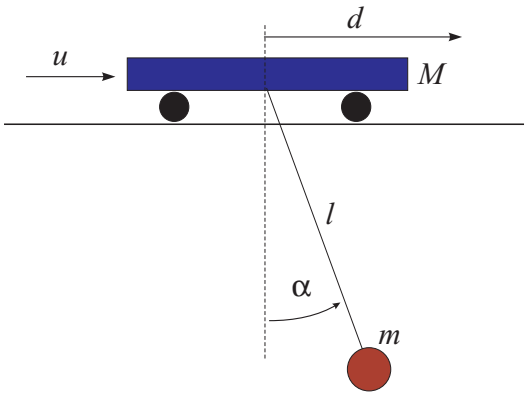

Figure 1: A schematic diagram of the container crane.

This system has one control input u, which is the reference to the motor control loop, aimed to control the velocity of the cart. This input u is commanded from the computer and is scaled between -10 and +10. There are three measured outputs: d – the position of the trolley, α – the angle between the cable and the vertical and l – the cable length. The parameters are given in the following table:

Table 1: Physical parameters and their values.

Symbol	Parameter	Value
M	trolley mass	$0.95\,\mathrm{kg}$
m	container mass	$1.30\,\mathrm{kg}$
l	cable length	0.20 to $1.20\,\mathrm{m}$
k_m	motor gain	$-10\,\mathrm{Nm}$
b_1	motor and trolley damping	$10\,\mathrm{kgs}^{-1}$
b_2	cable hinge damping	$0.75\,\mathrm{kgs}^{-1}$

The values of the parameters k_m, b_1 and b_2 are approximate and must determined by means of experiments.

Control Objective

Design an anti-sway controller. The controlled system should be able to quickly follow a reference for the trolley position (given by the joystick or using a predefined signal), while minimizing the container swing. You can start with a constant cable length and, if time permits, design also a controller for the cable length.

Simulink Template

A Simulink template `cranetemplate.mdl` contains the necessary real-time interface blocks and some scopes. Make your own copy of this file and use it as a starting point for your experiments. Before starting the first simulation, define the sampling period h as a variable in the workspace of MATLAB.