Integration Project Systems and Control (SC42035)
Ball & Beam Experiment

Description

The ball and beam setup consists of a beam actuated by a motor and a ball. The motor can change the angle of the beam. The ball is rolling on the beam. The objective is to control the motion of the beam to position the ball. Figure 1 shows the setup.

Figure 1: Photo of the ball and beam setup.

This system has one control input u, which is the voltage driving the motor. This input is commanded from the computer and saturated to -10 and +10.There are three measured outputs: d – the displacement of the ball in millimeters relative to the center of the beam, α – the angle of the motor in radians, and $\Delta\alpha$ the relative angle. Some physical parameters of the system are listed in Table 1. Most of the values can easily be determined by measuring the dimensions and masses.

Table 1: Physical parameters and their values.

Symbol	Parameter	Value
l_b	beam length	42.55 cm
l_l	lever arm length	12 cm
l_s	support arm length	16 cm
r_b	ball radius	1.27 cm
m_b	ball mass	0.064 kg

Control Objective

Design a controller that makes the ball follow a specified reference trajectory for d. The controlled system should have zero steady state error in d and adequate disturbance rejection properties, i.e., it should be able to recover from a small tick against the ball.

Simulink Template

A Simulink template `BandB.slx` 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.