Integration Project Systems and Control (SC42035)
Helicopter Experiment

Description

The 'helicopter' setup consists of a beam attached to a fixed pole. The beam can freely rotate in the horizontal and vertical planes. At both ends of the beam, DC motors with propellers are attached. One motor is used to control the vertical angle (elevation), the other one the horizontal angle (azimuth). The objective is to control the motors such that attitude of the beam follows a specified reference. In a simpler version of this experiment, the beam can be locked in a fixed position in the horizontal plane and only the vertical angle is controlled by using one propeller. The schematic diagram in 1 shows the construction of the system including the relevant variables. Positive directions of variables are indicated by arrows.
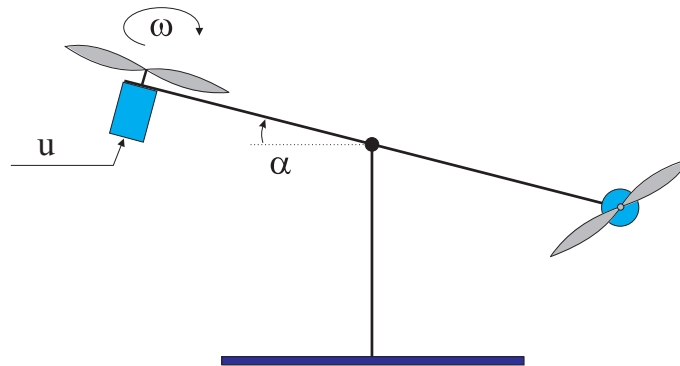

Figure 1: Schematic drawing of the helicopter setup.

For each angle, this system has one control input u, which is the voltage applied to the respective motor. This input is commanded from the computer and is scaled between -1 (corresponding to the maximal voltage making propeller and the beam rotate in the negative sense) and +1 (corresponding to the maximal voltage making the propeller and the beam rotate in the positive sense).

There are two measured outputs: ω – the angular velocity of the propeller, and α – the angle of the beam. The measurement of ω is scaled between -1 (corresponding to the maximal negative velocity) and +1 (corresponding to the maximal positive velocity). You will need to calibrate those measurements to correspond to their physical units, e.g., radians. The sensor offsets and gains are defined by the script `hwinit.m`. Unfortunately the Simulink file that comes with the setup works only with Matlab version 2014 or 2015. You can use the `m`-files that are given as a template as well to communicate with the setup.

Control Objective

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

Simulink Template

A Simulink template `helitemplate.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 MATLAB workspace.