Laboratory Experiment III: Implementation of a Position Controller

MTRN3020 Modelling and Control of Mechatronic Systems

Abstract

This document is complementary to the position controller design guide you may have used to design the position controller. A brief explanation of the experimental set up and the required content of the report can be found in this document.

1 Experimental Setup

The experimental set up consists of a motor that drives a revolute joint via a gear box. The motor is mounted vertically, inside a safety box and carries an arm that can be extended or shortened along an axis that is perpendicular to the axis of rotation of the motor. The inertia of the revolute joint can be changed by changing the extension of the arm.

The control input to the system is the voltage to be applied to the motor. To generate the applied voltage, a pulse width modulation (PWM) amplifier is used. Hence, we can consider the controller output as the input to the PWM amplifier. Therefore the units of the output of the controller you would design is "PWM Units". The controller makes its decision based on the error in speed. To complete the position control loop, position feedback loop is created and the desired speed for the speed controller is determined based on the position error.

The motor has two encoders, one on the input shaft and another on the output shaft of the gear box. As the point of interest is the output shaft, the position controller loop uses the output shaft encoder. The encoder on the input shaft is used to obtain the shaft speed for the speed controller. The gear ratio of the gear box is 34.8 : 1.

2 The Experiment

The following two parts form the experiment.

2.1 Part A - Design Verification

This part is designed to verify if you have carried out the position controller design correctly. The design is correct, if the actual response shows zero steady state error and shows a response with a time constant corresponding to the point chosen on the root locus.

2.2 Part B - Effect of Modelling Uncertainties

In this part, the controller designed for a given system is tested on a different system. This is equivalent to designing a controller without knowing the system parameters exactly. An explainable deviation in the responses should be seen.

3 Report Content

The report must have the following. **If items 1. and 2. below are not adhered to, your report will not be marked. If a report is late by more than a week, a penalty of 1 mark per week applies. The formal deadline for the submission of reports is 06 October 2012, 5pm. All reports must be submitted electronically to Blackboard.**

1. A cover page containing title of the experiment (16pt font size centred), the course code and course name(14pt centred) and the statement "I verify that the contents of this report are my own work" in 12 pt font centred. Your electronic submission will be taken as your signature to this statement. Then mention your name(12pt), student number(12pt) and date(12pt) at the bottom right hand corner of the cover page on three separate lines.
2. All sections, pages, figures and tables must be numbered. Equations may be numbered as necessary.
3. Introduction - briefly describe what the experiment is about (1 mark).
4. Aim - the purpose of the experiment (1 mark).
5. Brief description of the experimental procedure (1 mark).
6. Controller design calculation (2 marks).
7. Simulink block diagram of the experiment. (3 marks).
8. Part A - Input to the Simulink block diagram the desired input position profile. This can be found in your A data file. Generate the Simulink block diagram's output and then compare the results by superimposing the experimental plot on it, to show that the design is correct by discussing these plots (3 marks).
9. Part B - Replace the above Simulink block diagram's plant transfer function (do not change or redesign the controller) by the transfer function of the incorrect system allocated to you and generate position outputs. Superimpose the experimental data plot on the Simulink generated data plots and explain any discrepancies. Also explain the discrepancies between the plots in Part A and the plots in Part B. (3 marks).
10. In a conclusion discuss the success or otherwise of the experiment and address the discrepancies, if any, between the simulated and experimental plots in both parts (1 mark).