EEL6871 Autonomic Computing Fall 2013 Homework 4
Assigned: Tuesday, Oct-1-2013 7pm
Due: Sunday, Oct-13-2013 11pm

Overview

This assignment is an extension of the preceding homework; you will design and implement a proportional-integral controller for your chosen program and its supporting cluster. In addition you will solve some textbook problems that will also help you prepare for the midterm exam.

Context

The context is unchanged from the previous assignment except that you will consider the disturbance input/noise input at this moment. Your Hadoop cluster will be running on physical machines that are shared by other people's clusters possibly at the same time. The load due to the "other" clusters can be treated as disturbance or "background noise".

Procedure

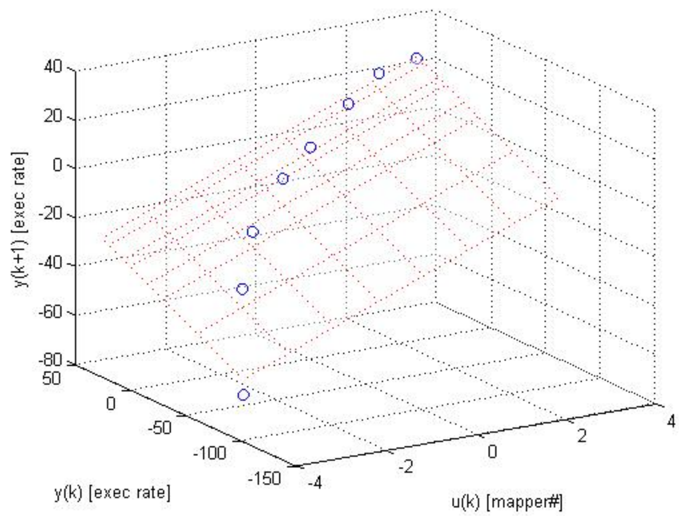
Design and implement the above-mentioned PI controller. There are no specific requirements though naturally it is expected to **track the reference input** and **reject disturbances**. Collect the following data from experiments in which you run your Hadoop system together with your controller: reference input, control input, measured output, and control error. There are two cases you must consider: constant reference input with disturbances and step reference input with disturbances. The values and step sizes of the reference input are left to you to choose. Give the ranges of these values for which the controller operates well, e.g. the step sizes for which the output converges to within X% of the reference input in Y time units. When implementing your controller choose two cased for the values of X and Y. One should be aggressive, i.e. X and Y should be small, and the other conservative. Your results should report both cases. Note that, as mentioned in the textbook, the system model was developed against y(k) and u(k), however the target system operates in terms of $\widetilde{y(k)}$ and $\widetilde{u(k)}$, dont forget to make the necessary adjustments.

Reference Input & Step size

Though you have the freedom to choose reference input and step size that are best suited for your application, here are some facts that you should keep in mind.

- After you modify the maximum number of mappers in fair-scheduler.xml, it takes 3 seconds or so to for that property to take effect. Hence it doesn't make sense to choose a step size that's smaller than 3 seconds.

- Large step size amounts to low sampling rate. You will lose a lot of information in discretization as a result of not sampling enough points.
- One experiment basically means the following process: start your Hadoop application, monitor the execution rate at run time, calculate the control error, feed that control error to the controller and obtain the control input based on the K_I, K_P you calculated from the target system model, adjust the target system online, monitor the execution rate and repeat. Again our goal is to have a controller that is able to adjust program execution rate at run time, that is all controlling process are performed "online" or dynamically.



- Above is one example of the target system model. Carefully choose the operating region and operation point as we are using first order equation to approximate the target system, if your operating region is on the nonlinear segment of the target system model, you might having trouble tracking the reference input.

Textbook Problems

3.8.a, 3.8.c, 3.9.a, 3.9.b, 5.3, 6.3.a, 6.3.c, 6.5 , 9.2 in the text book. For example, 3.8.a means chapter 3, exercise 8.a.

Deliverables

To demonstrate you have completed the assignment successfully you will submit the following items:

1. A PDF file named *your_name*_answers.pdf including the answers to the questions in the textbook.
2. Another PDF file named *your_name*_hw4.pdf containing the following items.

(a) The linear difference equation to be used as a model of the target system, the operating point of your system and your choice of the parameter K_I, K_P. Also state which operating region your system operates well and the reason for choosing the specific operating point.

(b) The closed loop poles, and predicted/theoretical values of k_s and M_p.

(c) Plots demonstrating the execution of your controller in the style of Figure 9.6 in the textbook, one for each of the scenarios described above. Have clearly labeled axes with units and appropriate titles.

(d) The conditions you define and ranges for which the controller operates well. Do this specifically for reference input size and step size. Explain your definition of "wellness".

3. The shell script or programs you used to implement the controller and collect the data at run time. Be sure to include a readme.txt to explain how to run your program including details such as the required libraries, command line to start your program, how it collect the data points, etc.

Submission Policy

– Follow strictly to the format specified in every homework. Incorrect submission formats will lead to a grade reduction.

– All submissions are expected by the deadline specified in the homework assignment. Grade is automatically reduced by 25% for every late day.

– Make sure you test your submitted code using the tar file you submitted before submission. If untar, make, compile or any other command needed to execute your program do not work, your homework grade will be zero.