MAE 1170 - Introduction to Mechanical Engineering

Cornell University, Fall 2009

Lego Mindstorms Laboratory Session #2
Thermostat

Introduction

This laboratory demonstrates very basic principles of the design and operation of feedback control systems. Feedback control is a major area of study in Mechanical Engineering. Gas turbines, weapons guidance systems, and vertical take-off and landing (VTOL) airplanes all use feedback control. Typically, mechanical actuators on these systems are controlled by a combination of computer hardware, software and sensors that may sense position, velocity, acceleration or anything else. The sensors and computers tell the mechanical components what to do.

In this lab, you will design, build and program a robot to act as a feedback control thermostat. The robot will try to keep the water at 40 degrees Celsius by adding cold water into the hot water, until the proper temperature is reached.

Equipment

One Lego Mindstorms Invention System kit, Lego temperature sensor, water proof containers, brass ball valve, mounting stand and duct tape.

Procedure

1. Write a program to read what temperature your sensor indicates. The TA will have a control source of hot water. Try to measure the approximate time it takes for the sensor to adjust to the proper temperature. This time is important in determining the intervals between adding cold water to the hot water.

2. Build your robot to control the valve. The method for controlling the ball valve is up to you. You may have to attach your robot to the valve using the tape provided.

3. Write a program to control the valve it, then download the program to the RCX unit with the infared transmitter.

4. Test and debug your robot until it is time to do the final run. When you are ready, the TA will watch you perform the test, then he will measure the final temperature of your water.

Questions

1. Give a detailed description of your robot, including the program. Draw the program as it appeared on the screen. How could your robot be improved? Include drawings of how your robot works.
2. What temperature did your robot bring the water to? If it was not exactly 40º, what are some possible reasons for the error? If it was exactly 40º, what made yours perfect?
3. How long did it take your program to reach the desired temperature? Try to think of some ways to lower the amount of time and the number of commands needed to reach the same goal.
4. Can you think of any other systems that use feedback control? List at least three (Not including those mentioned in the introduction).
5. Include a paragraph on what was accomplished in Lab this week. Was your group able to complete the task?

Lab Report

Include answers to all questions, all the data you collected, drawings of how your robot works, as well as how the program works, and comments and suggestions for the lab.