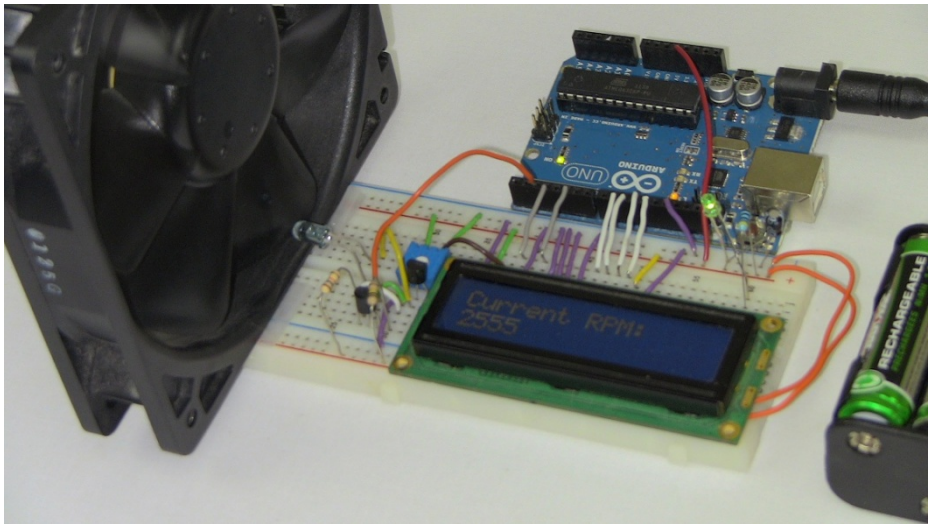
CENG314 EMBEDDED COMPUTER SYSTEMS

LABORATORY WORK 4

INTRODUCTION

A proportional-integral-derivative controller (PID controller) is a control loop feedback mechanism (controller) widely used in industrial control systems. A PID controller calculates an "error" value as the difference between a measured process variable and a desired setpoint. The controller attempts to minimize the error by adjusting the process control outputs.



In this lab session, we will control the rotation speed of a fan via a PI controller. The controller will keep the fan speed at a desired setpoint. The fan speed should be controlled even in the presence of external physical interference.

MATERIALS

1x Arduino board
1x Breadboard
1x HD44780 compatible 2x16 character LCD
1x infrared led (transmitter)
1x infrared phototransistor (receiver/detector)
1x 100k ohm resistor
1x 330 ohm resistor
1x10k ohm potentiometer
1x TIP 121 transistor
1x 1N4001 diode
1x 2.7k resistor
1x 12V computer cooling fan (80mm)

PRE-LAB

Please bring your ideas or solutions on the matters below in the beginning on the lab session in written form.
1) Can 50% fan speed be reached with a 50% duty cycle PWM signal? Explain your answer.
2) What would be your approach in designing the PI fan controller and how would you choose the initial values of Kp and Ki?

LABORATORY WORK

You are required to extend the work done in the previous sessions to implement a PI fan controller. The fan controller should keep the fan at 50% of its maximum possible RPM under any circumstances. Since the groups have the maximum speed of their fan from the previous sessions, 50% of fan speed is also a known value. This target value may vary from group to group, therefore each group will stick to their own setpoint. Fan speed should be monitored by the sensor circuit. PWM signal output should be altered in a meaningful way to keep the fan at constant speed. At this point, a PI control strategy will be implemented and tested by physically forcing the fan to slow down and relaxing so as to have an effect of variable load. That is to say, if a person lightly touches an object to the fan and slows it down, the controller should respond and modify the PWM signal to speed the fan up. Simultaneously, the RPM value from the fan should be read and displayed on the LCD screen as well as the duty cycle of the PWM signal.

For this lab session, you will be using the same circuit you used last week. This week's lab builds upon your progress so far.

Follow the steps below to complete your goal for this lab session.

1. Use your circuit from last week.
2. Write a program that utilizes a PI controller to control the fan speed as described above. Display the RPM value and duty cycle on the LCD.
3. Test the operation of the controller as by lightly touching the fan in the center. As speed decreases, your controller should increase duty cycle to counter the physical effect and increase fan speed.
4. Demonstrate your running circuit to the lab assistant.