EE443L Lab 5: DC Motor Position Control

Introduction

Applications such as robot joint control often require precise positioning of DC motors. This lab investigates the use of proportional position control for DC motor positioning as shown in figure 1.

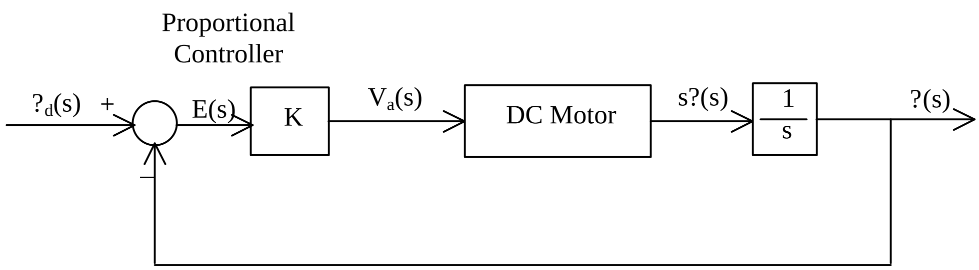

Figure 1: Proportional Position Control of a DC Motor

Procedure

1. Determine the motor position transfer function ?(s)/V_a(s) that relates motor position to input voltage. How many poles does this transfer function have at s = 0? The number of poles at s = 0 is referred to as the system type and directly influences the steady state error of the closed loop control system.

2. Determine the closed-loop system transfer function ?(s)/$?_d$(s) in terms of the motor parameters and controller gain K. Note that this transfer function relates the motor position to the desired motor position.

3. What values of K will yield zero steady state error for a fixed desired motor position? Explain why this result occurs by comparing the proportional closed loop motor position control system of this week with the proportional closed loop motor speed control system of last week.

4. What effect will varying K have on the system response?

5. Download the VI lab5.vi and its associated sub VI Counter_Setup.vi from N:/EE443L/LAB5/. This VI utilizes a counter on the data acquisition board connected to a LS7084 quadrature encoder to counter interface device as shown in figure 2. This implementation utilizes the rising and falling edges and phase difference of the two quadrature encoder signals to yield 2000 counts per revolution of the motor from 500 count encoders. Run the VI without motor power and turn the motor one full revolution in both directions to verify the 2000 counts per revolution.

6. Create a proportional closed loop position controller using the components of lab5.vi for position feedback. Keep in mind the following:
   a) the 2000 counts/revolution will need to be converted to radians,
   b) PWM generation and position and error plotting will need to be added,
   c) the analog input setup of past labs can be utilized to achieve accurate timing and as long as the analog input is activated motor velocities can be plotted for observation,
   d) ensure positive PWM corresponds to increasing position, otherwise we'll have positive feedback.

7. Rotate the motor to 0 rad (0 deg on the motor label) by hand let $?_d$(t) = p u(t) rad which turns on after the control loop starts to get a nice view of the step response. Run your controller for several values of K starting with K small and work your way up. Printout responses (position, velocity, and error) for three K values and note how varying K affects the steady state error, rise time, and settling time. Also note any unexpected results.

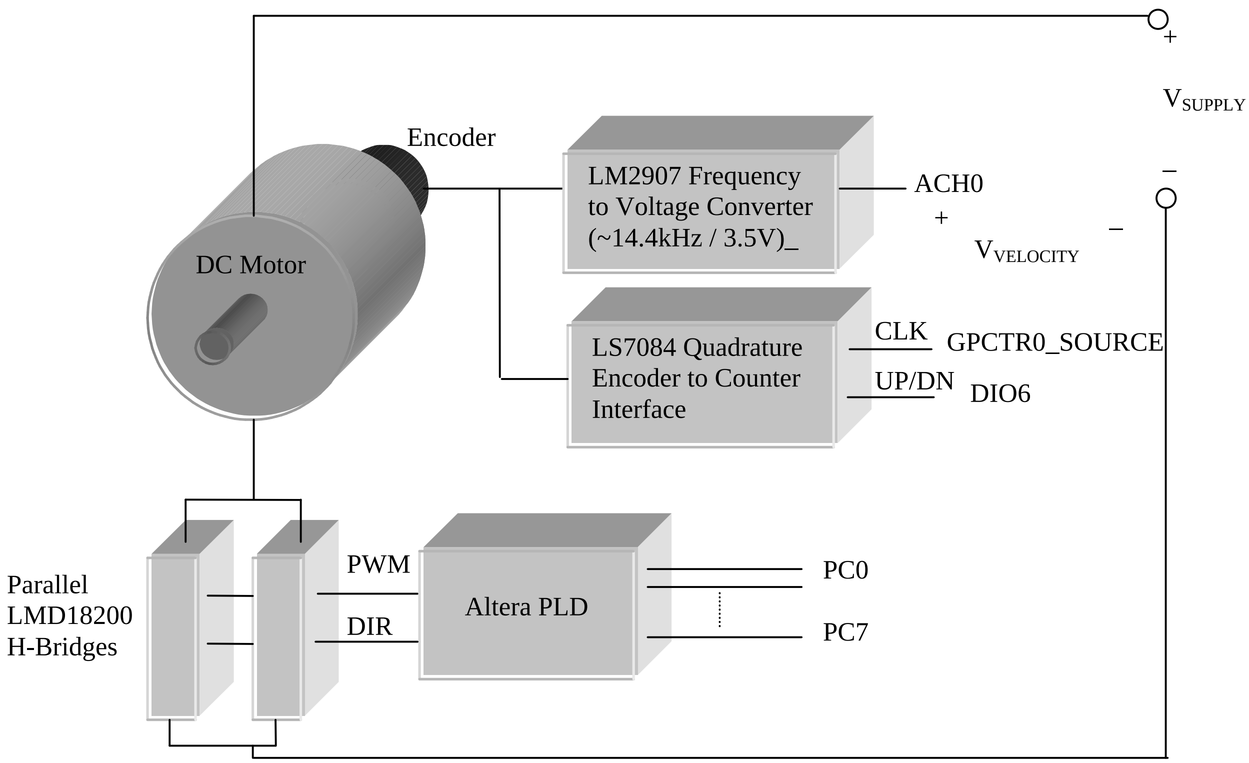

Figure 2: DC Motor Experiment Setup