RENSSELAER MECHATRONICS

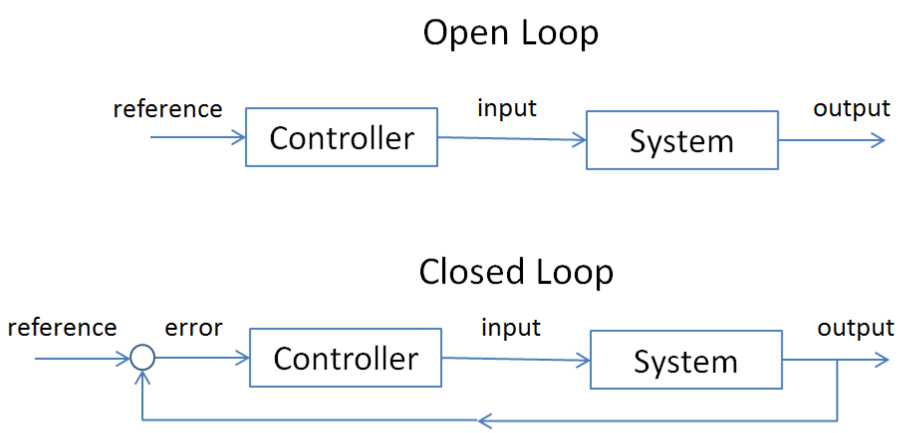
Basic DC Motor Position Control

Objectives:

- Control the position of the motor shaft
- Introduce basic control concepts
    - Closed loop feedback control
        - Instability: delays and controller gain

Background Information:

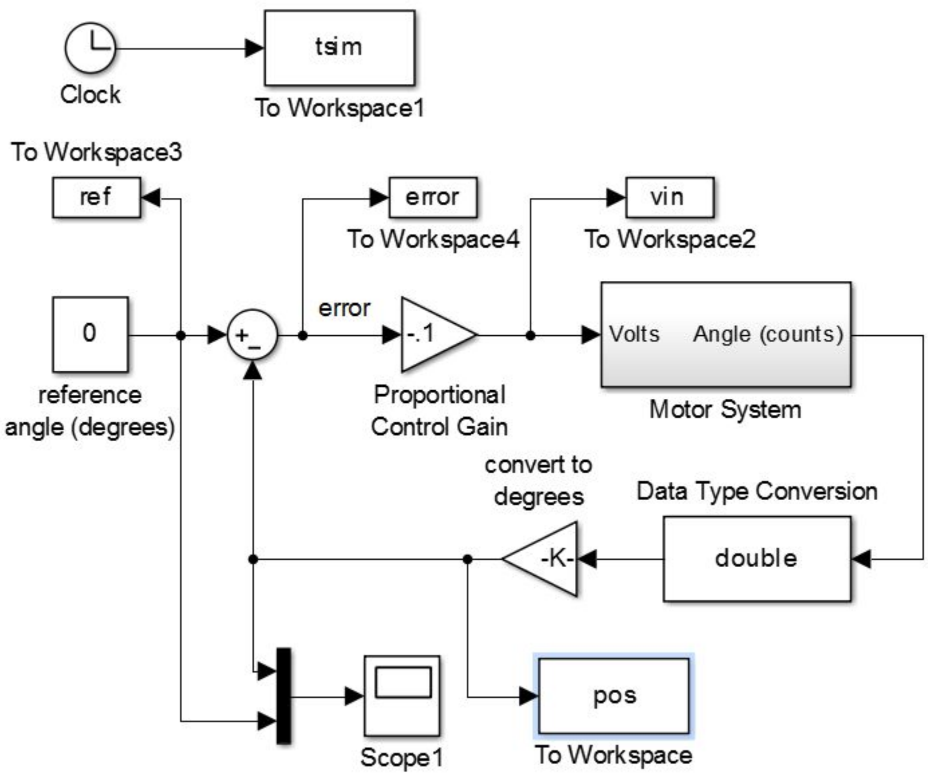
Controlling the output without directly measuring the output is called Open Loop control. If the output is measured and this information is used in the control this is called Closed Loop feedback control:



Measuring the output of interest and using this information in the control design is called closed loop feedback control. The basic strategy is to measure the output of interest, compare this to the desired output to generate an error signal and then try to reduce this error.

Proportional Control:

Build the following Simulink diagram:



The motor system is a subsystem created from the following blocks (review how to make a subsystem from previous labs. Use appropriate driver and encoder blocks for your system):

- Be sure to use the proper value for Vsupply from your previous labs
- What value should be used to convert from the output in counts to degrees?
- If the position is initially zero and the control law is V=Kp*(reference – 0), what is the maximum gain before the controller will saturate (demand more voltage than is available) when the reference is 90 degrees?
- Run the Simulink diagram. **If the error does not decrease initially the measured value may need to have the sign changed (since the motor is going in the wrong direction). This is shown as a negative in the 'Proportional Control Gain' block, but should be placed inside of the motor system).**
    - Use a time step size of .03 seconds in external mode
    - Since the initial gain is zero the system should remain at rest
    - Change the proportional gain to .03 then change the reference to 90 then back to zero
    - Change the proportional gain to .1 then change the reference to 90 then back to zero
    - What do you notice?

- Modify simulation settings
    - Change the time step size to .1 seconds in external mode
    - Change the proportional gain to .1 then change the reference to 90 then back to zero
    - What do you notice?

Questions:

- Create a single plot that shows the reference and position vs. time for the following cases (you may want to use the 'save' command to save your data between each experiment for plotting later)
    - Step size of .03:
        - proportional gain of 0.01
        - proportional gain of 0.05
        - proportional gain of 0.1
- Create a single plot that shows the reference and position vs. time for the following cases
    - Step size of 0.1:
        - proportional gain of 0.01
        - proportional gain of 0.05
        - Proportional gain of 0.1

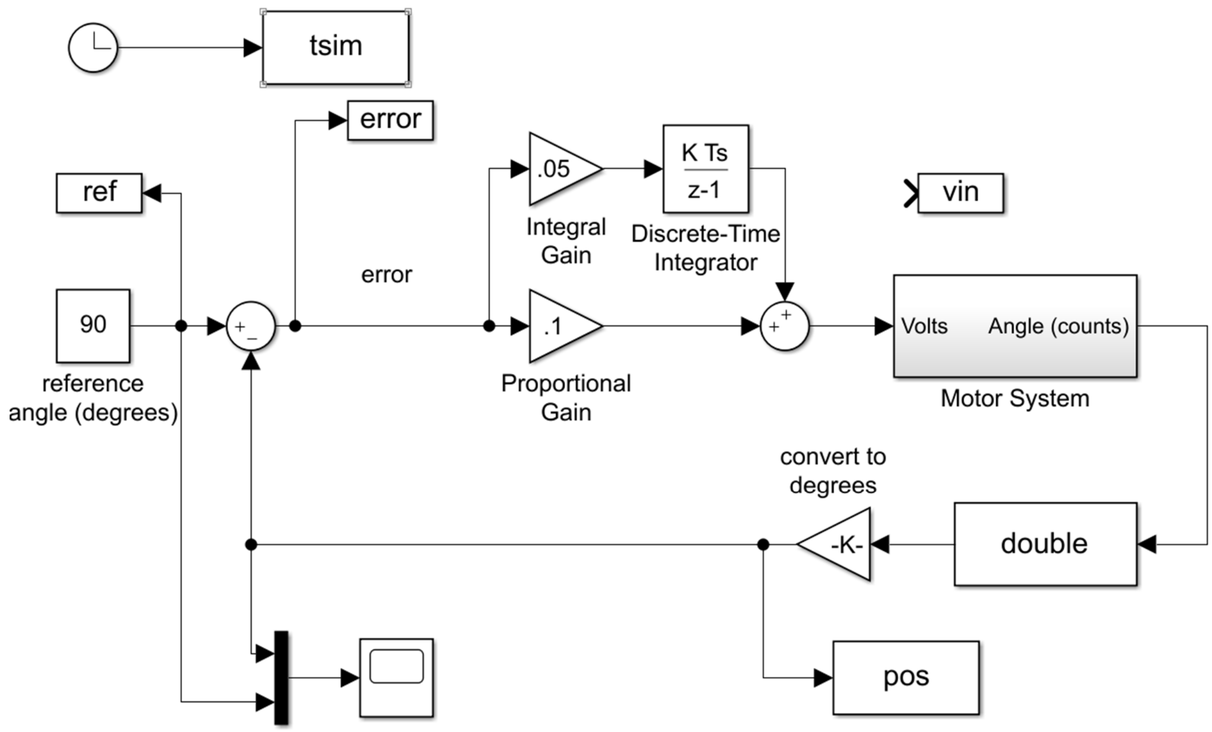
Comment on the effect of the varying the gain on the control system performance. Does it get to 90?

Comment on the effect of the varying the step size on the control system performance. How does the step size affect the performance?

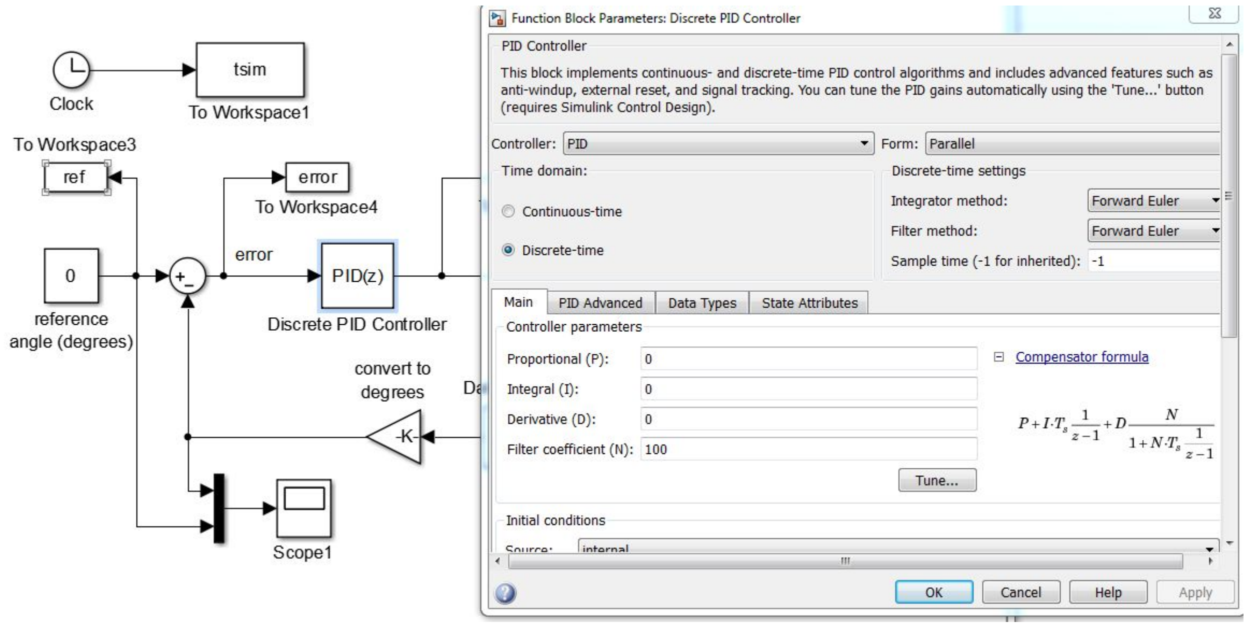
Proportional Plus Integral Control:

Proportional only control does not eliminate the steady state error. If the error signal is integrated this value will keep increasing as long as there is a steady state error and a control effort can be applied that

Build the following Simulink diagram:



- Run this on the system.
  - Use a time step size of .03
  - Change the proportional gain to .05, then the reference to 90 – the response should be the same as before with a steady state error
  - Change the integral gain to .01 – what do you observe? Try .02 what do you observe?
- You can also perform the proportional plus integral part using the PID block.



Questions:

- Provide a plot showing the difference of the performance with and without the integral gain. Does it go to 90 in both cases?