ECE 476/676 - Homework #4

Timing, Analog I/O, Motors with Binary Inputs

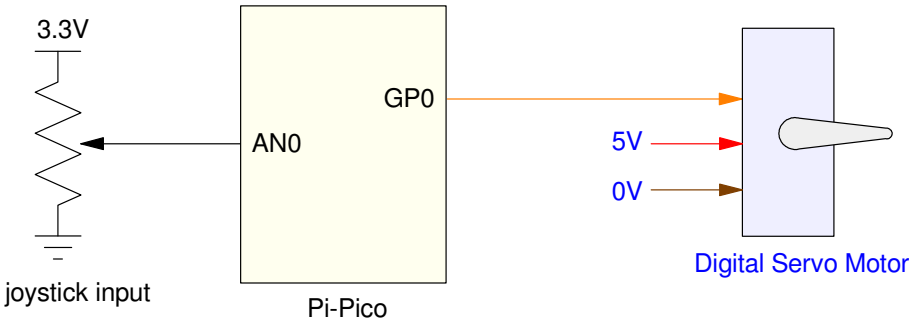
Digital Servo Motor Angle Control

1) Hardware: Connect your Pico to your digital servo motor (blue motor with a three wire interface.

- Yellow: Signal (0.5ms to 2.5ms pulse @ 50Hz)
- Red: +5V
- Brown: 0V

Write a test program to verify you can

- Read the analog input from your joystick
- Drive the motor from 0 degrees (0.5ms pulse) to 180 degrees (2.5ms pulse)f



Angle Control: Static System

2) Write a python program so that the angle of the servo motor is proportional to the joystick position:

$$PW = a \cdot A/D + b$$

such that

- Pulse width = 0.5ms when A/D = 0x0000
- Pulse width = 2.5ms when A/D = 0xFFFF
- Pulse width is proportional to the A/D reading in between

3) Verify your code works

- Short video works
- Print out time, analog input, and pulse width in the shell window also works

Angle Control: 1st-Order Differential Equation

4) Write a python program so that the angle of the servo motor is related to the joystick position according to a 1st-order differential equation with a time-constant of one second:

$$y' + y = x$$

where

- x is the analog input from the joystick from 0% to 100% and
- y is the angle of the digital servo motor, ranging from 0% (0.5ms pulse) to 100% (2.5ms pulse)

5) Verify your code works

- Short video works
- Print out time, analog input, and pulse width in the shell window also works

Sample Code:

- Let X be the analog input from 0 to 100%.
- Let Y be the angle of the motor from 0 to 100%

Assuming a sampling rate of 10ms, your python code might look similar to this:

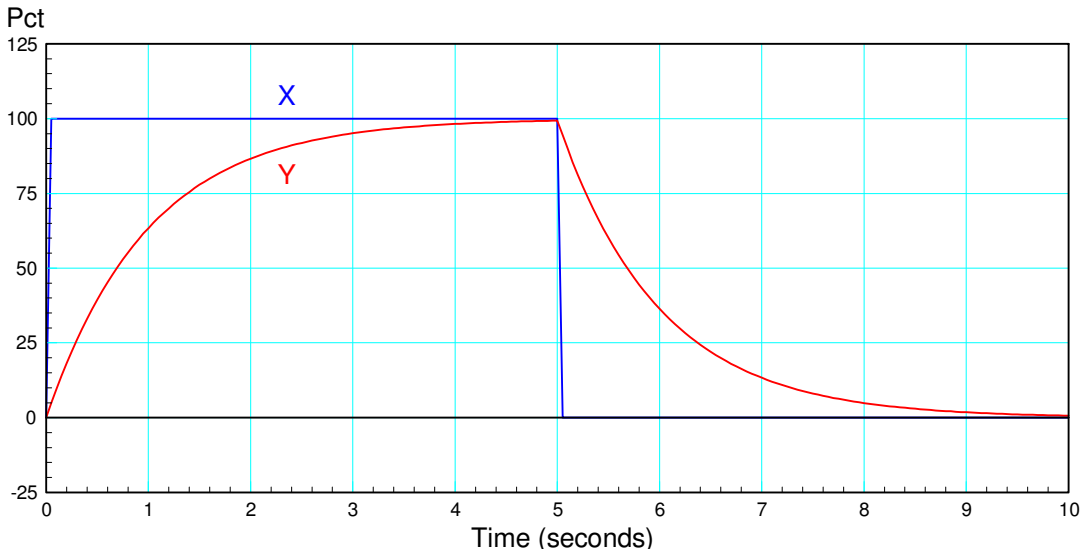
```
dt = 0.01
y = 0

kx = 100 / 65535

while(1):
    x = kx * a2d0.read_u16()
    dy = -y + x
    y += dy * dt
    sleep(dt)
```

Additional code needs to be added so that Y drives the pulse width to the motor.

note: Instead of using numerical integration, you can also implement this filter using a difference equation and z-transforms if you like. (covered in ECE 376)



Angle Control: 2nd-Order Differential Equation

6) Write a python program so that the angle of the servo motor is related to the joystick position according to a 1st-order differential equation with a time-constant of one second:

$$y'' + 2y' + 10y = 7x$$

where

- x is the analog input from the joystick from 0% to 100% and
- y is the angle of the digital servo motor, ranging from 0% (0.5ms pulse) to 100% (2.5ms pulse)

7) Verify your code works

- Short video works
- Print out time, analog input, and pulse width in the shell window also works

Sample Code: Assuming a sampling rate of 10ms

```
dt = 0.01
y = dy = d2y = 0

kx = 100 / 65535

while(1):
    x = kx * a2d0.read_u16()
    dy2 = -dy - 10*y - 10*x
    dy += d2y * dt
    y += dy * dt
    sleep(dt)
```

Additional code needs to be added so that Y drives the pulse width to the motor.