**ENGR 2110** - Principles of Engineering
Fall 2019

Profs. Hoover, Govindasamy, Millner, & Reifel
Lab 2 - **Due before class Fri., 9/27**

# Lab 2 - DIY 3D Scanner

## Objectives

1) Build and program a rudimentary 3D scanner using a pan/tilt mechanism
2) Scan an object of known, well-defined geometry
3) Visualize the output from your scanner

## Introduction

The first lab should have gotten you comfortable with (or at least aware of) how to read and write digital signals, how to read and convert analog signals, and how to use an analog input to change the digital behavior of your circuit.

The purpose of this lab is to introduce sensors and actuators. **Sensors** are devices that transduce a physical quantity in the world (distance, force, pressure, chemical concentrations, etc.) into a different, often more easily measurable, physical quantity like voltage. **Actuators** are duals to sensors in that they transform one form of energy (hydraulic pressure, chemical energy in gasoline, electrical potential, etc.) into mechanical work.

This lab will make use of an infrared distance sensor and two hobby servo motors. An infrared distance sensor is an infrared emitter (LED) paired with an infrared detector (photodiode). The detector measures the intensity of the IR light reflected off of an object in its field of view. The output of the sensor is an analog voltage. A hobby servo motor is more than just a motor; it's a DC motor connected to a potentiometer (to measure the shaft angle), hardware proportional-integral-derivative (PID) controller (to perform position control), and a gear train (to increase torque and decrease speed). A hobby servo is controlled using a square wave form that is pulsed at a fixed frequency. The time that the waveform signal is set to "on" determines what the position of the shaft should be. This scheme is called "pulse width modulation" (PWM) and the percentage of "on" time during the period is called the "duty cycle". Most hobby servos use a pulse width of between 1ms and 2ms (sometimes the range can be as wide as 0.8ms to 2.2ms).

## Requirements

Create a pan/tilt mechanism using the servos and sensor provided for you that is controlled by an Arduino. Transmit servo angle and distance information from your sensor to your laptop for storage and, ultimately, visualization. Using a software package of your choice (MATLAB, Python, JavaScript, etc.) create a 3D visual representation of an object of known, well-defined geometry.

## Suggested Steps

1. Connect your sensor to the appropriate pins on the arduino and verify that it works using the "AnalogInput" example from the Arduino development environment.
2. Test that serial connection between your laptop and the Arduino can relay sensor data using the "AnalogInOutSerial" example in the Arduino IDE. We have also created a sample sketch that sends data back to the laptop after receiving commands from a sample Python script. (The teaching team will provide support for students understanding and building upon the samples listed above; additionally, we are linking unsupported options you can learn from on your own: sample Matlab script, sample sketch 2, sample Python script 2.)
3. Test the functionality of your servos using the "Sweep" example in the Arduino IDE (under "Servo").
4. Calibrate your distance sensor. Calibration is the process of getting a set of readings for known distances and determining the mathematical relationship