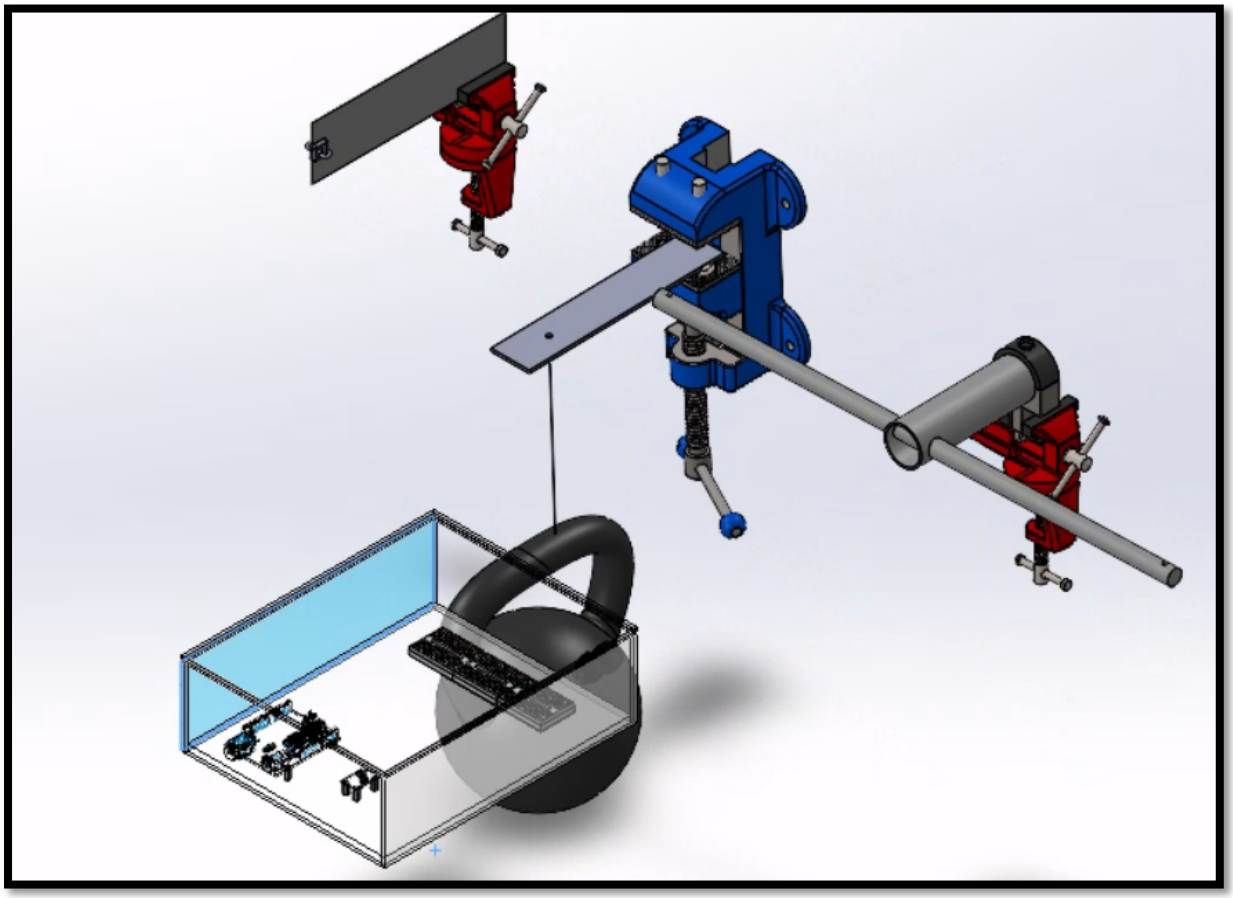


Strain Gauge Demonstration Apparatus Operation Manual

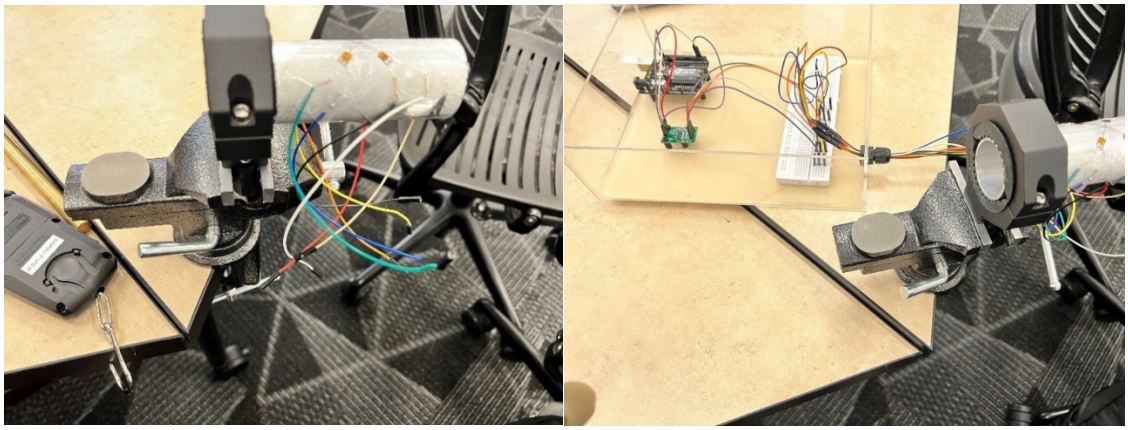
Content

1 Introduction

Strain Gauge Demonstration Apparatus is a laboratory strain measurement device that can simultaneously measure axial load, bending, torsion and internal pressure. It is easy to operate and has many functions. In general, the device is composed of four independent parts, the first three parts for measuring axial load, bending, and torsion can be assembled and disassembled, and the measuring internal pressure is a complete device. For these parts which can be assembled, the whole device can be divided into two sections. One being electronics and the other being load cells. The electronics section for an individual measurement device is composed of an Arduino board, a touchscreen, an HX711 load cell amplifier, and a Wheatstone bridge circuit. The overall structure of this section is sequential. The Wheatstone bridge circuit, HX711, and the Arduino board, are connected one by one. The three also make up the physical core of this section. In addition, the Arduino board is externally connected to the computer via USB port, with programs written within the Arduino application to control the running of the device. A PC will be needed to connect to the Arduino board to provide the power and show the measurement reading as. And the team used acrylic panels to make the floor and surroundings for the electronic part. It can effectively protect the stability of the equipment.

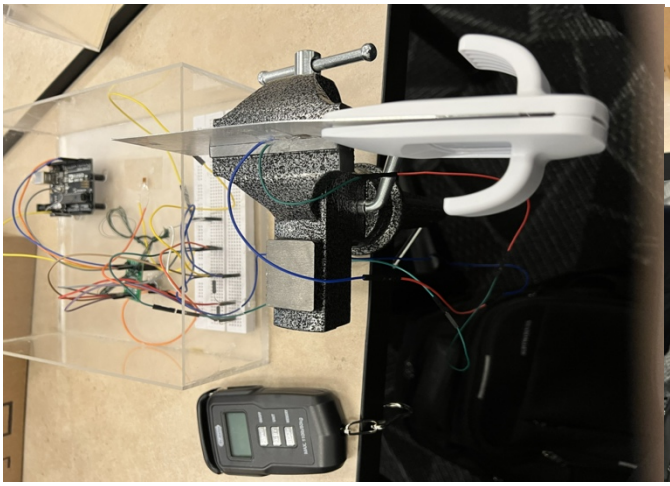
The second section is the load cell, which is basically the unit combined by strain gauges and a piece of metal. We deform the metal by applying a corresponding force to it, so that the strain gauge deforms accordingly to measure the strain. They are fixed on a stable surface (such as a table) by clamp. As for the measurement of internal pressure, it is a complete device (does not support disassembly). The following part will specifically introduce the installation and use of each part.

2 Assembly/Disassembly



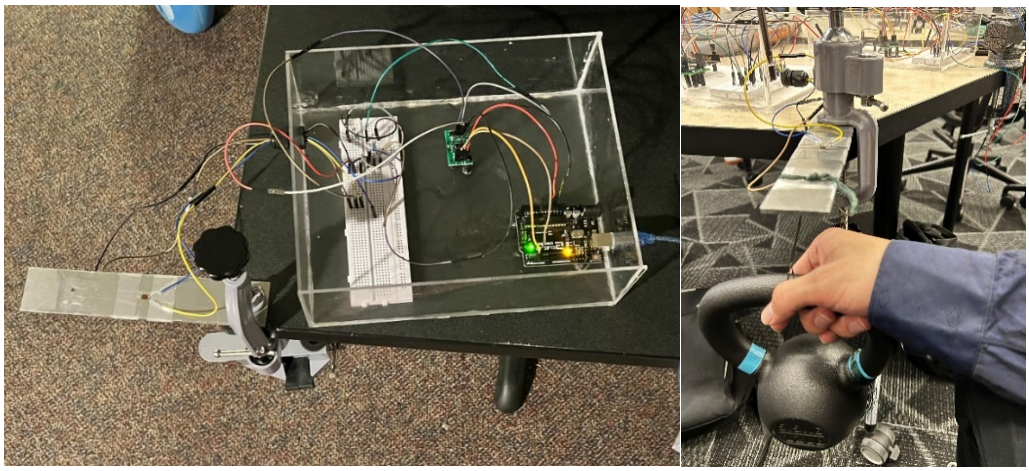
In the device assembly part, there is a corresponding circuit box for each load cell. You only need to connect the wires on the circuit box and the load cell in the same color. Note: There are 2 wires for axial load, 4 wires for bending, and 8 wires for torsion.

3 Axial Load Device



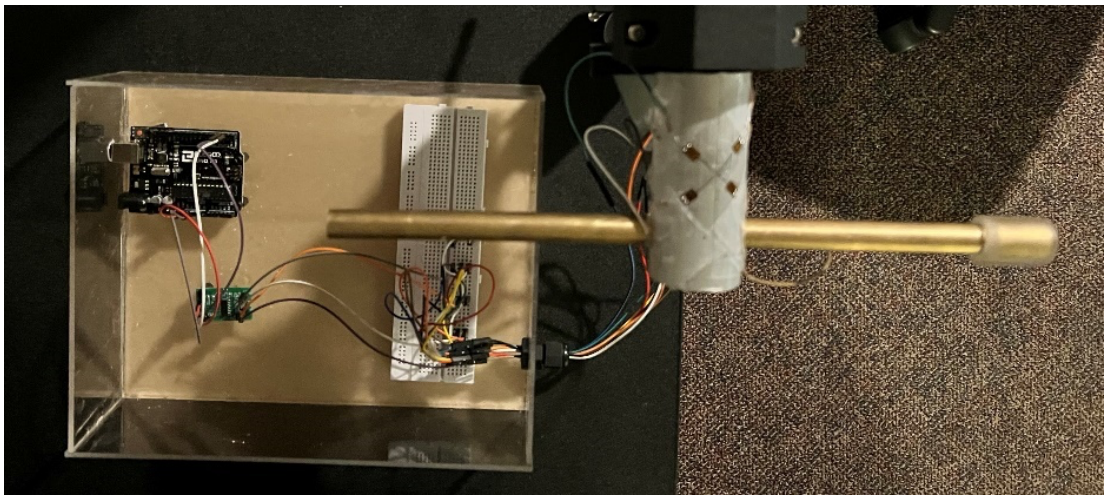
For the axial load device, after connecting the circuit, please put two rubber bands on the installed hook. Then use the tensioner to pull the rubber band and make it stretch. The value on the tension meter is the force experienced by the load cell at this time. Please keep the strain gauge, rubber band and tensioner on the same line. At the same time, ensure that the load cell cannot be bent.

4 Bending Device



As can be seen from the figure, the load cell of the bending part is a rectangular metal bar. Two strain gauges are respectively attached to the upper and lower surfaces in the middle of the metal bar. We need to use a clamp to fix one end of the metal bar, and then connect the strain gauge to the circuit part (male and female wires are used here, and the circuit connection is very simple). Then turn on the computer to run the program and hang a heavy object on the other end of the metal bar to apply bending to the metal piece. Then the reading will be showed on the computer.

5 Torsion Device



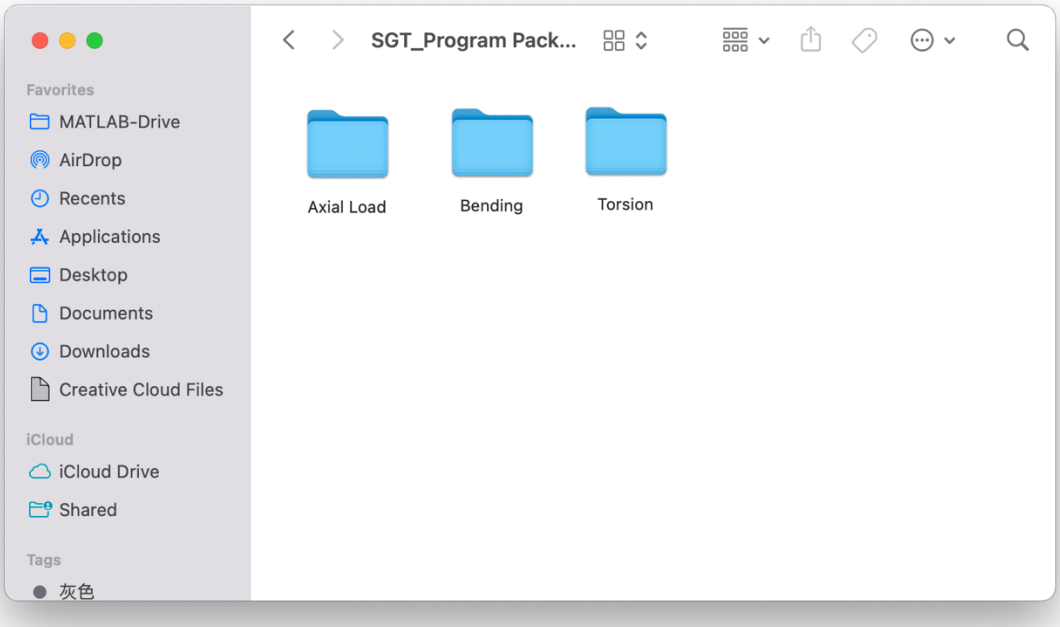
In the picture, you can see our equipment for measuring torsion. Since we used a full bridge circuit, we placed four strain gauges on the metal hollow cylinder. One end of the hollow cylinder is fixed with a clamp, and a metal rod is inserted into the other end. We apply force on one end of the metal rod to apply torsion. The test can be performed after we connect it to the circuit part, and the measurement result will be recorded by the computer.

6 Computer Program Setup

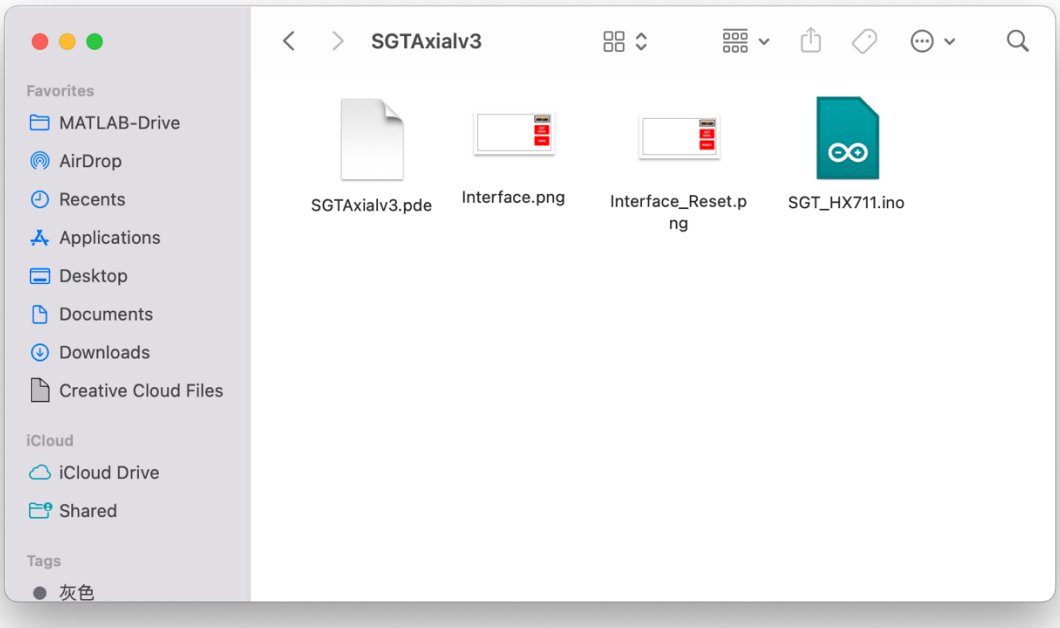
In this apparatus, all devices except the internal pressure device are required to run by computer programs. To download the program package, click the link: https://ceias.nau.edu/capstone/projects/ME/2021/21Su04_SGT/documents.html

Find the document title **"Program Package"**, click the **"DOWNLOAD PACKAGE"** button. If you see a zip file named **"SGT_Program Package.zip"**, the download is successful.

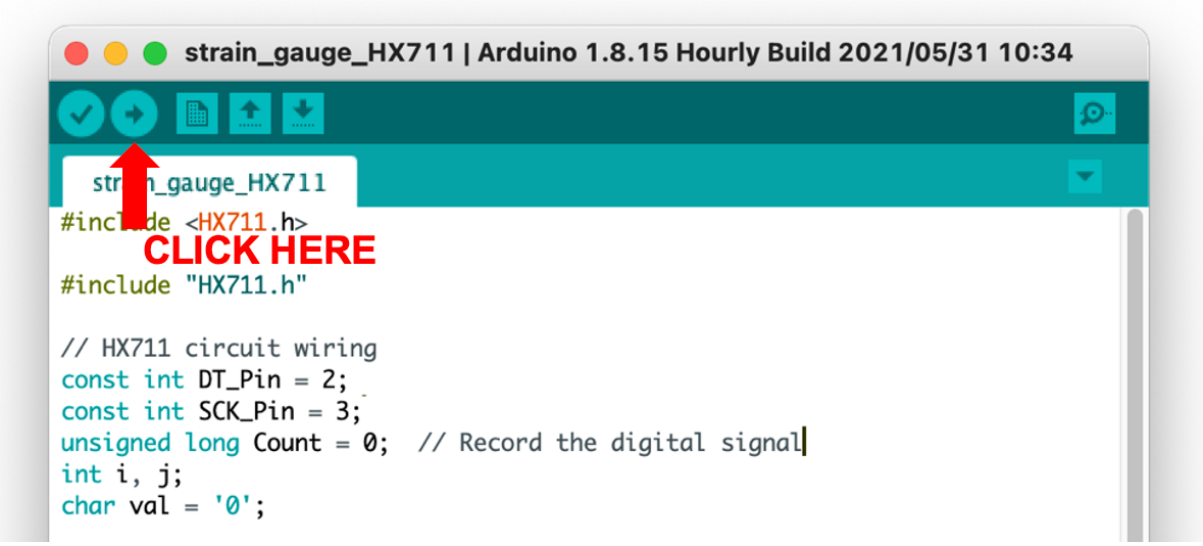
The zip file will contain three folders, each would fit into the corresponding device based on their names.



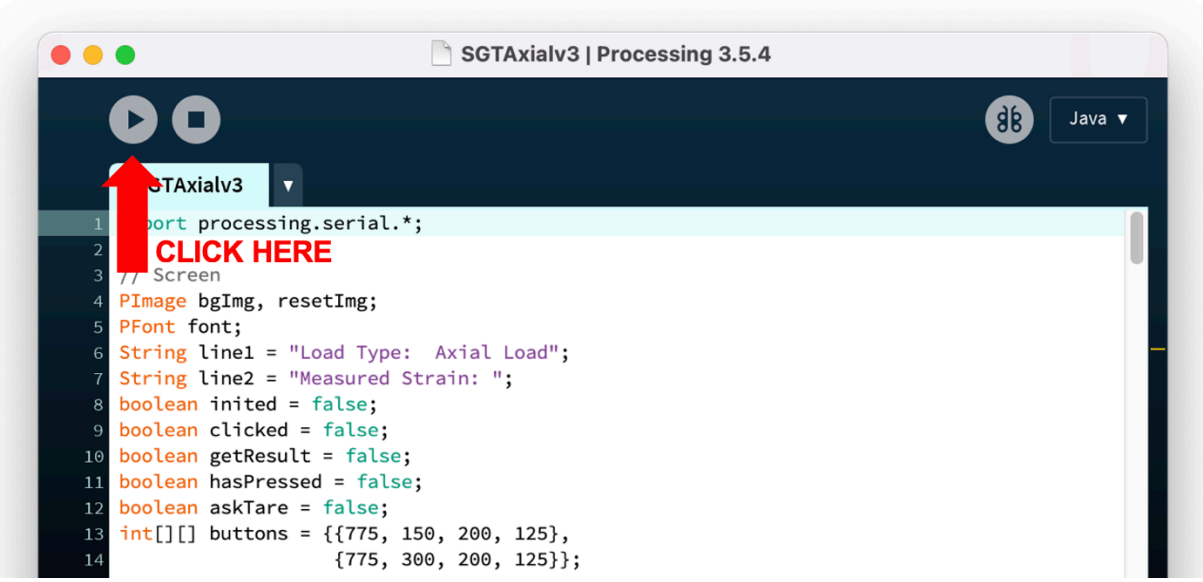
Open one of the folders, and you will see two programs and two images. One program is in (.ino) format and another is in (.pde) format. To run these two programs, you need to download **Arduino** and **Processing 3** on your PC.
IMPORTANT NOTE: DO NOT move or delete the images!



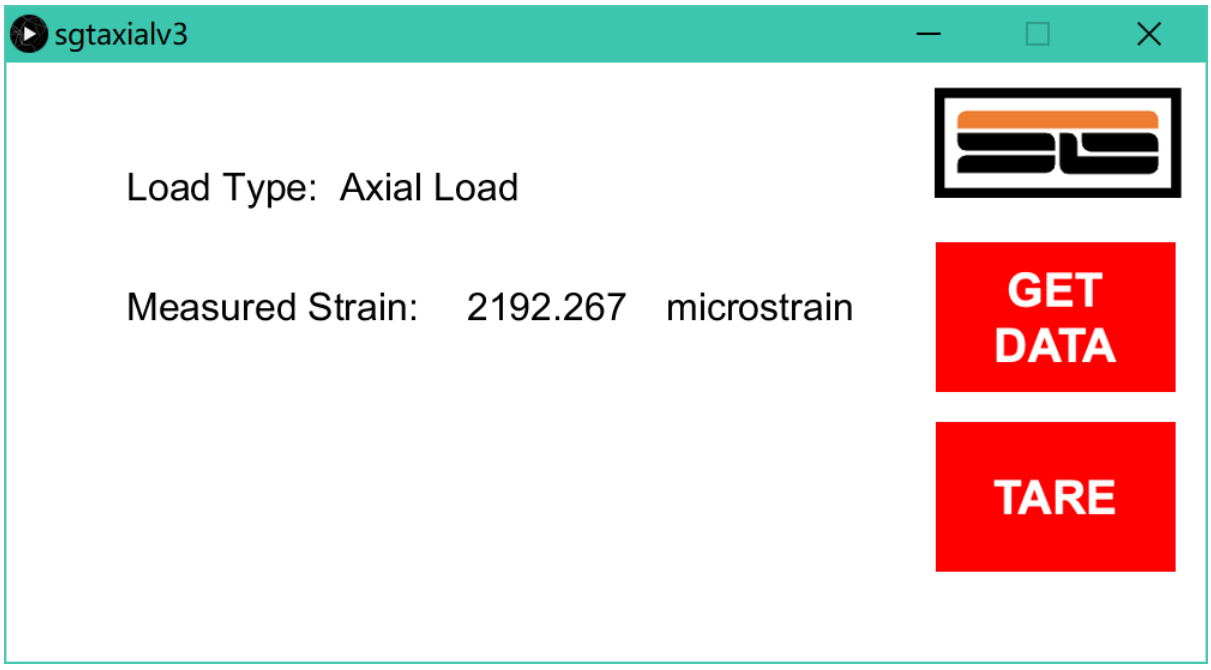
When operating on the device, you need to open both programs. After connecting the Arduino board to your PC, switch to the (.ino) program. Click **"Tools → Port"**, make sure the program is connected to the correct port (which is the external Arduino board). After that, you can upload the program.



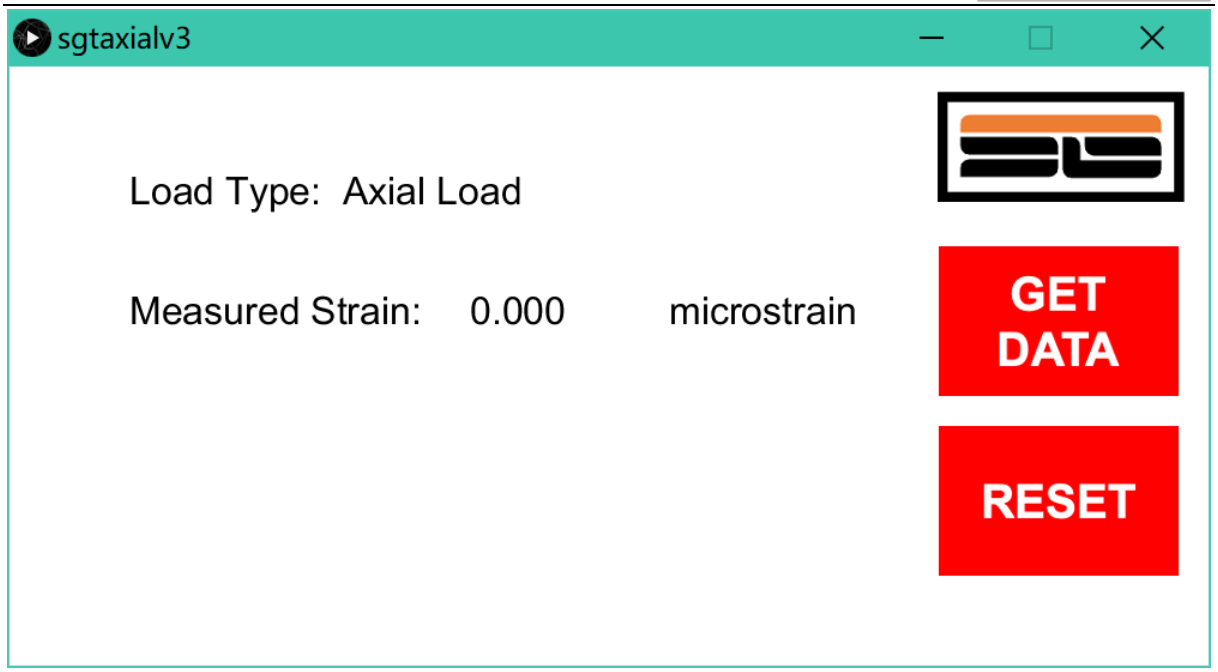
Then switch to the (.pde) program, run this program. If the program does not find the correct port, change the port index number in **"int portIndex = 1;"** on Line 18.



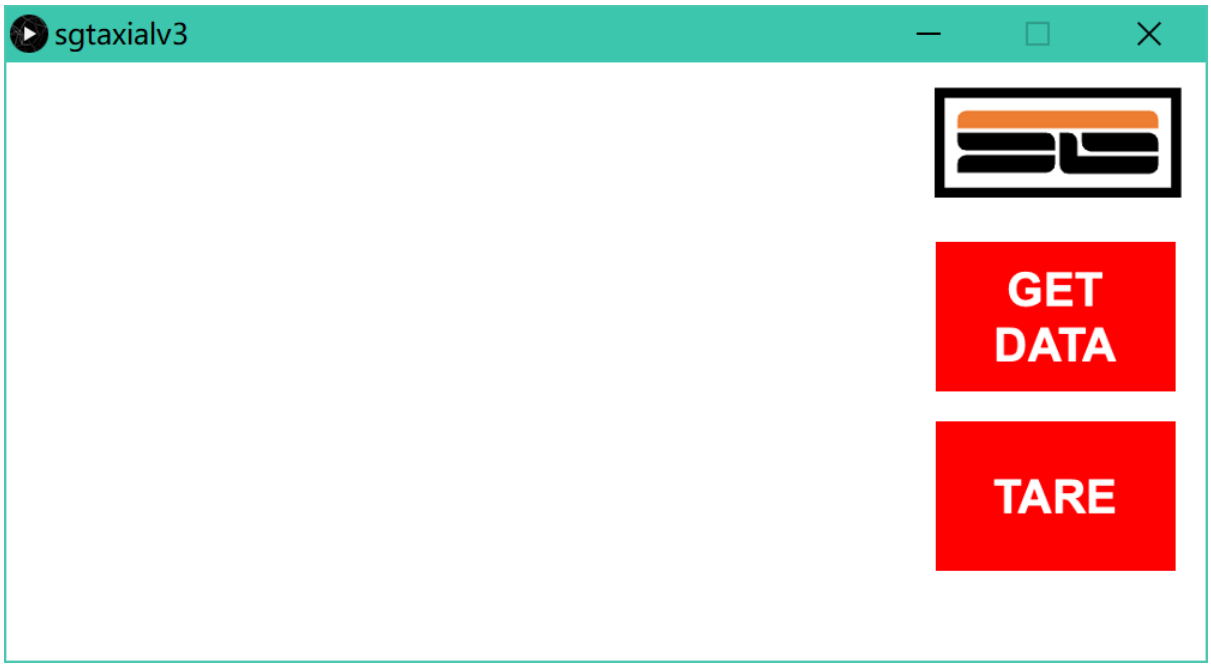
The starting interface of the program will look like the figure below. Click **"GET DATA"** button to get an initial strain reading. Clicking it for multiple times will update this reading.



Click the **"TARE"** button, and all the data gotten after the click will be reduced by the last reading displayed on the interface before the tare. This can be used as clearing the strain offsets. Meanwhile, the **"TARE"** button would turn into **"RESET"**.



Click the **"RESET"** button, and the interface will be cleared along with the previous tare effect. Clicking **"GET DATA"** again will create a new set of non-tared data.



7 Internal Pressure Device

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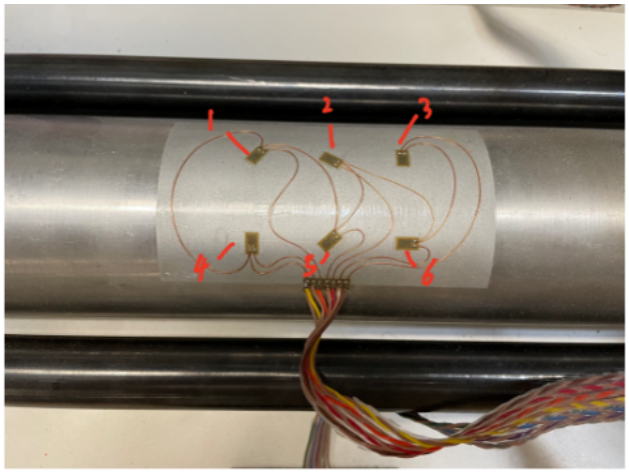

This part is a whole and does not require a computer as an external display. There are six strain gauge in this part, they can measure the strain of different direction. This device is hydraulic, and the fluid in it is oil. The knob on the left side is the used to extrude the oil into the cylinder. There is also a knob on the left side, tighten it, you can compress the internal volume. So, when using it, firstly, make sure there is oil in it, and then turn the right knob to squeeze the oil in. When you see the pressure gauge on the top, start to turn the left knob to squeeze the inner space until you get the pressure you want. Then you will get 6 data on the monitor, each one corresponds to the punctuation on the map.
Remember to restore it after use.