Physical Design Proposal E+M$^2 and team \#1$

Maduabuchi Okolo, Maria Peregrina, Ethan Wrobel

Activity Report

1 Proposed Solution

To summarize the solutions that are being implemented, you have to look at both the hardware and software for the tensiometer system. On the hardware side is improving the pulley system by adding a crank,changing the clamps to allow easier access to stretch the material. With the addition of improving the software to allow both the HX711 scale and the VL53L1X to be more accurate.

2 System Architecture

To implement the design that will lead to a greatly improved tensiometer system, the following components were added to the design. A crank (Figure 1.A) was added to the top of the tensiometer (Figure 1.I), which will allow the rope(Figure 1.B) to start slowly being pulled up. Thus allowing the material to stretch in the improved 3D printed clamps (Figure 1.F). After that, the process of the stress-strain curve will be started by finding both the force using the HX711 load scale (Figure 1.E) and the distance using the VL53L1X laser-ranging module(Figure 1.H). This is all being calculated by using the Ardunio (Figure 1.D) and breadboard (Figure 1.C) , which would be connected to a student's and/or lab assistant's laptop.

The technical aspect of the design was changed based upon the addition of the VL53L1X laser-ranging module(Figure 1.H).

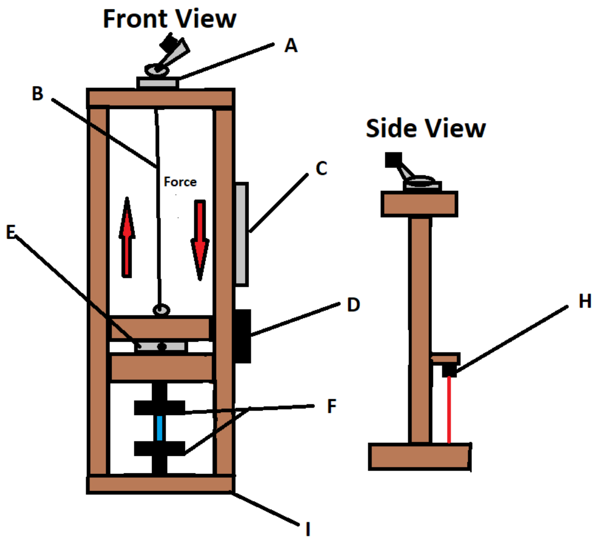

Figure 1. Current state of the tensiometer physical design.

Following the design of the circuit in Figure 2, it depicts the current system with the load cell acting a wheatstone bridge and the resulting output voltage amplified to the range of the ADC. The HX711 board uses the amplified value to perform a ADC conversion and then communicates the results using the I2C communication standard with the attached microcontroller. With the addition of the VL53L1X board that will use infrared technology to measure the distance between that of the sensor

- *Maduabuchi Okolo,*
  E-mail: mokolo@albany.edu,
- *Maria Peregrina,*
  E-mail: mperegrina@albany.edu,
- *Ethan Wrobel,*
  E-mail: ewrobel@albany.edu,
  University at Albany.

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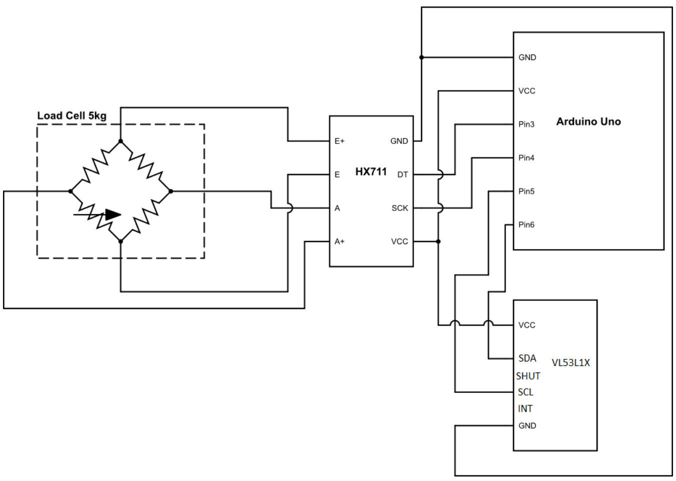

Figure 2. Updated schematic diagram of tensiometer electronics with laser-ranging module

and the piece of wood, without the interference of reflectivity. The component also will communicate the results using an I2C communication interface, that will be attached to the microcontroller like the Hx711 board.

2.1 System Components

In order to improve the Ultimate Tensile Strength, a pulling winch/crank, 3D-printed clamps, and a VL53L1X laser-ranging module were added to the system. Once each part is added to the system, there will be test trials to see if any other modifications need to be made. When using the original Ultimate Tensile Strength Tester model there was difficulty using the clamps to test the material. To solve this issue, there was research done to find a user friendly clamp that also won't be time consuming, when trying to open them. Therefore, a 3D-design was created to solve this problem. Additionally, another issue was the inaccurate data collected from the Ultrasonic range sensor. The Ultrasonic range sensor, will be replaced by a laser-ranging module sensor to improve the output values. The laser-ranging module sensor was the sensor decided on because it eliminates any sound inference caused around the system. A pulling winch/crank, was added to the system because it makes for a uniform stretching of material. Therefore, eliminating human error when pulling the rope to stretch the material. The table summarizes any new parts and a cost estimate which is shown in Table 1.

Item	Part #	Cost
Laser Ranging Module Sensor	SK001	$16.80
Clamps	3D-print	$0
Pulling Winch	DL600A	$31.31
TOTAL		**$48.11**

Table 1
An overview of the new parts that are being used in the improved Ultimate Tensile Strength Tester.

2.1.1 *Pulling Winch/Crank*

The user will pull the handle of the winch in order to stretch the material in a uniform way. This is done until the material is broken.

2.1.2 *VL53L1X Laser-ranging module*

The laser-ranging module sensor will measure the distance between sensor and the bottom of tensiometer. The distance will be seen from the laser beam.

2.1.3 *3D-printed Clamps*

The 3D-printed clamps has three screws which will be used to secure the material.To allow the students to quickly be able to insert and replace the materials that are going to be stretched.

2.2 Engineering Standards

In the current system, there are two communication standards (protocols) that are utilized: I2C and UART, as shown in figure 3.

2.2.1 *I2C Protocol*

The I2C protocol is used to allow the controller(PC) to talk with the peripheral(load censor). There are other protocols that achieve this but I2C is simpler to use(only 2 wires). I2C also supports multiple peripherals and controllers, this leaves more room for the expansion of this project. Lastly, I2C lets the user know if data was successfully sent.

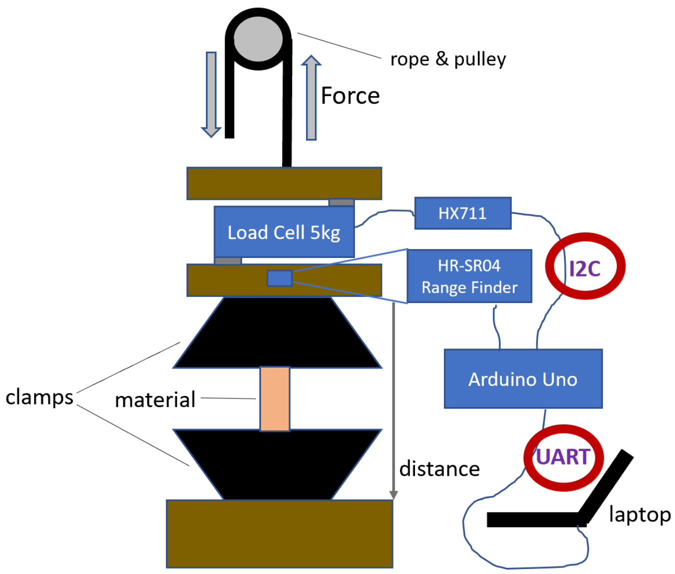

Figure 3. The current tensiometer system implements two communication standards (protocol) I2C and UART.

2.2.2 UART Protocol

For this project UART is used for a asynchronous serial connection from a PC to the Arduino UNO Integrated circuit. UART allows two devices to communicate directly with each other(transmit and receive data). The UART converts serial data to parallel data and vice versa.

2.2.3 Data Standards

This project is using CSV files. CSV files are text files that use commas to separate values, this allows for the making of tables of data. CSV files help to organize data and this data has a value within the file. If a user wants to pull data from a CSV file they could use the storage location of the data within the CSV file to access it using another program. For this project we make a graph representing the data within a CSV file(stress/strain).