# Physical Design Proposal
# Team 10

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*Activity Report*

## 1 Proposed Solution

To improve the current system to meet the end goal expectations the range sensor will be replaced with a more reliable sensor, and a manual crank winch system will replace the current rope pulley that is being used. The manual crank winch will make the load cell data be more accurate and stable as the material gets pulled, and the more reliable range sensor will give more accurate and precise values. Software improvements to the interface will be implemented along with a LCD display. The average user should not be expected to read lines of code and a fast moving data window to understand what is happening. These improvements will help the tensiometer system output more reliable data, which will make the stress-strain curve more accurate and precise.

## 2 System Architecture

In order to implement the design on the current state of the tensiometer, some minor physical changes will be implemented.

The current state of the tensiometer design can be viewed on Figure 1. The improved design that will be implemented is depicted by Figure 2.


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The hand cranked winch will be bolted to the top of the tensiometer. A steel wired rope will be used along with the winch. With these two things working in tandem, there will be no give on the rope to interfere with the application of force on the load sensor, and the winch will be mounted at the location such that the force will be applied directly vertically.

The new ultrasonic range sensor will be mounted at location G depicted by Figure 2. The location is already in the optimal location, so there is no need to change that from the current design. The accuracy of the readings will be an improvement over the current sensor. The electronics will be kept the same as well for a seamless transition.

The LCD display will be mounted at a location such that the user can monitor the measurements while conducting an experiment at the same time. The display will be configured so that the force and distance will be displayed simultaneously. The arduino IDE will operate in tandem with the display, collecting the data necessary to transmit to a .csv file.

Below is the description of the individual system components along with references to diagrams for visual aid.

### 2.1 System Components

#### *2.1.1 US-100 Ultrasonic Range Sensor*

The first component from the original system that needed to be changed was the ultrasonic range sensor. The original Ultrasonic range sensor that was apart of the original design was the HC-S04. The new range sensor that were

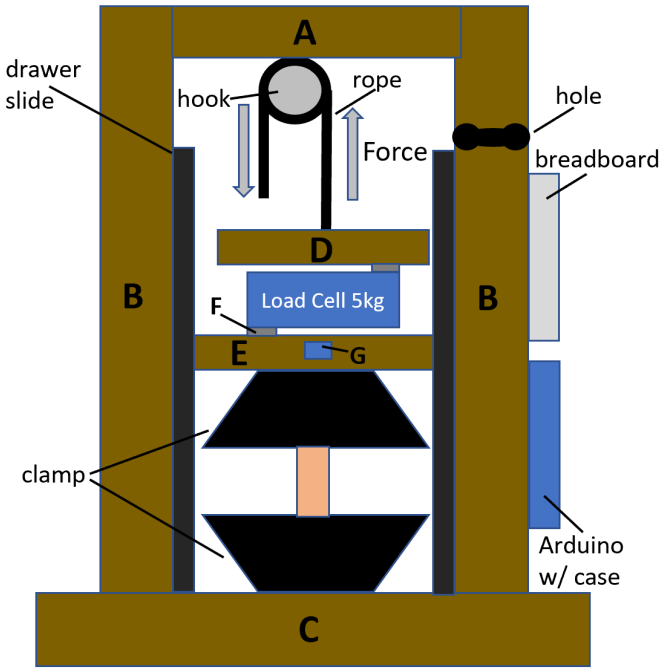


Figure 1. Current state of the tensiometer physical design.

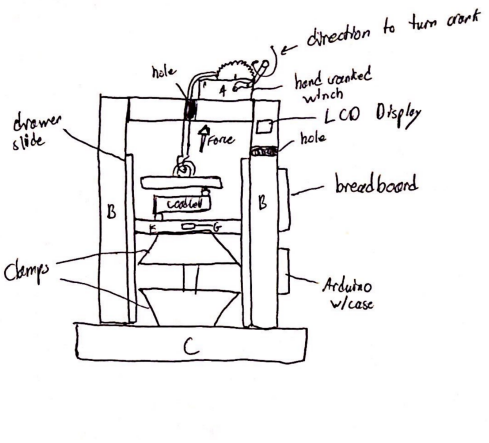


Figure 2. Improved physical design of the tensiometer

| Item | Part # | Cost |
|---|---|---|
| Ultrasonic Range Sensor | US-100 | $7 |
| Load Cell 5kg | SEN-14729 | $12 |
| Amplifier | HX711 | $10 |
| Microcontoller | Ard. Uno | $15 |
| HD44870 1602 LCD Display | HD44870 | $15 |
| Capacity Heavy Duty Hand Winch | 007 | $30 |
| **TOTAL** | | **$89** |

Table 1

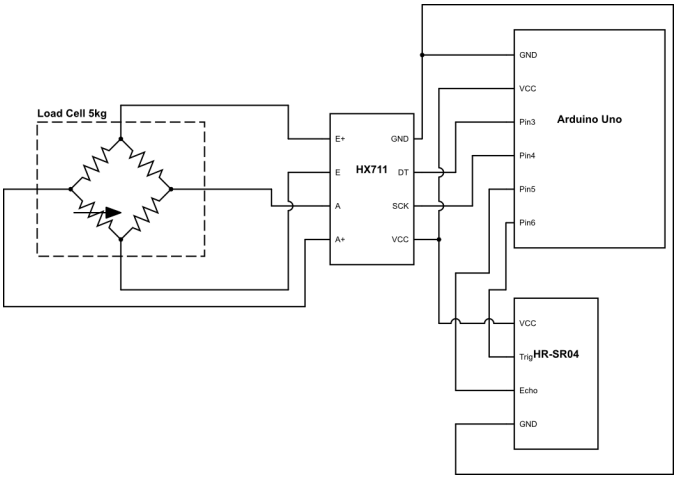


Figure 3. Schematic diagram of tensiometer electronics.

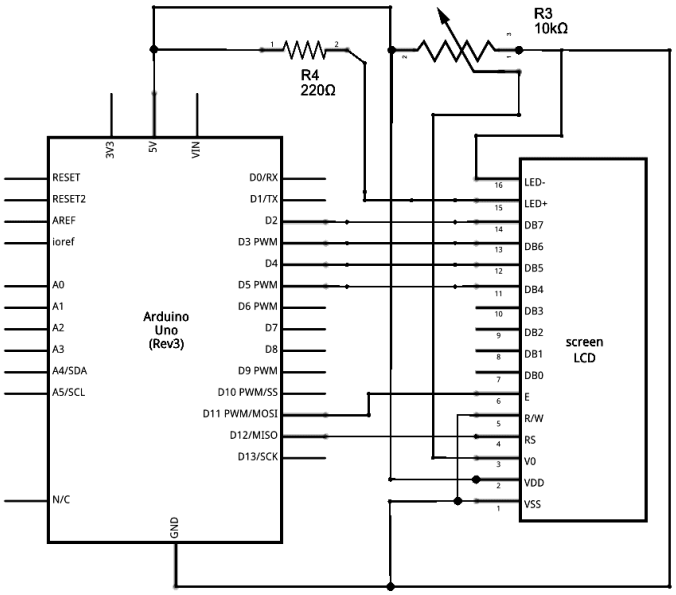


Figure 4. Schematic diagram of LCD display electronics.

are implementing in to our tensiometer system is the US-100. We decided to try out the US-100 after comparing the HC-S04 to the US-100 and the HC-S05. The US-100 has the ability to give much more precise data over the HC-S04 and the HC-S05 because it reads the temperature of the room which helps get more precise data due to the speed of sound changing based on the temperature while doing the experiment.

### 2.1.2 *Heavy Duty Hand Winch*

For the hand cranked winch to work properly, a hole will be drilled at the center of the top

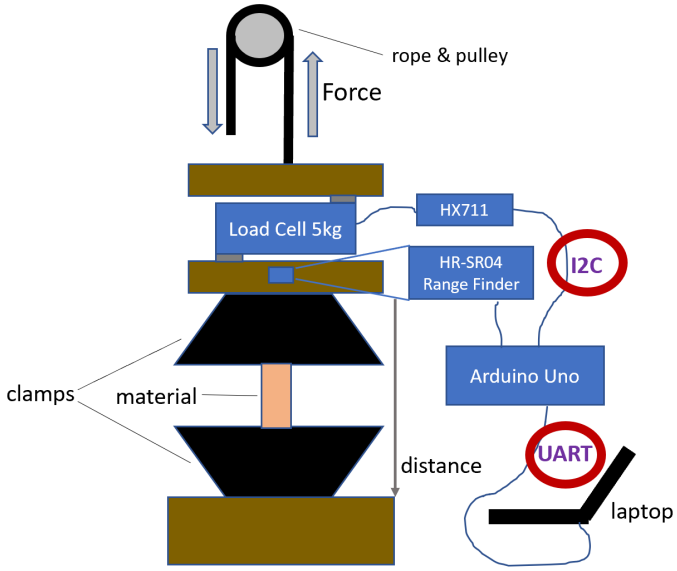


Figure 5. The current tensiometer system implements two communication standards (protocol) I2C and UART.

section (labeled A in Figure 1, 2). The hand winch will be bolted to the top of the tensiometer system. The steel-wired rope will then be ran through the hole, with a mooring hook attached at the end. A steel ring will be attached to the center of the piece containing the load cell labeled as D in Figure 1. The mooring hook will latch to this ring and will serve as the improvement on the current rope/pulley.

#### *2.1.3 HD44870 1602 LCD Display*

The LCD Display will be mounted on the right bracket of the tensiometer. Labeled in Figure 2 at location B (right). This will be integrated into the current circuitry of the tensiometer electronics. An updated diagram of how the circuitry will be integrated into the Arduino Uno can be seen on Figure 4. This location was chosen so that while the user is conducting an experiment the force and distance values can be seen at the same time. The serial monitor will still be used to collect the data for a .csv file. This will function as a supplemental physical portion of the design.

### 2.2 Engineering Standards

Document which engineering standards are incorporated into your system design. In the current system, there are two communication standards (protocols) that are utilized: I2C and UART, as shown in figure 5. Briefly describe how these work. Are there any other standards that are included in your system, such as data formatting standards? If so, briefly document them.

#### *2.2.1 I2C Protocol*

The I2C protocol is a communication protocol, that uses two wires instead of 4 like the SPI protocol uses. The I2C protocol is a little slower transferring data from one peripheral/controller to another. In this system the I2C protocol communicates between the Hx711 controller board and the Arduino to transfer data that the load cell collects and sends it to the Arduino.

#### *2.2.2 UART Protocol*

The UART protocol is a universal asynchronous receiver/Transmitter used to transmit and receive serial data. In our system the UART protocol help transmit/receive the data, imputed to the Arduino from the load cell and range sensor, to the laptop so that the data can be displayed for the user in the serial monitor. It is also used to transmit/receive data from the laptop to the Arduino.

#### *2.2.3 Data Standards*

All data collection from the Arduino IDE will be formatted so that it can be transferred to Excel seamlessly as .csv file. The distance will be it's own field, and the force will be another separate field; both will be separated by a comma.