Physical Design Proposal
Team # 8

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Activity Report

1 Proposed Solution

An existing tensile tester was provided and various improvements were supplemented that should increase the usability and overall accuracy of the system. The existing single point load cell was replaced with a S-type load cell. A motor was also introduced into the system, removing the need for students to manually stretch their materials. Improvements to the software aided the development of an accurate and precise distance/tension measurement system.

2 System Architecture

The DC motor boasting a worm drive gearbox is implemented at the top of the tensile tester frame. Its purpose is to vertically pull on the S-type load cell and remove the need for any manual operation (**figure 2**). The current system circuitry contains a load cell acting as a Wheatstone bridge. The resulting output voltage will be amplified to the range of the ADC. The H7x711 board uses said amplified voltage to perform an ADC conversion. It then communicates the results using the I2C communication standard in unison with the connected micro-controller (**figure 3**).

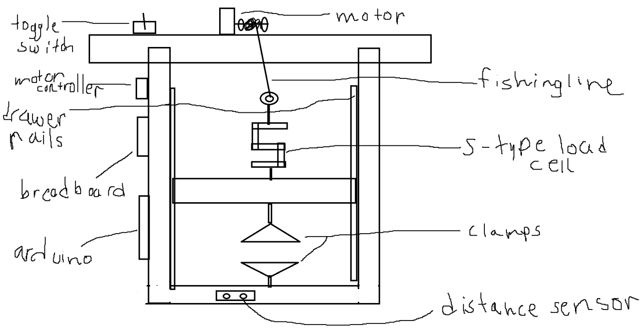

Figure 1. **Current state of the tensile tester physical design. components are labeled in the image**

2.0.1 Load Cell (5kg) / HX711 Amplifier

The existing load cell was replaced with a vertically mounted S-Type load cell to reduce horizontal displacement. The S-type load cell has the same weight rating as the single point load cell. It was soldered to the HX711 Amp Board in the same fashion as the previous design.

2.0.2 Ultrasonic Range Sensor

The Ultrasonic Sensor is unchanged other then the algorithm used to collect data. Testing proved that the sensor is accurate enough for our application. Further software improvements are being considered if needed.

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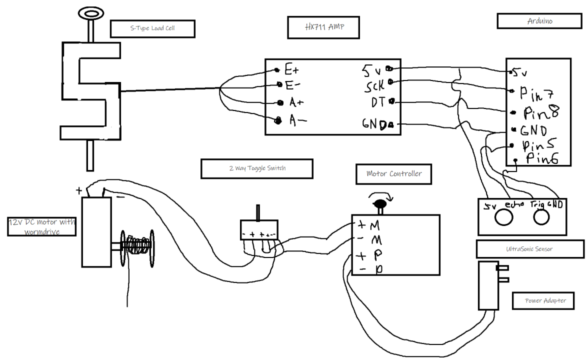

Figure 2. **Schematic diagram of tensile tester electronics.**

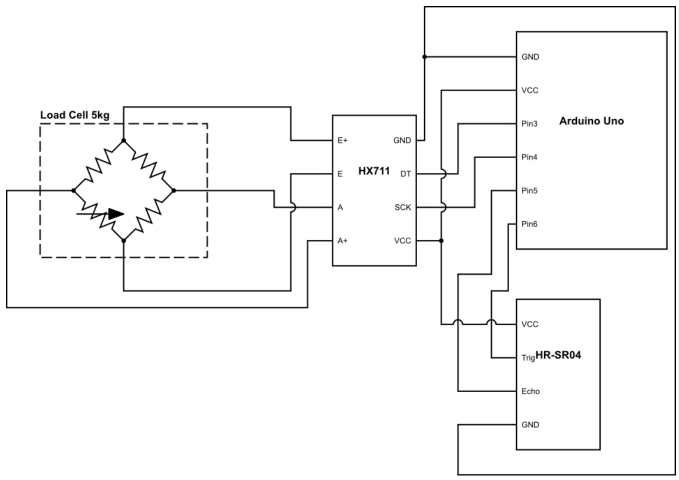

Figure 3. **Schematic diagram of tensile tester electronics.**

2.0.3 Micro controller

The micro controller of choice was the Arduino Uno. There have been no issues identified at this time with the current micro-controller and provides more then enough functionality. It will most likely be used in the final system.

2.0.4 12 V DC Motor w/ Worm Drive

The original system required the student to perform the test by manually pulling a rope to stretch their materials. This process was both tedious and inaccurate. To reduce the implications of manually stretching materials, the idea of an electric winch was introduced. The motor moves at a constant RPM and has no backlash due to the worm drive gearbox. The addition of this winch allows users to perform the test with the simple flip of a switch.

- Parts Expence (Item, Price, person)

Date	Item	Price	Person
03/22	Load Cell Sensor	36.99	Ali
	DC motor	17.59	Alex
	Winch Wheel	7.55	Alex
	Switch	5	Jeb
	Clamp Fixture (x2)	41.4	Alex
	Threaded Rod	2.89	Jeb
	Thread Locker	4.50	Jeb
	Eyelet Bolt	1.99	Jeb

Figure 4. **This is an overview new parts purchased and their estimated cost.**

2.0.5 Laptop w/ Arduino Software

The current system requires use of a computer running the Arduino IDE to collect data from the serial monitor and transferring said data into a CSV file. We intend to streamline this process using Aruindo GUI library.

2.0.6 Push Pull Force Fixture

The current system requires a tester to loosen 12 screws in order to place the material in the clamps. The team found this to be both extremely inefficient and observed the jaws on the clamp could induce premature tearing of the material. We plan to replace the existing clamp with a push pull force fixture. These fixtures have one easy to grip tightening knob and a greater holding force which make for a better overall clamp.

2.1 Engineering Standards

In the current system, there are two communication standards (protocols) that are utilized: I2C and UART, as shown in figures 6 & 7. We used data formatting standards included with Arduinos CSV Parser library.The parser turns a CSV string into an associative array. It was written with care about speed/space efficiency.

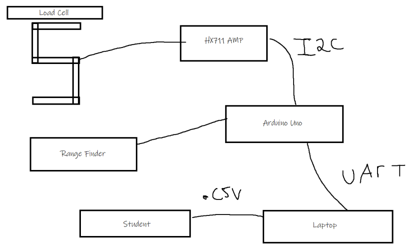

Figure 5. **The current tensile tester system implements two communication standards (protocols) I2C and UART.**

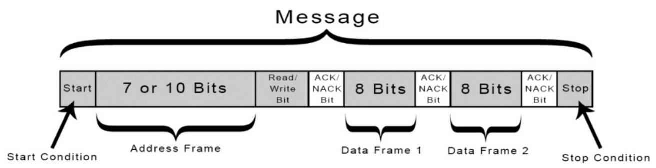

Figure 6. I2C Data Format

2.1.1 I2C Protocol

Any data that travels from our distance or load cell is transmitted to the Arduino Uno using the I2C communication protocol.

2.1.2 UART Protocol

Any data that travels from the Arduino Uno board to the testersp laptop is sent using the UART communication protocol.

2.1.3 Data Standards

After data collection the data is formatted into a .CSV file format by Arduino's CSV Parser library. This .CSV file is much easier for the tester to manipulate and extract information from then just simply using the serial monitor.

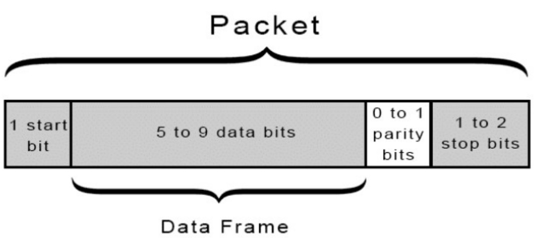

Figure 7. UART Data Format