Uniaxial Tensiometer Design

Brianna Lossow, Alexander Karampelas, Omar Elmejjati
Department of Electrical & Computer Engineering, University at Albany

Problem Statement

- The University at Albany's chemistry department, as part of their educational mission, intends to build a laboratory for undergraduate students where they can gain hands on experience testing various material properties (including tensile strength). However, due to the extremely high cost of commercial products they have been unable to equip such a laboratory.
- The goal of this project is to build an accurate, low cost, easy to use uniaxial tensile strength tester to support this educational mission.

System Requirements

- **System Accuracy:** The system should be able to accurately measure the stress-strain curve, such that Young's Modulus and Ultimate Tensile Strength can be calculated to within two significant figures.
- **System Ease-of-Use:** The system should be easy to calibrate and operate by undergraduate students without requiring knowledge of electronics or software programming.

System Components & Budget

Part	Purpose	Cost
Load Cell 20kg	Measures Force	$4
Touch Screen	User Interface	$16
microSD Card + Converter	Data Storage	$14
Microcontroller	Controls System	$40
Various Hardware	System Improvements	
	TOTAL	$87

Project Partners

- Special thanks for Professor Chen, Feldblyun, Yeung, and the University at Albany's Chemistry Department for sponsoring this project.
- This project was developed in ECE442: *Systems Analysis & Design* in the Electrical & Computer Engineering Department.

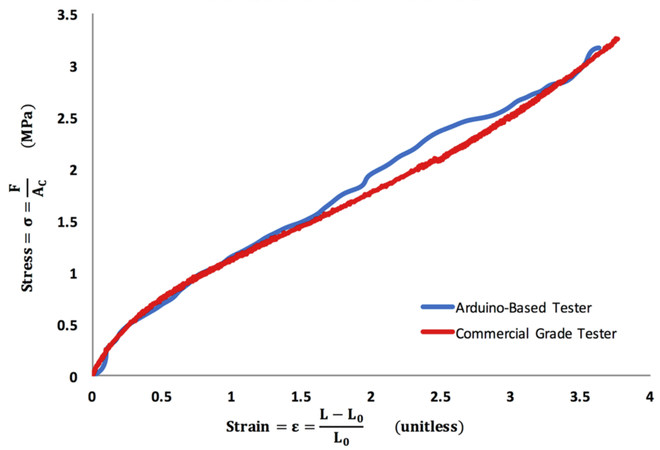
Experimental Results

System Accuracy

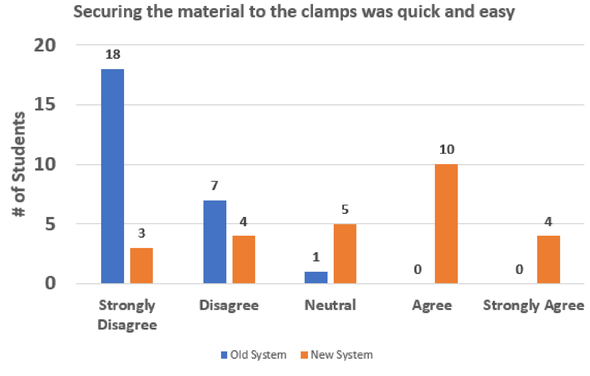
Metric	Sample	Our System	Known Value	Error
Young's Modulus	Latex	950 ± 10 kPa	740 ± 10 kPa	+22%
…	Nitrile	3.1 ± 0.2 MPa	2.4 ± 0.2 MPa	+29%
Ult. Tensile Strength	Latex	4.1 ± 0.1 MPa	3.3 ± 0.1 MPa	+24%
…	Nitrile	5.3 ± 0.1 MPa	4.4 ± 0.1 MPa	+20%

Experimental values compared to values achieved using a commercial-grade tensiometer

Stress-Strain Curve



Stress-strain curve for a latex glove for the Arduino-based and commercial-grade tensiometers



Students were given a survey in which they rated how easy the improved tensiometer is to use compared to the original design

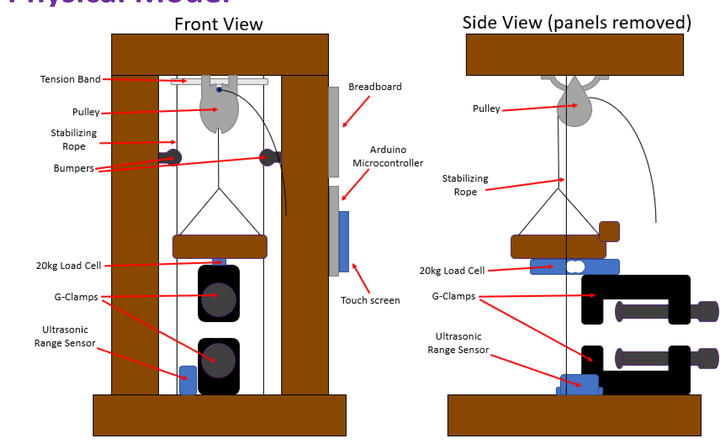
System Design

Key System Features

To satisfy system requirements, we incorporated the following design modifications:

- **Item #1**: Touch-screen GUI to facilitate ease-of-use
- **Item #2:** Improved clamp design for ease-of-use
- **Item #3:** Integrated microSD card for easy data transfer
- **Item #4:** Higher capacity load cell to increase system durability

Physical Model



View of the tensiometer from the front (left) and the side (right) with the side pieces removed for clarity

User Interface Layout

The main menu (left), the calibrate menu (center), and the tare menu (right) within the associated graphical user interface