Logical Design Proposal Improving the Ultimate Tensile Strength Team One

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Activity Report

Abstract—Based upon the original design of the tensiometer, issues were encountered that inhibited the process to calculate a stress-strain curve. Therefore, by replacing the clamps and adding a winch, the system would improve drastically. The original clamps that were given lowered the amount of time you can measure force in a given amount of time, due to how long it takes to actually put the material within said clamps. Thus, 3-D printed clamps that make the process of measuring the material easier. Same thing can be said about the original pulley system. Originally someone would have to pull on the rope manually to allow force to be measured and to stretch the material, but this leads to inaccuracy due to many factors like pulling the rope too fast. So, by adding a winch to the design, it allows us to stretch the material with a rope at a more constant speed that can be replicated. Once, these improvements are made, the next step would be to find the median of the load and distance data. This will be done by improving the program that is used to help compute the stress-strain curve.

Index Terms—Uniaxial Tensiometer, System Analysis, Engineering Design

1 Background

While using the Ultimate Tensile Strength Tester there were some issues that arose. Such issues were: the tensiometer clamps, accurately of the distance which is due to the ultrasonic proximity sensor. In order to test the system with some real material, like nitrile medical gloves we need to open the tensiometer clamps to place the material between them. However, screwing open and securing the material in the tensiometer clamps wasn't user friendly and also time consuming when doing various trials. Once the material was placed between the tensiometer clamps, the material was stretched to collect data. The data was skewed and once the material broke, the ultrasonic proximity sensor was displaying inaccurate data. In order to improve on these issues, we decided to change the tensiometer clamps.There were some limitations in this solution, because when searching for clamps there weren't an existing solutions on the market. The clamps were either to big, or didn't have teeth to hold the material. Therefore, we decided to 3D-print our own design of a tensiometer clamp. This improvement will benefit the project stakeholders by making the system user friendly. Another improvement we will implement is including a mini winch which will be used to pull the rope. This will help improve the accuracy of the ultrasonic proximity sensor by eliminating human error when pulling the rope. Data accurately and precision is the most important aspects therefore benefit the customer using the system.Some limitations in this solution were being able to find a mini winch on the market that fits the dimensions of our system and is within our budget.

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2 System Requirements & Constraints

Figure 1 depicts the system use cases discussed in class. In this section, define requirements that your proposed system addresses. See the constraints section (Section 2.3) for non-functional system requirements that have already been defined in class. This section should focus on functional requirements. It is critical here that you prioritize requirements that are the **most important** to the stakeholder. These are the requirements that your proposed idea should be improving. For each requirement, summarize the required functionality in detail. Use subsections to organize this information.

2.1 Requirement #1 Simple Clamps

This clamp will hold onto the User's material. The User must use a screw driver, the two pieces of the clamp and the material they are testing to interact with the clamp. The User needs to separate the two parts of a clamp with a screw driver(flat head or corkscrew), then place the material in between the "teeth" of the two parts of the clamp. Afterwards, the User must use the screwdriver to hold the two parts of the clamp with the material in between. These actions are performed twice in total for each edge of the material. The User will see two clamps screwed onto the machine. The clamp they see will have one part that is long and is directly screwed onto the machine. The other part of the clamp is screwed onto the first part the clamp.

Normal Flow
To Secure material to the clamps

- **Step #1: Remove screws from clamps**
- **Step #2: Place material within clamps**
- **Step #3: Screw clamps back together to secure material**

Alternative Flow
Material slips through clamp

- **Step #1: Unscrew clamps again**
- **Step #2: Place material through clamps**
- **Step #3: Screw clamps back together to secure material**

2.2 Requirement #2 Crank System

The use case that aligns with a crank system is the Run tensile test use case. The crank system will stretch the material as long as the User wills it to. The User, will rotate the crank handle after their tensile test has started and will continue to do so until the material snaps or the load sensor has reached it's max load. The User will see a simple crank attached to the tensile tester that has a rope attached to it. This crank is behind the tensile tester, and the User should also see a handle attached to this crank.

Normal Flow
Operating Crank

- **Step #1: Make sure material is secured**
- **Step #2: Look for crank handle behind the tensiometer**
- **Step #3: Turn crank counter clockwise**

Alternative Flow
Crank is stuck or won't move

- **Step #1: Make sure crank is being turned counter clockwise**
- **Step #2: Look for the wheel section of the crank and look for abnormalities that are preventing the wheel from moving**
- **Step #3: Turn crank to see if the prior steps have fixed anything**

2.3 Constraints

Constraints restrict the design process and limit the potential solutions. For this project, system constraints have already been defined and have been given to you below:

- **Time Constraint:** Completed and read to presentation/demonstrate by April 22nd

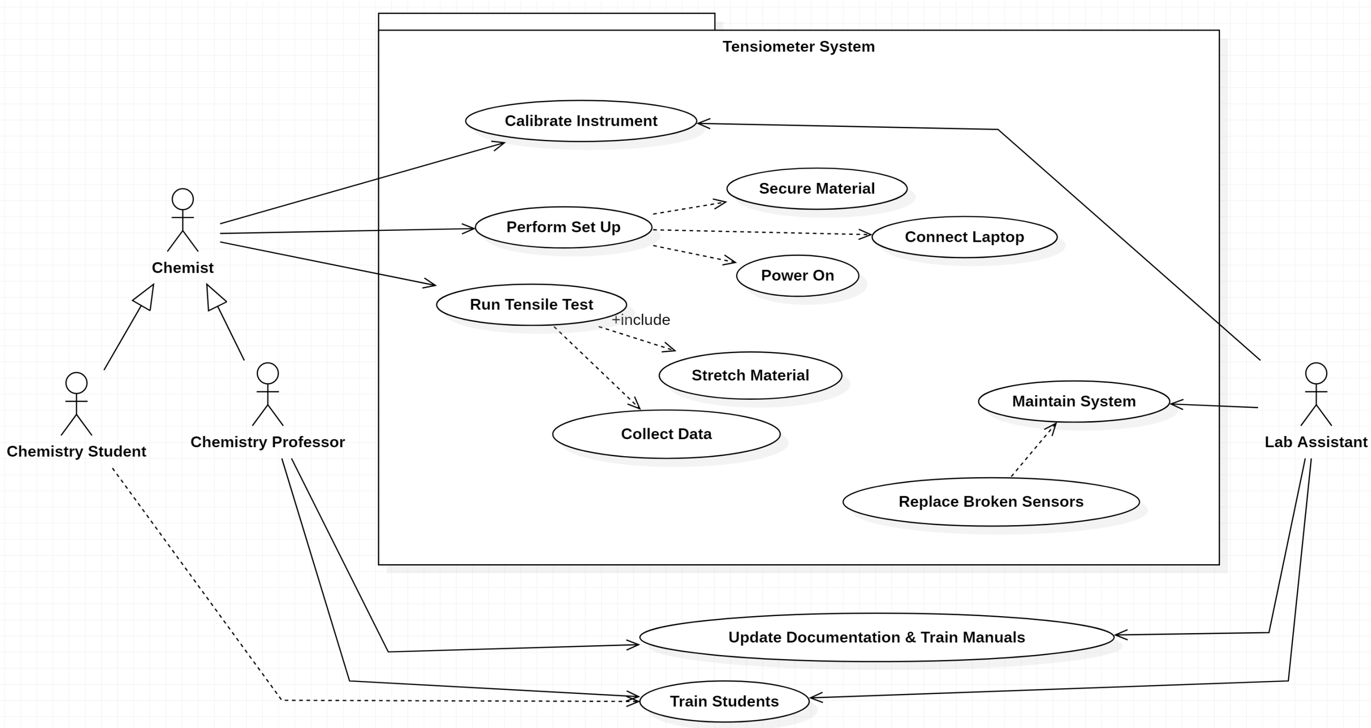

Figure 1. Use case model of the tensiometer system depicting system actors and the desire actions the system is required to support.

- **Budget:** Cost needs to be below $150. Going over budget will require strong justification as to the value added from the cost overrun.
- **Replication:** Relatively straight-forward process to replicate your work, such that we can build out a lab of identical tensiometers.
- **Accessibility of Parts:** Parts need to be readily accessible, ship quickly (not on back order) and available from common part suppliers (e.g., Digikey, Mouser, Adafruit, SparkFun, Amazon). Avoid parts that are difficult to source.
- **Safety:** System must be safe to operate without significant training or supervision

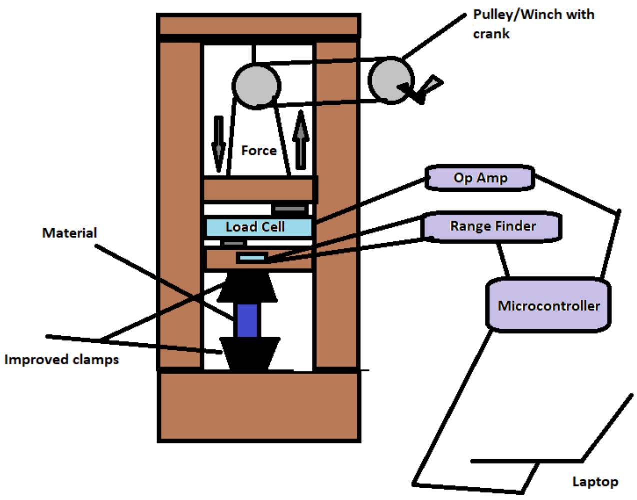

Figure 2. Improved Tensiometer Design

3 Logical Design

As seen in the diagram, we put forth ideas that will further improve our tensiometer design to make it easier to use. Most of the design functions are the same as before, where the load cell will measure the force of the material (that is being held by clamps) over the distance that is being stretched by. Although, within our diagram we sought out to make an improvement on the clamps to allow ease within holding the material and a pulley/winch with a crank to make the stretching of a material easier.

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3.1 Design Justification

This design was chosen based upon the existing problems that we saw with the base design, thus allowing us to innovate and create a better system.

References