The Knotorious Five

September 26th - October 2nd

Client: Dr. Margene Anderson, Dr. Sara Colopy. Dr. Paul Merkatoris
Advisor: Professor Wally Block

Team Members:
Madison Michels (mmichels2@wisc.edu), Leader
Lucy Hockerman (lhockerman@wisc.edu), Communicator
Presley Hansen (pmhansen3@wisc.edu), BWIG
Sadie Rowe (skrowe2@wisc.edu), BPAG
Kate Hiller (khiller@wisc.edu), BSAC

Problem Statement:

In veterinary training, mastering the skill of applying appropriate suture tension is essential for successful wound closure and patient recovery, However, novice practitioners often struggle to judge the correct amount of force needed, leading to either insufficient tension or excessive tension, which can cause plastic deformation of the suture material or tissue damage. Currently, the evaluation of suture technique relies heavily upon subjective instructor feedback, lacking objective, real-time metrics to guide learners. This gap hinders consistent skill development and increases the risk of procedural errors. There is a critical need for a real-time suture tension measurement and feedback system to help students learn to apply optimal tension, prevent material or tissue compromise, and improve surgical outcomes through data-driven training.

Brief Status Update:

This week, the team learned the proper suturing technique for a square knot and had our second client meeting. We began working on our preliminary presentation and drew up potential design ideas for the three measurement approaches. The team met multiple times throughout the week to evaluate our choices and fine tune the preliminary presentation. We presented our presentation to our advisor, Wally Block, for feedback and plan to present again on Friday, October 3rd.

Team Goals:

- In the upcoming week, the team plans to divide into three groups to tackle our preliminary prototyping. We have one team assigned to prototyping a force sensor system, one prototyping a displacement sensor system, and one researching cameras for an AI image analysis system.

Individual Accomplishments:

- Lucy: This week, I worked on my section of the preliminary design presentation that focused on tension and pressure methods.
- Presley: This week, I worked on my portion of the preliminary design presentation, which included the displacement measurement technique. I created two different design drawings, one which used a ruler and one which used a location sensor to measure displacement as an indicator of plastic deformation in the knot.
- Maddie: This week I ordered and fabricated a force sensor resistor circuit. I built a voltage divider circuit and wrote code to process the output voltage, converting it into resistance. I also worked on my presentation slides and formalized the presentation. (MY PROGRESS IS SHOWN AT THE BOTTOM OF THIS DOCUMENT)
- Sadie: This week, I developed my section of the preliminary design presentation, which addressed product design specifications and described how knot characteristics can be optically analyzed to assess knot security. I also began work on the preliminary presentation so next week can be focused on making tangible project progress.
- Kate: This week I worked on my section of the preliminary design presentation, which included establishing the need for the product and competing force measurement designs.

Individual Struggles:

- Lucy: No struggles this week
- Presley: I was struggling to decide which designs the team should move forward with prototyping, but after a conversation with our advisor I think we have come to a decision.
- Maddie: I am struggling to convert the resistance output into a force value. I also am unsure thus far of what resistor value to use in my circuit.
- Sadie: This week, I struggled to identify which design was best to move forward with, but I feel more confident after our team's conversation with Dr. Block
- Kate: I have no struggles this week.

Individual Goals:

- Lucy: I plan to complete the preliminary report sections involving testing methods. This will involve researching previous testing methods and discussing with the team the main PDS requirements that are a priority for initial prototype testing.
- Presley: I plan to work on my portion of the preliminary report, specifically in regards with the measurement technique of displacement. I would also like to start prototyping with the force/pressure measurement technique.
- Maddie: I plan to create a csv file to store the sensor data in that can be utilized to record different forces and resistance values during testing of different resistors, locations on the hand, and suture sizes.

- Sadie: I plan to set up a meeting with Dr. Andreas Velten, a professor here who develops imaging and pattern recognition methods using ultra-fast single-photon cameras. I hope to learn from his expertise and explore ideas for how we might characterize good versus bad knots with a machine learning model. I will also complete my work on the preliminary report.
- Kate: I plan to complete the background and design evaluation portion of the preliminary report. I also plan on starting to prototype my assigned measurement method, if this is the tension/force method, I will complete MTS testing to create a stress vs. strain graph to quantify the material properties.

Project Timeline:

Week	Description	Status
9/5 - 9/11 Week 1	Initial research	Complete
	Client Meeting 1	Complete
	Team Meeting 1	Complete 9/12
	Advisor Meeting 1	Advisor did not attend
9/12 - 9/18 Week 2	Product Design Specifications	Due 9/16
	Team Meeting 2	Complete 9/18
9/19 - 9/25 Week 3	Design Matrix	Due 9/25
	Team Meeting 3	Complete 9/22 Complete 9/24
	Advisor Meeting 2	Complete 9/19
	Meeting with Dr. Numinkar	Complete 9/24
9/26 - 10/2 Week 4	Client Meeting 3	Complete 9/26
	Team Meeting 4	Complete 9/29 and 10/1
	Preliminary Presentation Review	Complete 10/1
10/3 - 10/9 Week 5	**Preliminary Presentation**	**Planned for 10/3 at 12:35 PM**
	Preliminary Report	**Due 10/8**

	Team Meeting 5	Planned for 10/6
10/10 - 10/16 Week 6		
10/17 - 10/23 Week 7		
10/24 - 10/30 Week 8		
10/31 - 11/7 Week 9		
11/8 - 11/14 Week 10		
11/15 - 11/21 Week 11		
11/22 - 11/28 Week 12		
11/29 - 12/5 Week 13		
12/6 - 12/12 Week 14		
12/13 - 12/18 Week 15		
Winter Break		

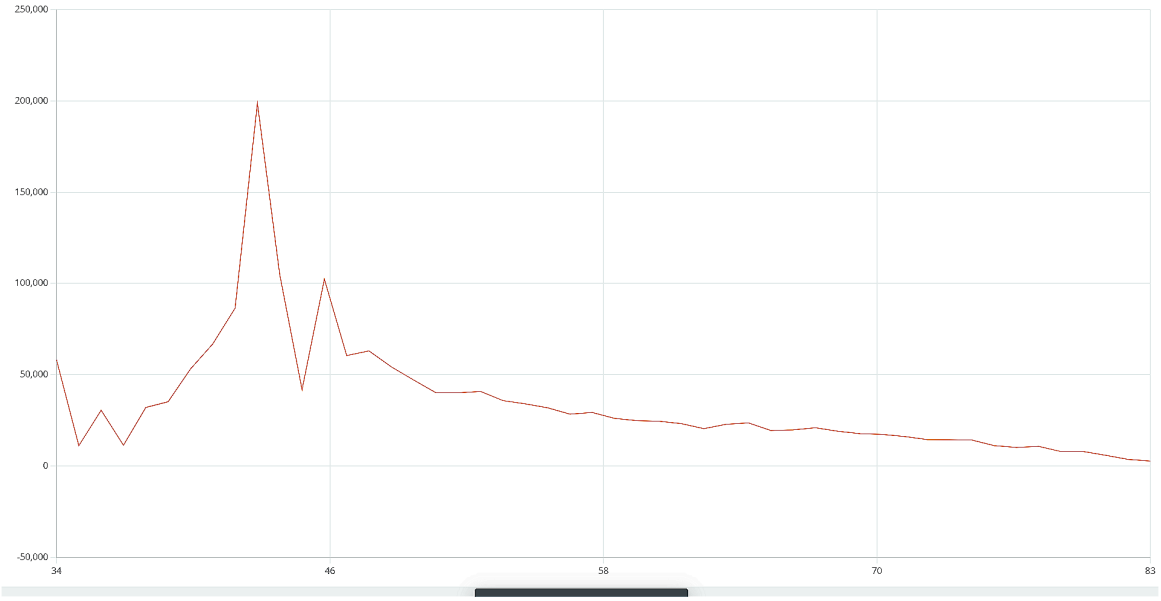
Expenses

Item	Description	Manufacturer	Mft Pt#	Vendor	Vendor Cat#	Date	QTY	Cost Each	Total	Link
Force Sensor Resistor	Force sensor that outputs resistance in a voltage	Haosie?	N/A	Amazon Prime	N/A	10/1	1	$7.59	$7.59	Link

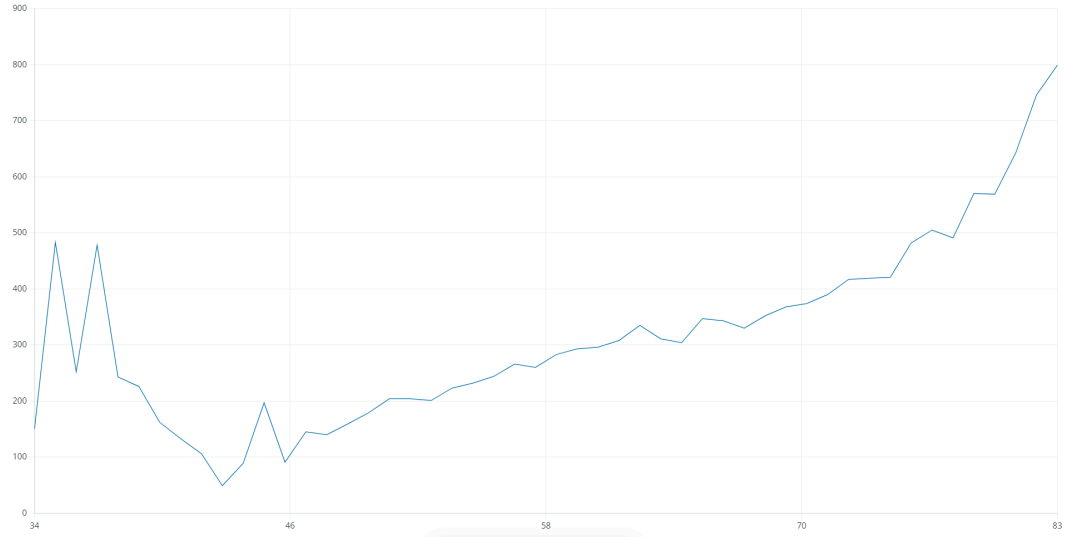
	divider circuit (2 in pack)									

Force Sensor Circuit, Code, and Output

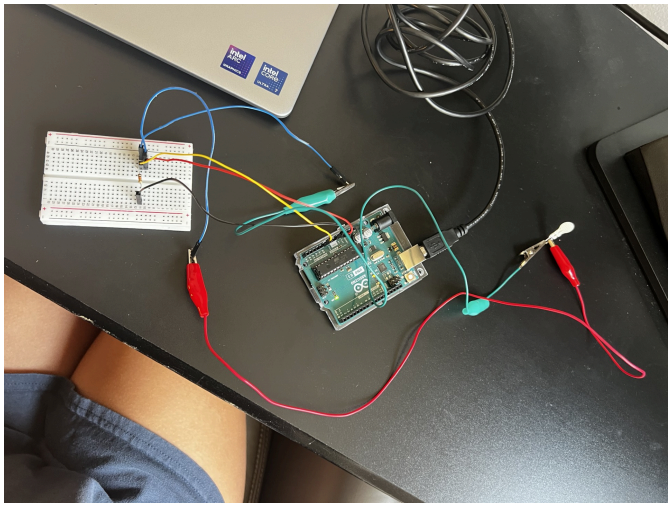
Resistance Output:



Force Output:



Circuit:



Code:

```
const int fsrPin = A0; // FSR connected to A0
void setup() {  Serial.begin(9600);}
void loop()
{  int fsrValue = analogRead(fsrPin); // Read FSR
float voltage = fsrValue * (5.0 / 1023.0); // Convert to voltage
float fsrResistance = (5.0 - voltage) * 10000.0 / voltage; // Estimate
resistance

Serial.print("\t");
Serial.print(fsrValue);
Serial.print("\t");
Serial.println(fsrResistance);
Serial.print("\t");
delay(500); //faster sampling for smoother plot, decrease delay}
```