The Knotorious Five

November 21st - December 4th

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
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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 re-evaluated each model using the same 40 testing images. From these tests, we collected accuracy, precision, recall, and F1 scores. We also created new confusion matrices for easier comparison between models. We spent the remainder of the week synthesizing our results and completing the final presentation.

Team Goals:

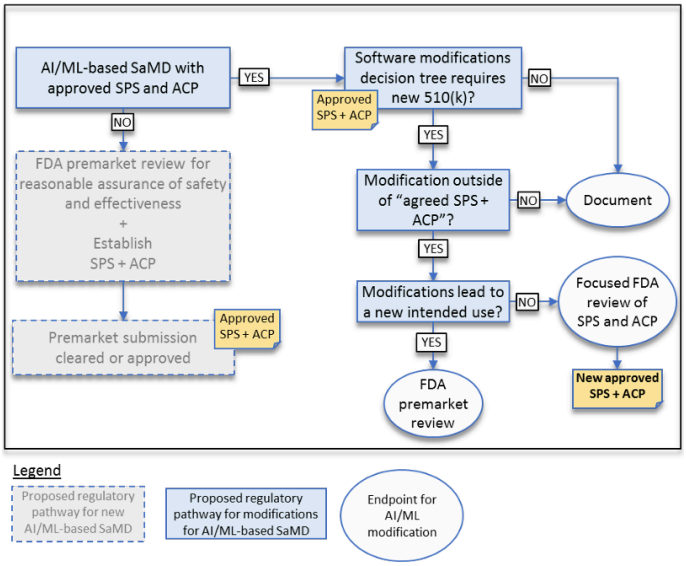
- In the upcoming week, the team plans to present our final presentation. We also plan to update the final report with our final designs, testing plans, and testing results.

Individual Accomplishments:

- Lucy: This week, I ran the RoboFlow model and gathered data on the confidence intervals for each image identification to assess the overall success of the model. I completed the discussion and future work sections of the team's final semester poster and

met with the group to go through presentation content and final report assignments. I conducted research that addressed possible F1 score variations, the positives using ResNet models, and CNN performance effects on background variability (see LabArchives).

- Presley: This week I re-ran my top only model with the new code that Maddie made to get new confusion matrix values for the results portion of the final presentation. I completed the Design Specifications and Concept Prototyping portions of the final presentation and met with the group to organize and practice for poster presentations on Friday.
- Maddie: This week, I created and ran new code to retest my two models on the same images as the other models. I created two new confusion matrices from this data. I completed the model design of the final presentation and met with the group to go through the presentation content. I printed the poster on Wednesday and did some final, clarifying research on ResNet and VGG features, hidden layers, and edits we can make in the future to improve the models. I also research FDA regulations around SaMDs and found this general layout for the path an SaMD needs to take for regulatory approval and regular checkpoints:



  - Research
    - Input layer: takes in new raw image data
    - Output layer: gives you the final result, like a label for image classification
    - Hidden layers: sit between input and output, do most of the work
      - Each hidden layer acts as a filter, filtering out certain features to focus on a different feature each time
      - Size of hidden layers equates to model success
        - Less than 30 hidden neurons: neural network may have lower accuracy and higher variability

        - More than 50 hidden neurons: model can generalize better and show less variability
    - Using multiple hidden layers allows you to learn more detailed image features but you need enough data to avoid adverse results
    - Regularization methods (like dropout) can reduce overfitting
    - ResNet solves gradient vanishing in deep neural networking - introduces residual connections
    - ResNet replaces a fully connected layer with a global average pool layer
- Kate: This week, I completed the problem statement and background & impact section on the final report. I met with the team to practice the presentation and finalize the poster. Then I printed and picked up the poster for the presentation on Friday. Also, I researched Convolutional Neural Networks (CNN) to better understand how the VGG and ResNet models work.
- Sadie: This week, I wrote Python code to load and evaluate the Roboflow model. I developed a script to loop through the 80-image test dataset and generate performance metrics comparable to the TensorFlow models, including the confusion matrix, accuracy, precision, recall, and F1 score. I analyzed results from all five models, created graphs for side-by-side comparison, and calculated additional metric values using **loose knots** as the positive condition. I then completed the results section of our poster and met with the team to rehearse the presentation prior to printing. In addition, I conducted research (documented in LabArchives) on FDA regulations for AI/ML-based medical devices, which helped clarify which model evaluation and documentation requirements are most important for our final deliverables.

Individual Struggles:

- Lucy: No struggles this week.
- Presley: No struggles this week.
- Maddie: No struggles this week.
- Kate: No struggles this week.
- Sadie: No struggles this week.

Individual Goals:

- Lucy: My goal for the upcoming week is to present the final poster with the team and complete all remaining final deliverables including the final report.
- Presley: My goal for the upcoming week is to complete my section of the final report and present our work at the poster presentation on Friday.
- Maddie: My goal for the upcoming week is to complete my report section and present our design with clarity and successfully answer questions.
- Kate: My goal for this week is to present our work this semester well on Friday and complete my section of the final report.

- Sadie: My goal for the upcoming week is to present our final poster and complete all remaining deliverables so we can wrap up the project for the semester and be fully prepared to continue next semester.

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	Complete 10/3 at 12:35 PM
	Preliminary Report	**Due 10/8**
10/10 - 10/16 Week 6	Advisor Meeting 3	Scheduled for 10/10
	Team Meeting 5	Scheduled for 10/10
10/17 - 10/23 Week 7	Advisor Meeting 3	Scheduled for 10/17
	Team Meeting 5	Scheduled for 10/17
	Force Sensor Resistor Value Testing and Research	Goal by 10/17

	Calibrate Sensor	Goal by 10/17
	Determine Output Force Equation	Goal by 10/17
	MTS Testing	Goal by 10/17
10/24 - 10/30 Week 8	Advisor Meeting 4	Scheduled for 10/24
	Team Meeting 6	Scheduled for 10/24
	Add Visual Queue to Circuit	Goal by 10/24
	RoboFlow Model	Goal by 10/24
	MTS Data Analysis	Goal by 10/24
	Python Model	Goal by 10/24
10/31 - 11/6 Week 9	**Show and Tell**	**Due 10/31**
	Team Meeting 7	Scheduled for 10/31
11/7 - 11/14 Week 10	Advisor Meeting 5	Scheduled for 11/07
	Team Meeting 8	Scheduled for 11/07
	Team Meeting 9	Scheduled for 11/12
11/14 - 11/20 Week 11	Advisor Meeting 6	Scheduled for 11/14
	Team Meeting 10	Scheduled for 11/14
	Team Meeting 11	Scheduled for 11/19
Thanksgiving Break 11/22 - 11/28		
11/29 - 12/5 Week 13	**Final Presentation**	**Due 12/05**
12/6 - 12/12 Week 14	**Final Report**	**Due 12/10**
	Advisor Meeting 7	Scheduled for 12/6
	Team Meeting 12	Scheduled for 12/6
12/13 - 12/18 Week 15	Advisor Meeting 8	Scheduled for 12/13
	Team Meeting 13	Scheduled for 12/13

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 divider circuit (2 in pack)	Haosie?	N/A	Amazon Prime	N/A	10/1	1	$7.59	$7.59	Link