CS480X Final Project Process Book

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Overview and Motivation

Overview

Our final project was an exploratory data analysis tool to visualize the data and assist in tuning the parameters of a clustering algorithm used to classify different types of contact on a prosthetic finger.

Thumb prosthesis to which the sensors will be attached

Motivation

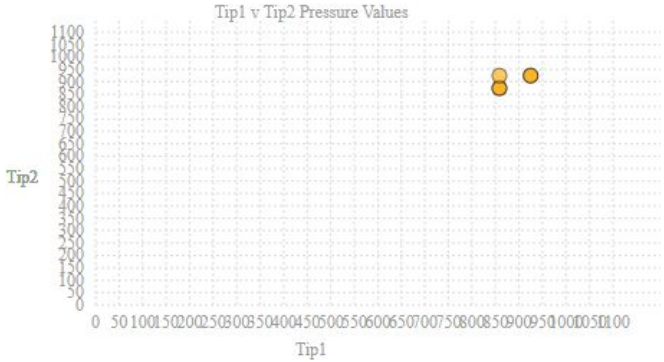
Brian Fay and Andrew Fisher's MQP is a partial hand prosthetic which has a haptic feedback component. The goal of the project is to provide 3 different types of haptic feedback patterns, corresponding to 3 different types of contact with the finger. Each segment of each finger is equipped with a velostat pressure sensor, which senses total pressure.

In order to categorize the data points we used a clustering algorithm on the values and their derivatives. We took the derivatives of the values to provide another meaningful dimension to the data. In order to determine the validity of this method we used a scatter plot and a parallel coordinate chart of the values and their derivatives to visualize the different categorizations. This visualization allows for immediate feedback as we use the tool built in to webpage to adjust our clustering algorithm.

Related Work

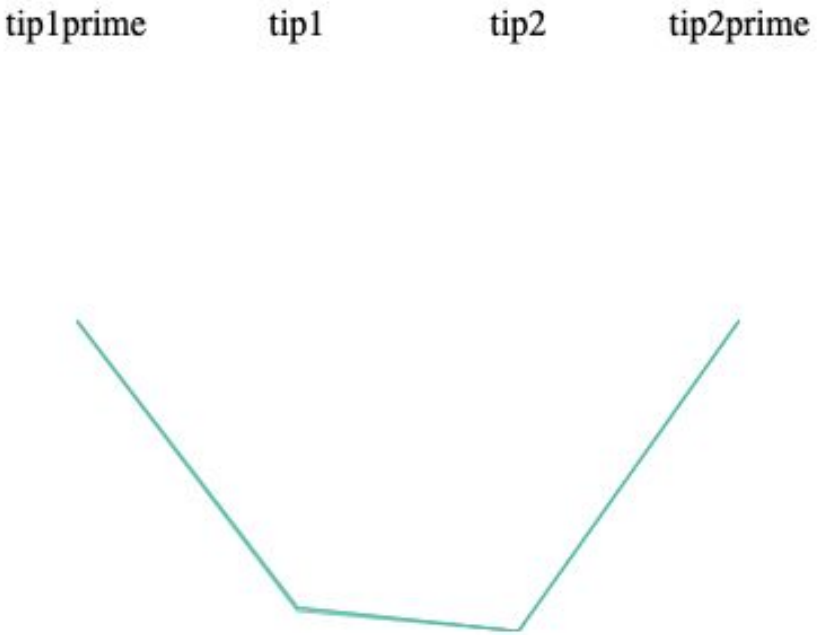
Scatter plot

One of the best ways we decided to visualize the data from the sensor would be in a scatter plot. This was because we thought it would be a simple, yet effective way to display the varying pressure values that the sensor data would provide. We set the scatterplot up so that the values appear as they happen from the video. The two most solid circles indicate what the pressure was. The faded circle would indicate when the pressure would decrease.



Parallel coordinate chart

Our parallel axis chart shows the pressure from the two fingertips and the first derivative of pressure. The graph automatically updates along with the video. It works by trying a path from the vertical axis of tip1prime to the axis of tip2prime



Questions

Initial questions

Initially we only sought to visualize the the dataset in a scatterplot and parallel category chart, along with their categorization represented though color. We wanted to know how different the data points were when plotted along their pressure value and its derivatives to determine if they were of a spread that was valid for clustering.

We also wanted to be able to visualize the results of a clustering algorithm to determine if the clustering algorithm and parameters produce results that make sense.

Additional Questions

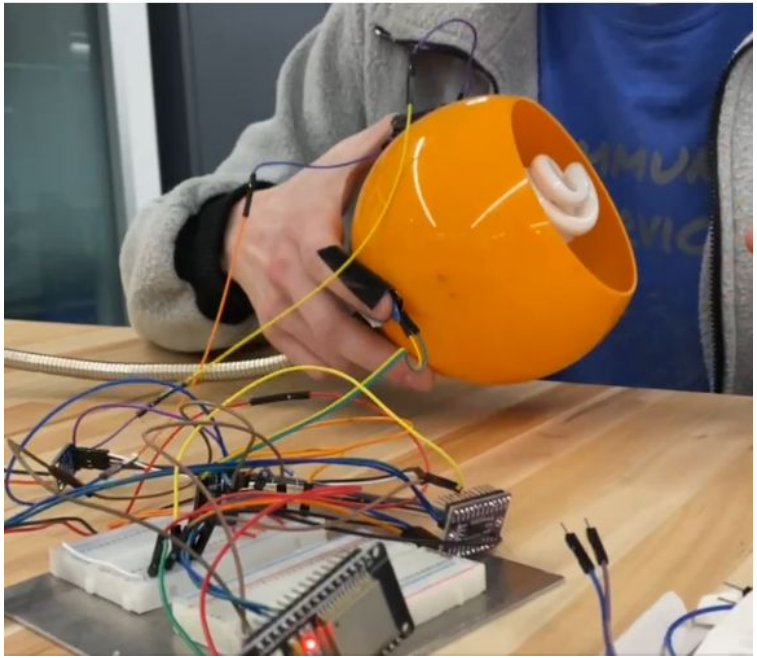
As we progressed, we realized that assigning meaning to the data points from only their pressure value and its derivatives was quite difficult, and we wanted to know if there was a way to aid in this. To do this we matched the timing of a video to data points appearing on a scatter plot, which made the meaning of the data points much clearer.

Data

Data Collection

To collect our data we taped two velostat pressure sensors to a team member's fingers and had them conduct a series of trials handling an object. The team member held, tapped, and let the object slip to provide a range of contact types.

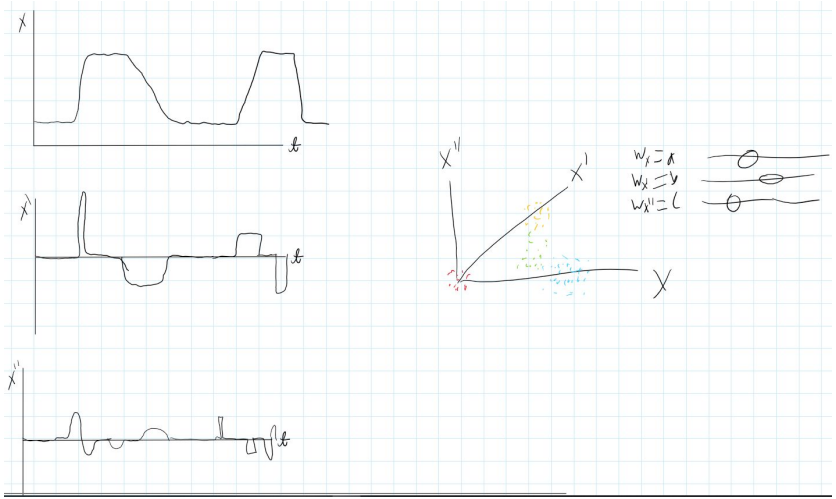
The data were recorded with timestamps as json.



Design Evolution:

Visualization changes

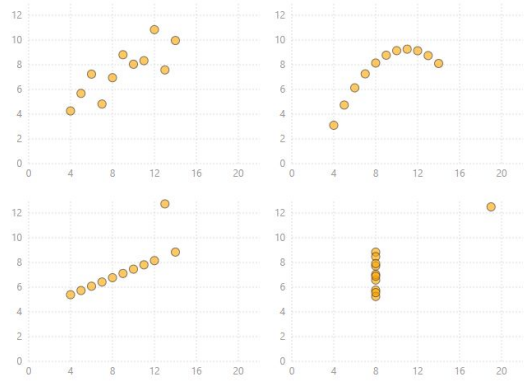
We originally sought to use the second derivative along with the first and the pressure value to make our visualizations in three dimensions, but we found that the noise and sampling rate made the second derivative un-meaningful. Thus we changed to make our visualizations all two dimensional, using only the pressure value and its first derivative. We also made the addition of a video timed with the the collected data appearing on a scatter plot to provide context to the values.



Original visualization plan with the second derivative.

Scatterplot changes

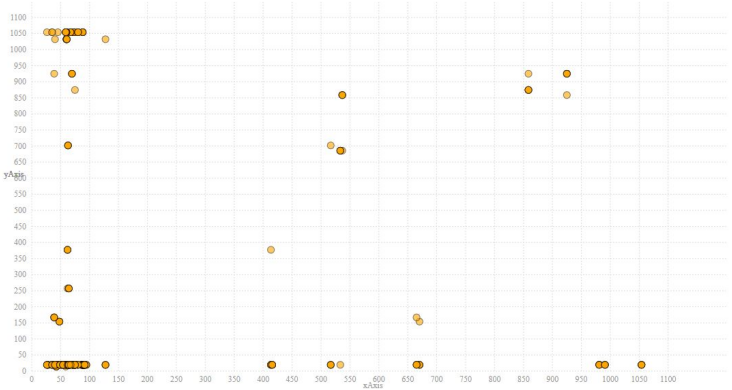
The initial code for the scatter plots was basic. It loaded in some arbitrary data from an array and would display them all. We used this as our base for the scatter plot.



First scatterplots

Scatterplot changes

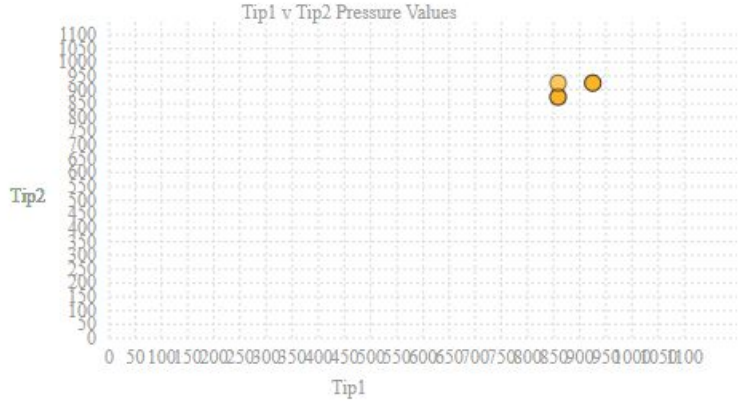
Our second iteration of the scatter plot was a more solidified version. For this iteration, we changed the code to load data from a .JSON file that contained the data points from the sensor. This iteration loaded and displayed all of the data at once. This wasn't fully what we wanted but it was a step in the final direction.



Second scatterplot attempt

Scatterplot changes

Our final scatterplot attempt was animated. The data from the sensor also had timestamps from the video where they occurred. What this allowed us to do would be to animate the scatterplot so that as the video played and the sensors would have different data recorded, the scatterplot would display the values that the sensor would read at that given time.



Final scatterplot attempt