PROJECT FOUR: MILESTONE 4 – COVER PAGE

Team Number: | Thurs-07

Please list full names and MacID's of all *present* Team Members
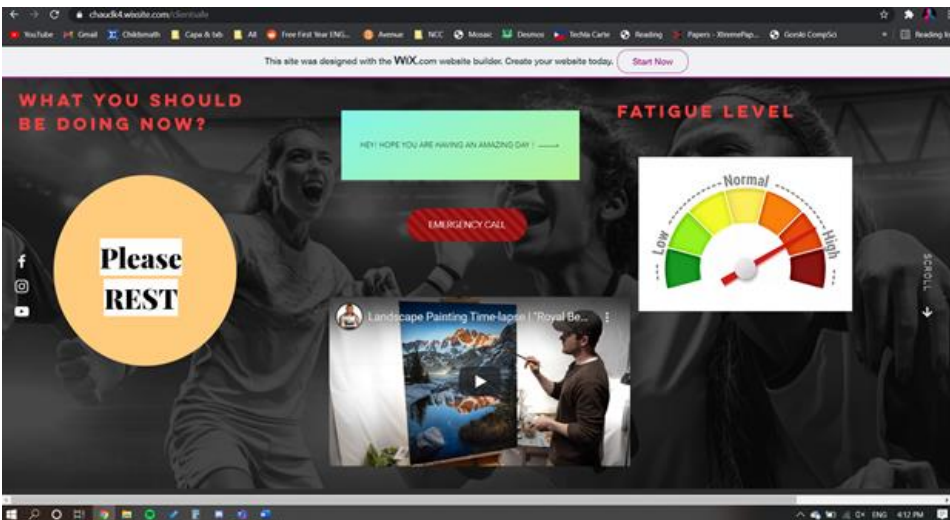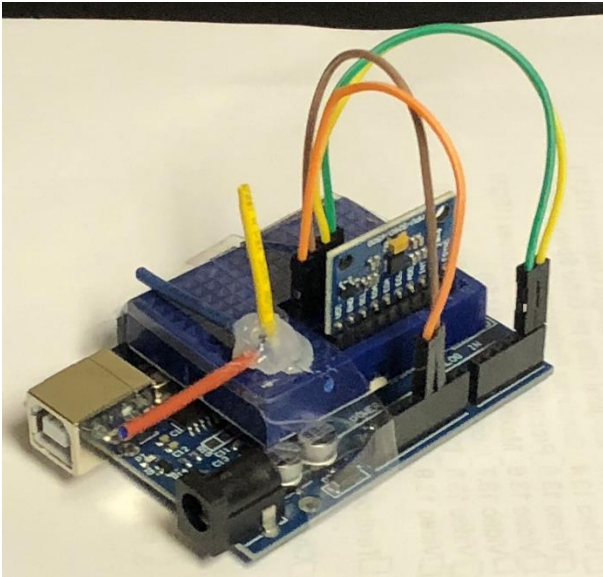
Full Name:	MacID:
Blake Freer	freerb
Samuel Parent	parens4
Dehe Meng	mengd9
Kartik Chaudhari	chaudk4

MILESTONE 4.1 – REFINED PROTOTYPE + PROTOTYPING TEST PLAN

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1. Take picture(s) of your refined prototype.
   → Insert your photo(s) as a Picture (Insert > Picture > This Device)
   → **Do not include more than *two* pictures per page**

Previous Prototypes

Previous Prototypes

File: Receive and Store Data

Lead: Blake Freer and Samuel Parent

Functions:

- Receive data from serial
- Format data in 2d array
- Store last x entries in a .csv file

*Note: preferably done using multiprocessing with concurrency model i.e. threading

File: Analyze Data

Lead: Samuel Parent

Functions:

- Possible: Find norm of the accelerometer data
- Possible: find the average jerk for a set of points
- Possible: Find the frequency of periodic acceleration using positive and negative as change values
- Determine the fatigue level:
  - using one of the above methods, determine if significant trembling has occurred in a time interval
  - if it has added 1 to fatigue level, if fatigue level is below 3, do nothing, if fatigue level is above 3 subtract 1
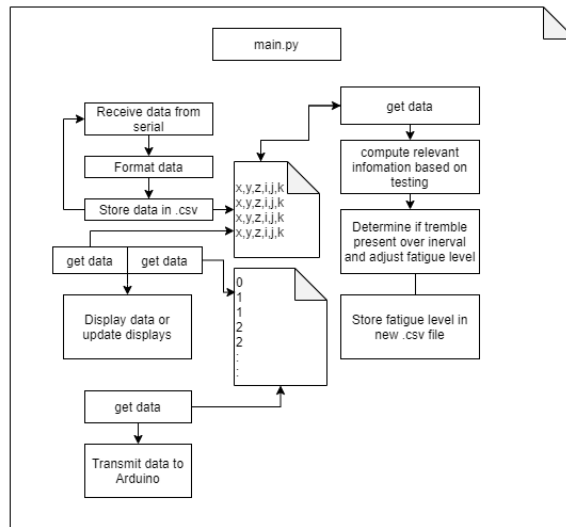 - returns the new fatigue level
- Read from CSV file

*Note: test data required to know how data analysis will be done.

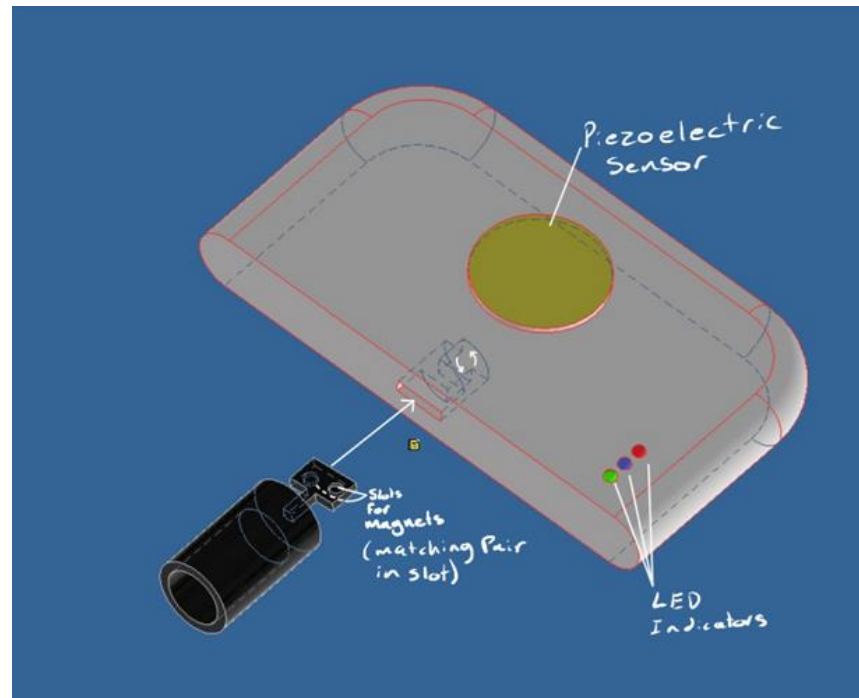**File: Receive and Store Data**

Lead: Kartik

Functions:

- Display level of fatigue
- Display graph
- Possible: update displays
- use: read from csv file from analyze data

File: Transmit Fatigue Data

Lead: Blake Freer

Functions:

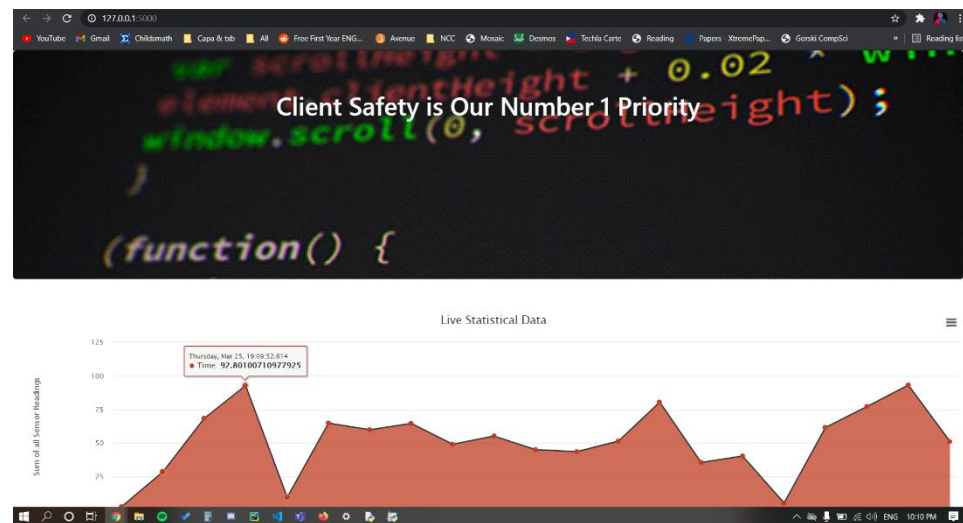- get data from csv
- send to arduino through serial

Previous Prototypes

Insert picture(s) of your refined prototype below.

__Refined Prototypes__
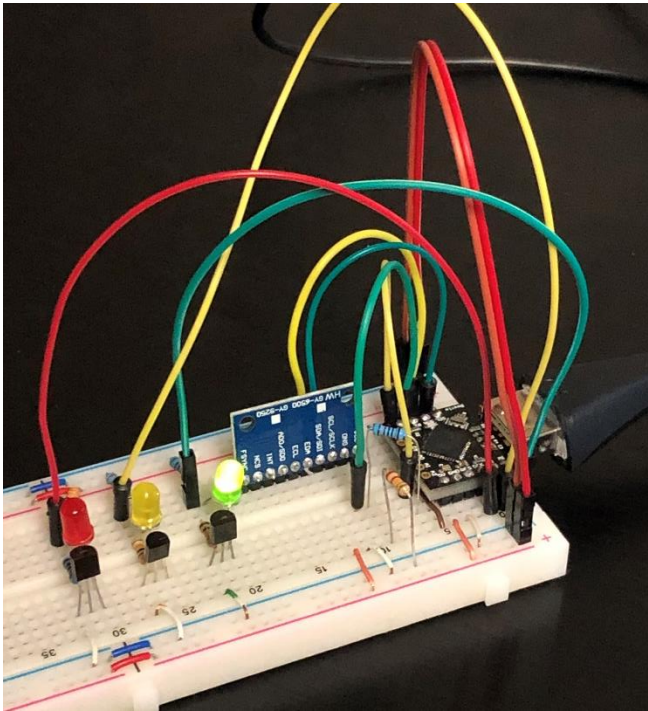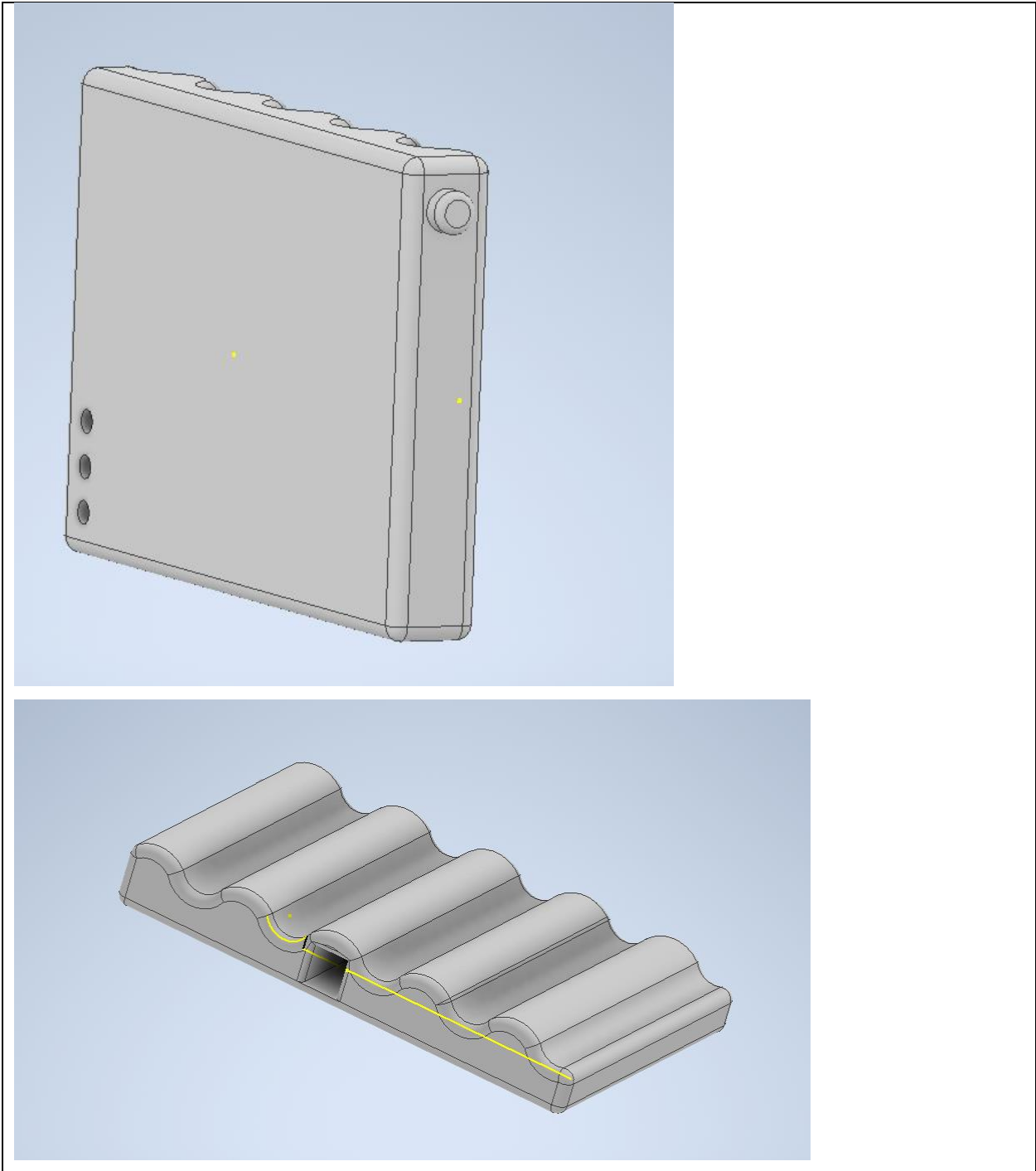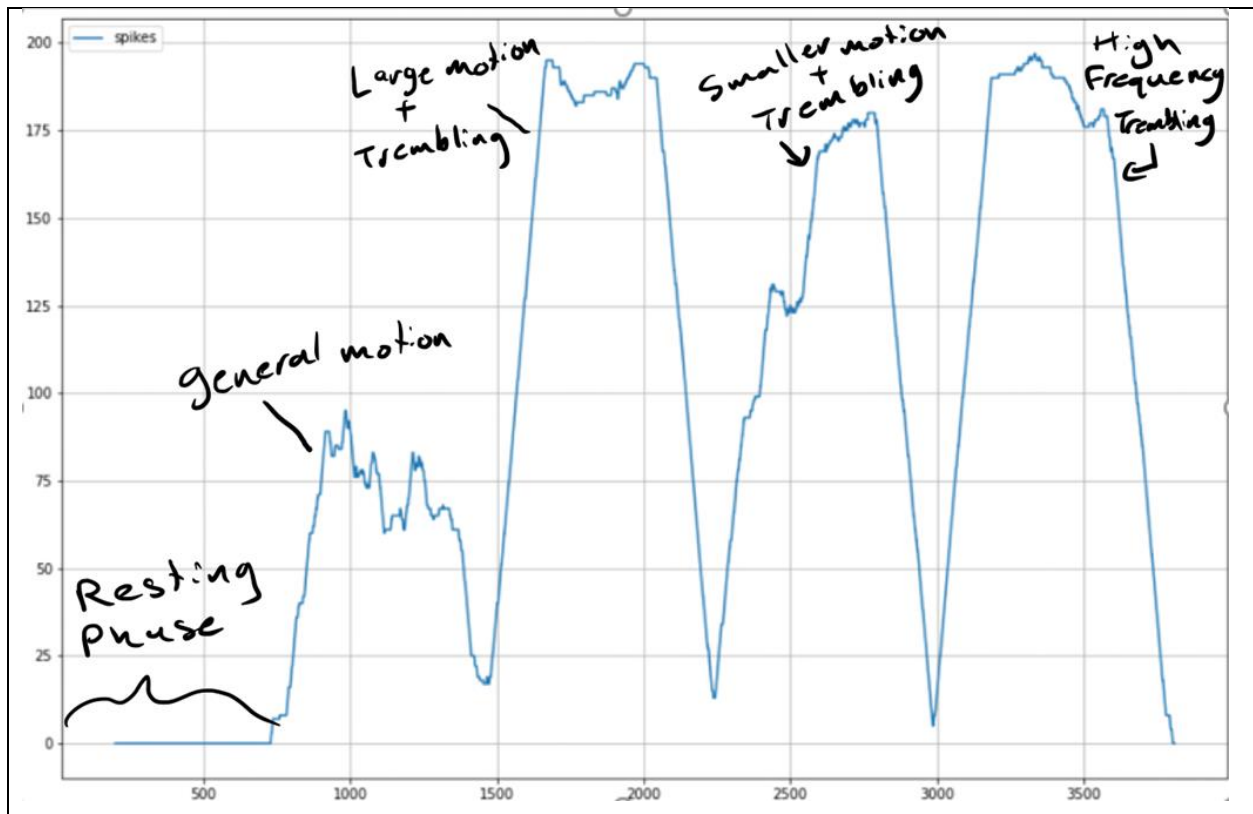
*Limit screenshots to no more than 2 per page. For additional screenshots, please copy and paste the above on a new page.

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2. Include details on how design concept was refined (what feedback was incorporated, what features are different than previous refined concept (initial prototype), etc.).

Circuit: Refined prototype is more user friendly, as suggested. It now can provide visual feedback via LEDs to communicate with the user, using the familiar traffic-light colour scheme. It also now uses a much smaller processing chip, so the device will weigh less, improving its usability.

Physical Design: Following feedback, we decided against using the glove design in favour of the tool handle holder. This should be more comfortable for our client. It also incorporates smooth grip positions to assist in usage. Other external features we removed to eliminated strange surfaces which may aggravate the client's conditions.

Data Analysis / Prediction Method: The algorithm has been significantly modified to better detect trembling due to fatigue. The algorithm can clearly detect the difference between regular painting motions and motion with trembling. By making use of a "rolling window," we analyze data in real time with a short delay (<1 second).

Front End Data Visualization: The initial prototype for the front end was purely cosmetic and had no functionality. As per feedback to make it more useful, it can now display data in real time and also added a meter which represents the current fatigue level of the client. By reading the CSV file (different sensor values) and then converting it to visual data we could show it to the user on our website.

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3. Create a detailed prototype testing plan. (Max 500 words)
    → Consider what is feasible with the resources you have
    → "Testing" can include analytic solutions such as hand calculations, motion simulations in Inventor
    → Explore what you might do if you had more time, money, tools, etc.
    → Use IEEE referencing if any research is done

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*Insert your **Present Testing Plan** (how you would test your prototype with the resources that you have available).*

Our Objectives:

- *Fatigue recognition ability*
- *Easy to Clean / resistance to contaminants*
- *Comfort of the design*

Fatigue Recognition Ability:

- With the help of different participants, we will test different "phases" of fatigue levels. We will start with a base test where they simply use the device with general motion.
- After this we get the participants to hold weights with their arms extended until they begin to feel fatigue.
- We will then get them to go through a similar general motion pattern.
- The previous two steps will be repeated two more times with higher levels of fatigue each time (by holding the weights for a longer period).

Comfort of the Design:

- Select few different participants randomly and we will test whether the participants feel comfortable to hold the handle.
- Let participants hold the pen with right hand for 5 minutes, after that ask them to rate the feeling of the handle with 1 to 5 points.
- Repeat previous steps with different participants and calculate average score.

Easy to clean:

- Try out the device and see whether it can be easily cleaned if it is contaminated.
- In this procedure we will paint the handle with pigments or dip it with sauces to simulate it is contaminated in daily use.
- Then we will try to clean the handle with water and towel to see if it can be cleaned easily.
- After the handle is cleaned, we will test if all the sensors and usb ports works normally, also we will take out the interior circuits and sensors to see whether they are exposed to water during clean process.

- All the steps above will be repeated and see whether the device is waterproof and easy to clean with multiple contaminations exert on it.

*Insert your **Future Testing Plan** (how you would test your prototype with the resources that you do not currently have available but may have in the future).*

Currently, we only have one model and cannot afford to break it during testing. However, with more time and resources, a durability test could be performed. We would subject the device to various repeated physical tests, such as shaking, impact, and drop tests, to ensure that it can withstand repeated use and abuse. Then the design could be improved to accommodate for any weaknesses that are not apparent on a mint device.

The test data was developed for the sole purpose of being easy to analyze and does not reflect actual usage by the client. With more time, we would meet with the client to tune the algorithm to her movements and fatigue patterns. We would supervise the client while using the device to get plenty of data to be used in algorithm design.

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4. Fill out the table below, detailing each team member's contribution to this stage

Team Member's Full Name:	Contribution:
Samuel Parent	Data analysis model, handle data output to Python-Arduino interface and front end, Fatigue recognition ability test plan
Kartik Chaudhari	Software - getting data from backend and then displaying on a website (front end), future test plans
Blake Freer	Circuit design, Arduino <-> Python Interface, Future test plans
Dehe Meng	Physical design(CAD model) for the handle holder

MILESTONE 4.2 – DESIGN REVIEW

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Include feedback from peers in this row.   - You could use Lysol wipes to clean the device.

Include feedback from science students in this row.
 	
   - The design should be tested with multiple people to see if the pain prediction is robust.
   - It should be durable to make sure her kids do not destroy the device.
   - The device may need to be cleaned as it will be used in a messy environment and water may damage the electronics.
   - Ensure it is easy to insert and remove the device

If applicable, include feedback from the client in this row. *N/A*