Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Driver Drowsiness Detection System

Team: Dakota Mouton, Sam Jakob, Ali Imran, Coady Lewis

Problem: Driver Drowsiness

Driving fatigue has been a major cause of accidents on the road. Truck drivers are at a greater risk of driver fatigue because of the long hours spent driving.

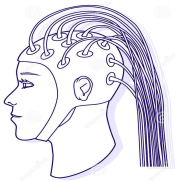
Solution: DDDS

- Solution proposal: Our Driver Drowsiness Detection System will use a machine learning (ML) algorithm and electroencephalogram (EEG) device to determine a driver's level of fatigue and alert the driver to rest.

System Overview

EEG

- Filter out unwanted frequencies.
- Take in brain waves in microvolts and amplify them to volts.
- Send data to MCU



MCU

- Receive incoming signals from EEG
- Send data to computer running ML algorithm

Simulator

- Collect training and testing data
- Muse 2 EEG device

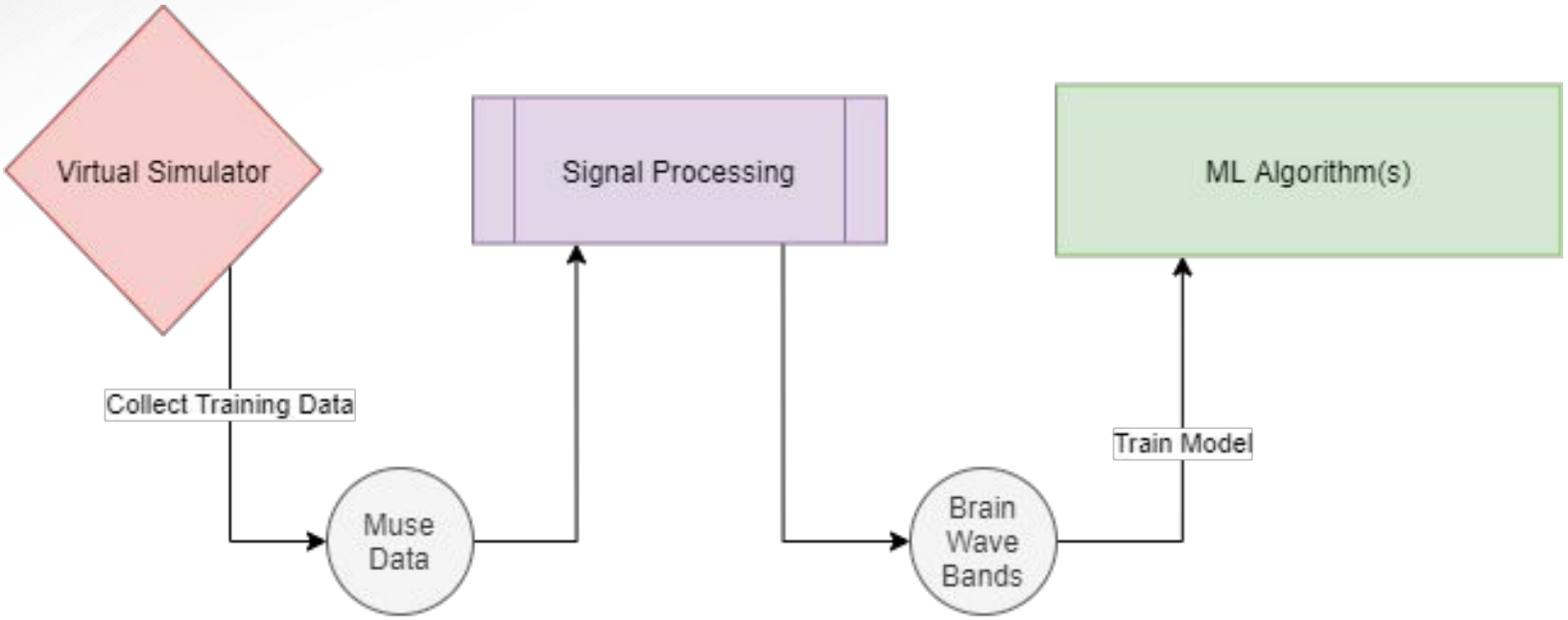
ML Algorithm

- Process EEG device signals
- Output mental fatigue state of user

Team 1: Dakota and Sam

Team 2: Coady and Ali

ML Algorithm Subsystem



Virtual Simulator

Simulator:

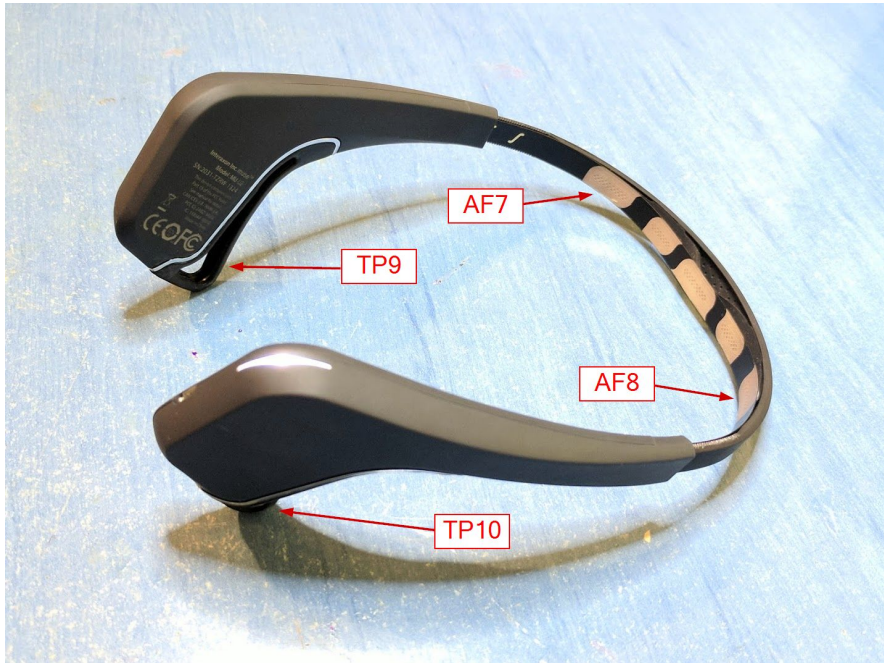
- Steering wheel and pedals
- American Truck Simulator

Data Collection:

- Training data
- Testing data

Wearable EEG

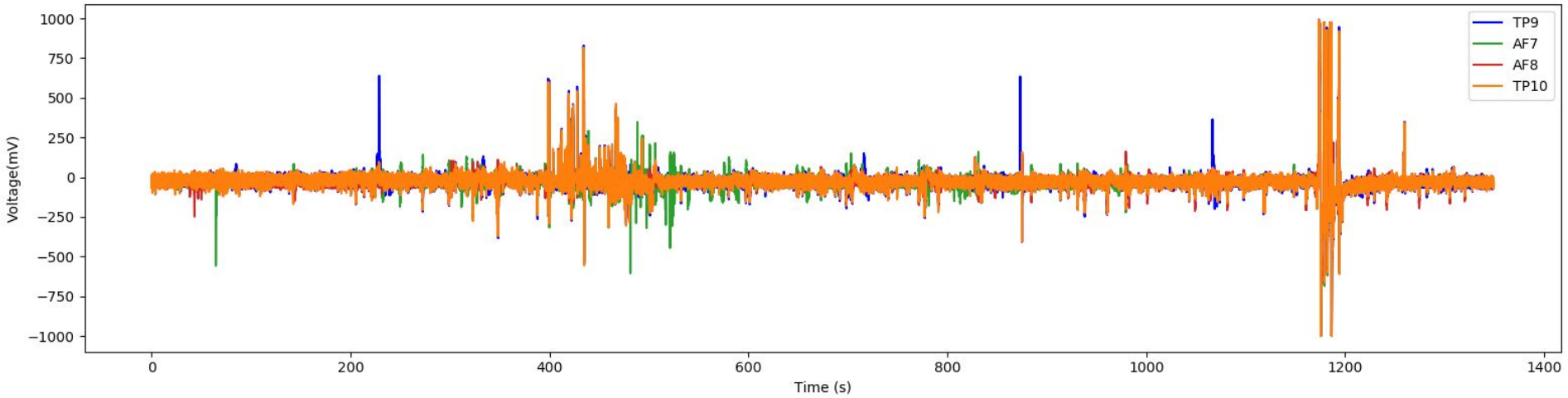
- Muse 2
  - Connectivity issues when testing simulator
  - Just resolved this week
  - Will ramp up data collection

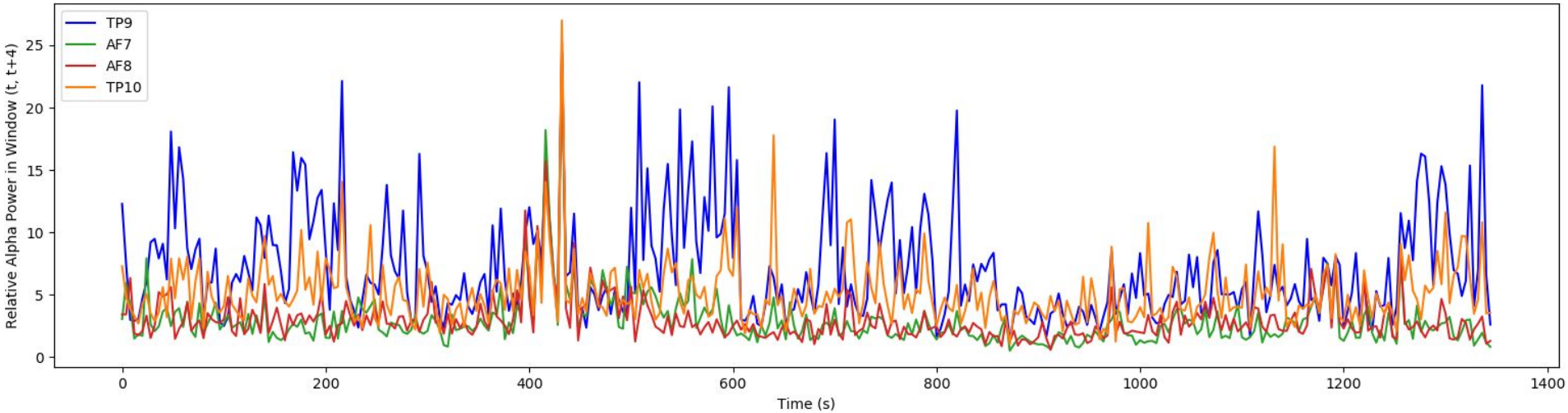


Signal Processing

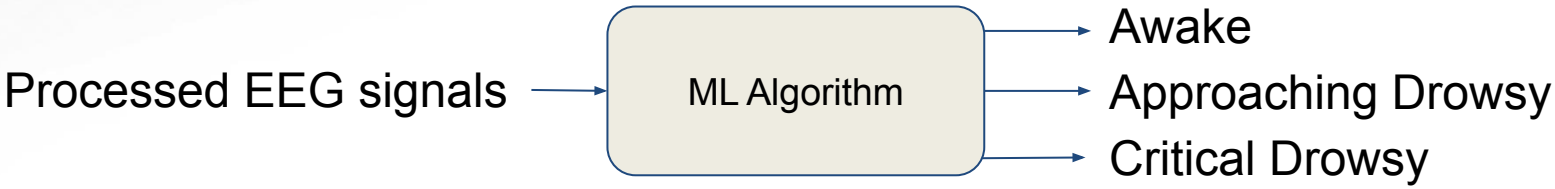
- Post-simulation analysis script completed
  - Still working on a real time analysis solution
- Decided to focus on Alpha (8-12 Hz) and Beta (12-30 Hz)
  - P_{Alpha}/P_{Beta}
- Currently using adjacent rectangular windows of 4s
  - Also considering a wavelet transform
  - Saved raw data gives us options
  - Need larger datasets and more testing with ML

Signal Processing





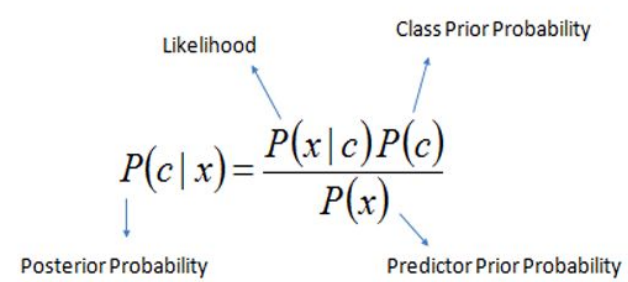
Machine Learning



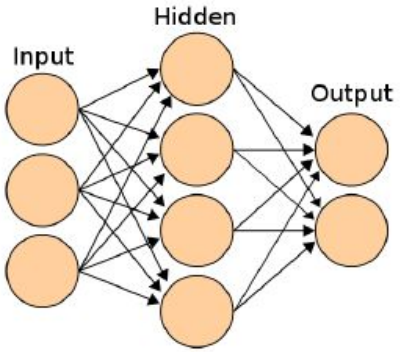
Models:
- Naive Bayes
- Feedforward Neural Network

Potential Models:
- Convolutional Neural Network
- Recurrent Neural Network

Naive Bayes



Neural Network



Iris Dataset:

```
[[ 7  0  0]
 [ 0 11  0]
 [ 0  1 11]]
[1.         0.95652174 0.95652174]
Total accuracy:  0.9666666666666667
```

```
30/30 [==============================]
0.9667
Test accuracy:  0.96666664
```

Our Current Data:

```
[[11 12]
 [ 3 18]]
[0.59459459 0.70588235]
Total accuracy:  0.6477092065327359
```

```
44/44 [==============================]
0.6364
Test accuracy:  0.6363636
```

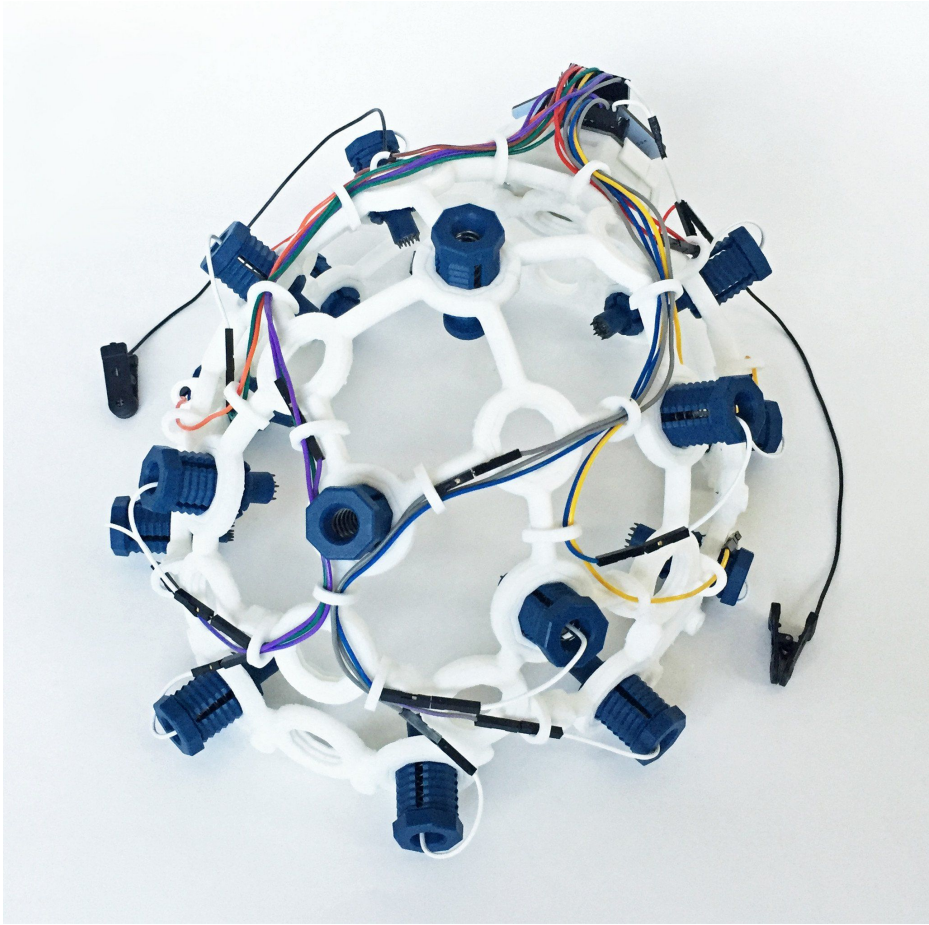
EEG Subsystem

Power System

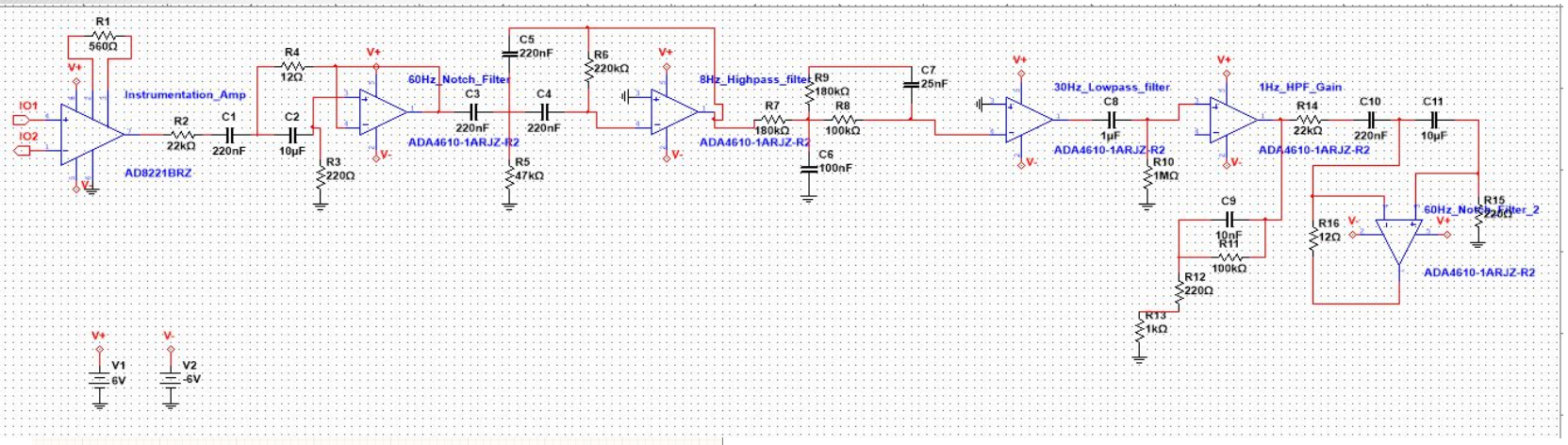
- 4 AA Batteries (6V total)
- Buck-boost convertor
- Use 5V for components

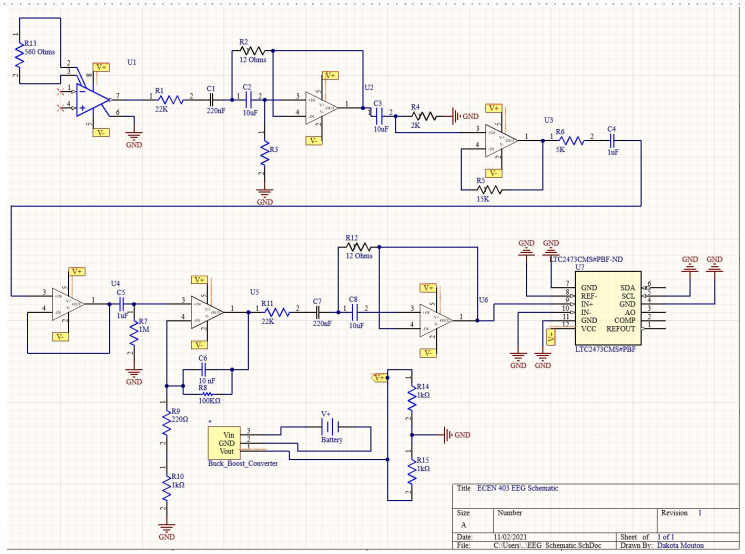
Main Components

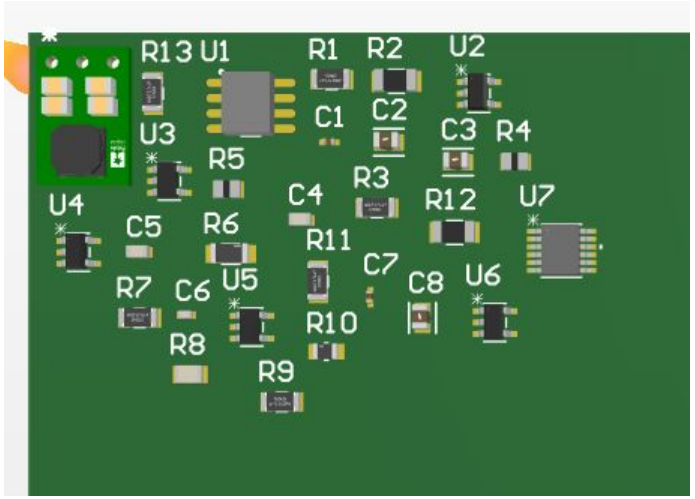
- AD8221 Instrumentation Amp
- 5 ADA4610 Op Amps
- 8 dry electrodes



EEG Subsystem







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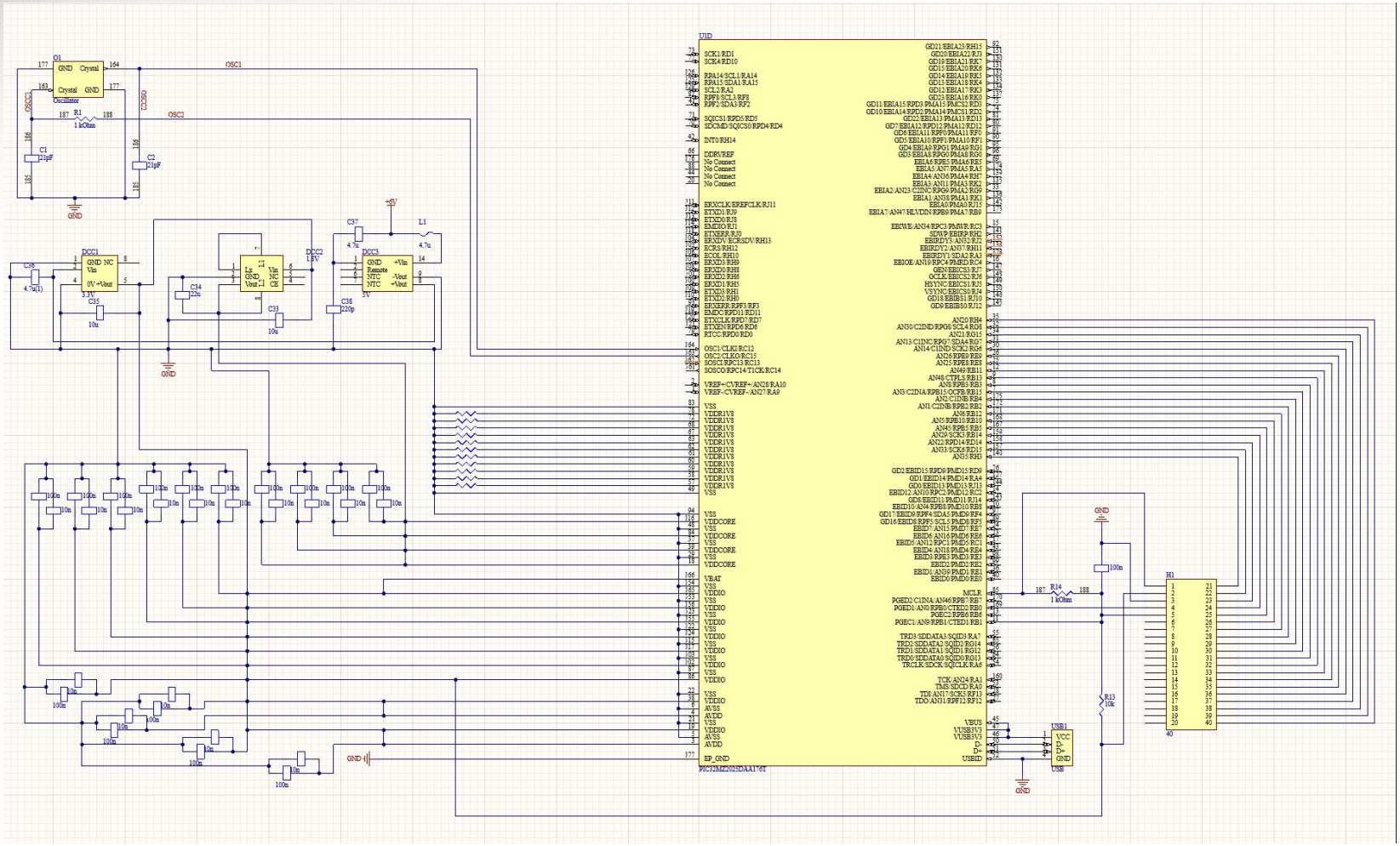
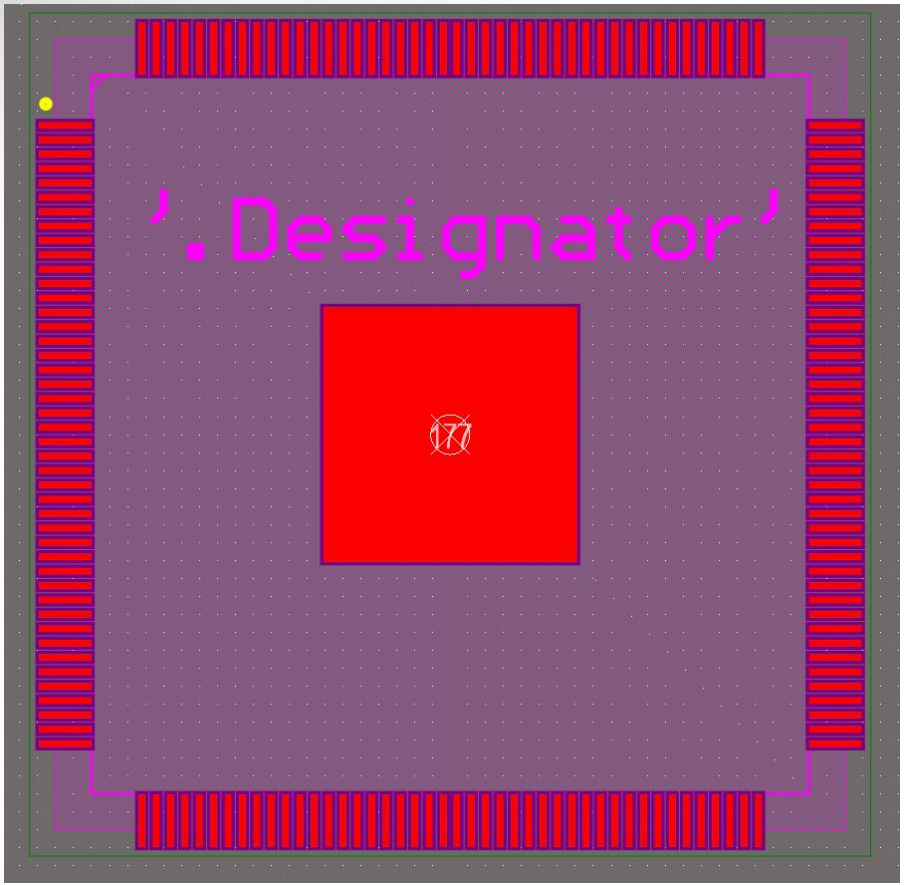
Microcontroller Subsystem



Microcontroller Subsystem



- Schematic Completed
- Developing PCB footprints
- Hoping to get PCB validated and printed by end of the week

Execution Plan

Driver Drowsiness Detection System Schedule:

Work	End Date	Owner	Status
Create team	8/31/21	All	
Receive project details	9/3/21	All	
Talk with project sponsor	9/9/21	All	
Research	9/14/21	All	
ConOps Report	9/16/21	All	
Assign subsystems	9/21/21	All	
FSR Report	10/4/21	All	
ICD Report	10/4/21	All	
Decide best ML algorithm	10/8/21	Ali, Coady	
Finish design of Development Board	10/8/21	Sam	
Test out Muse 2 device	10/12/21	Ali, Coady	
Create midterm presentation	10/12/21	All	
Get virtual simulator parts ordered	10/13/21	Ali, Coady	
Midterm Presentation	10/13/21	All	
Get MCU parts ordered	10/15/21	Sam	
Workout MCU Schematic in Altium for PCB	10/15/21	Sam	
Learn ML algorithm using basic tutorials and online datasets	10/17/21	Ali, Coady	
Create EEG filtering program	10/17/21	Ali, Coady	
Assemble virtual simulator rig	10/19/21	Ali, Coady	
Workout EEG Schematic in Altium for PCB	10/19/21	Dakota	
Finish Circuit Design of EEG	10/19/21	Dakota	
Collect training data from simulator	10/19/21	All	
Test filtering program off of collected data	10/20/21	Ali, Coady	
Have PCB Design approved and ready to print	10/22/21	Sam	
Get EEG device parts ordered	10/22/21	Dakota	
Have PCB Design Approved and Ready to Print	10/26/21	Dakota	
Code MCU to sample data	10/26/21	Sam	
Create status update presentation	10/30/21	All	
Status Update Presentation	11/1/21	All	
Create ML algorithm off of collected data	11/2/21	Ali, Coady	
Connect EEG to Electrodes and Test	11/2/21	Dakota	
Validate and Troubleshoot EEG	11/2/21	Dakota	
Test and Debug MCU	11/2/21	Sam	
Test ML algorithm with new simulator data	11/7/21	All	
Verify ML algorithm detection rate > 90%	11/14/21	Ali, Coady	
Finished Working EEG	11/23/21	Dakota	
Finished Working MCU	11/23/21	Sam	
Final validation checks for each subsystem	11/27/21	All	
Create final presentation	11/27/21	All	
Final Presentation	11/29/21	All	
Finish final report	11/30/21	All	
Final Report	12/1/21	All	

- Completed
- On Schedule
- Behind

Validation plan

Driver Drowsiness Detection Validation Plan:

Task	Specification	Result	Owner
ML Algorithm drowsiness detection	>90% success rate		Ali, Coady
Performance of data collection and processing every interval: • EEG data collection • Transfer and signal processing • Fatigue state output	< 30 seconds < 10 seconds < 10 seconds < 10 seconds		All Dakota Sam Ali, Coady
MCU powers on	VDDIO: 3.3V VDDCORE: 1.8V		Sam
MCU samples all data	8 Hz < f < 30 Hz		Sam
MCU sends data to CPU	100% success rate		Sam
EEG Filters below 8 Hz	f>=8 Hz		Dakota
EEG Filters Above 30 Hz	f<=30 Hz		Dakota
Gain from Instrumentation Amplifier close to 100	G = 80+		Dakota
Final voltage readings have amplified from microvolts to volts	0.81172<V<0.148 But V<1		Dakota
System voltage input	6 V		All
Peak Power Consumption	2 W		All