Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Driver Drowsiness Detection System

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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

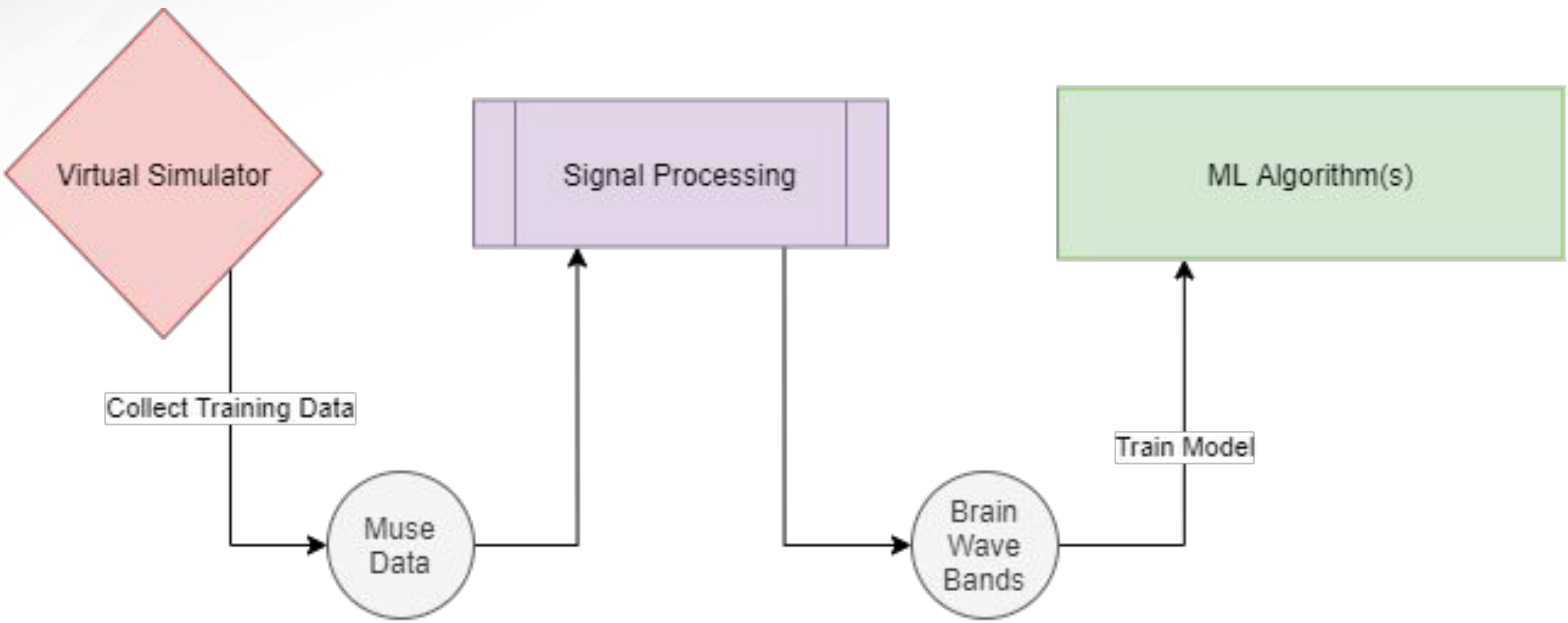
ML Algorithm

- 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:

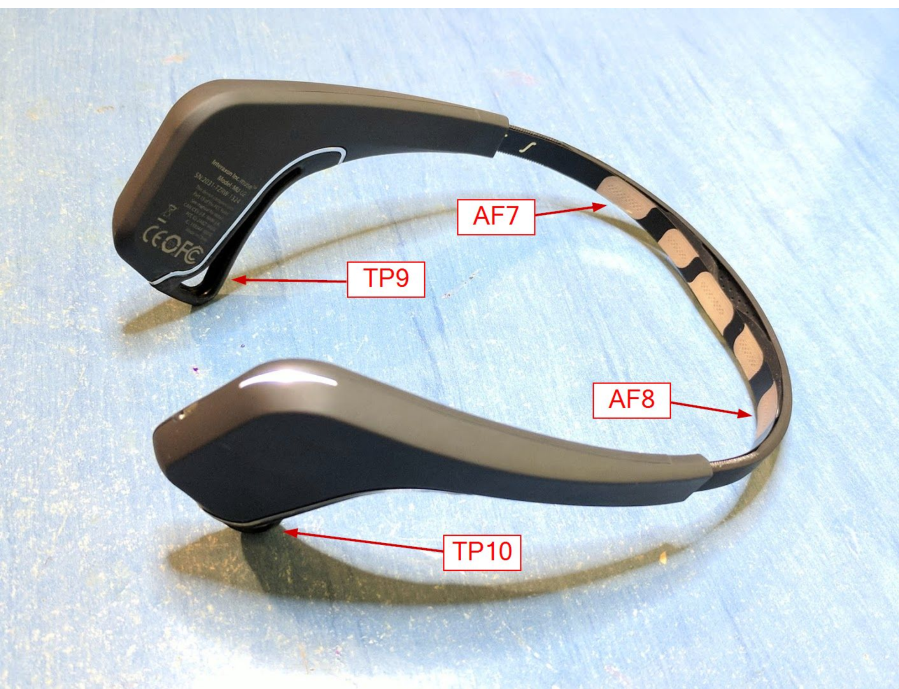
- Steering wheel and pedals
- Monitor
- Truck driving simulator game

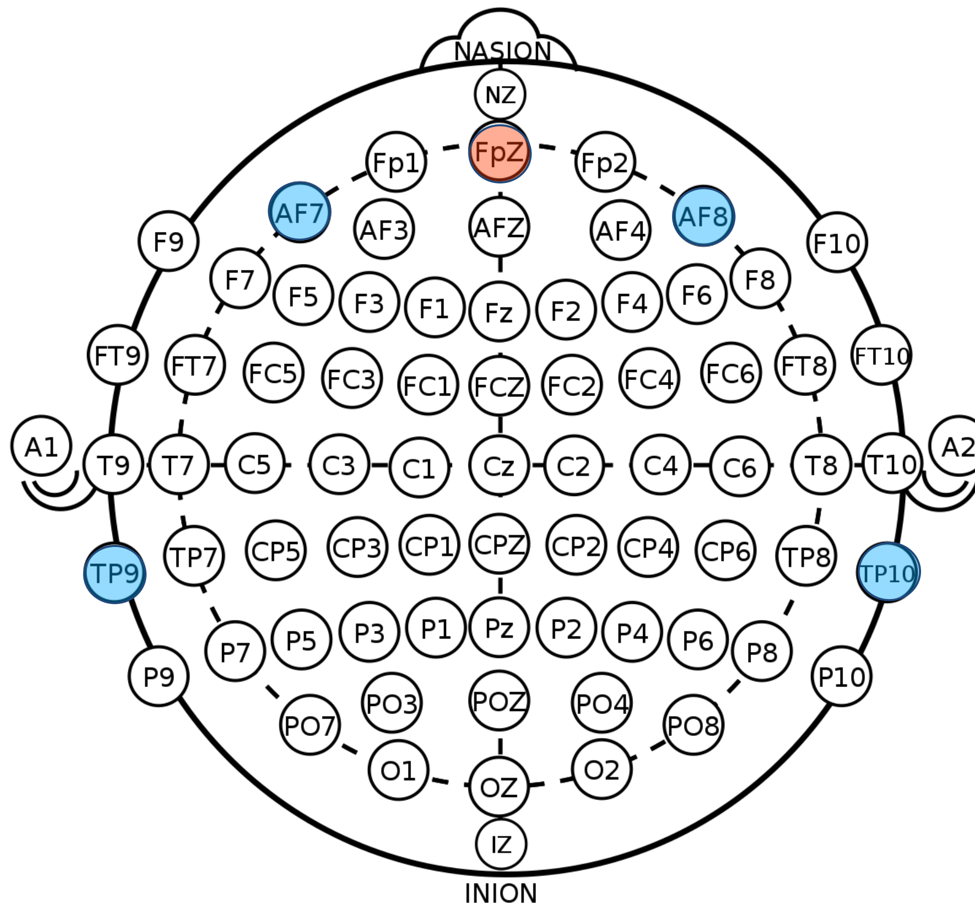
Data Collection:

- Training data
- Testing data

Wearable EEG

- Muse 2
  - Consumer EEG
  - 4 Electrodes
  - Reference at FpZ

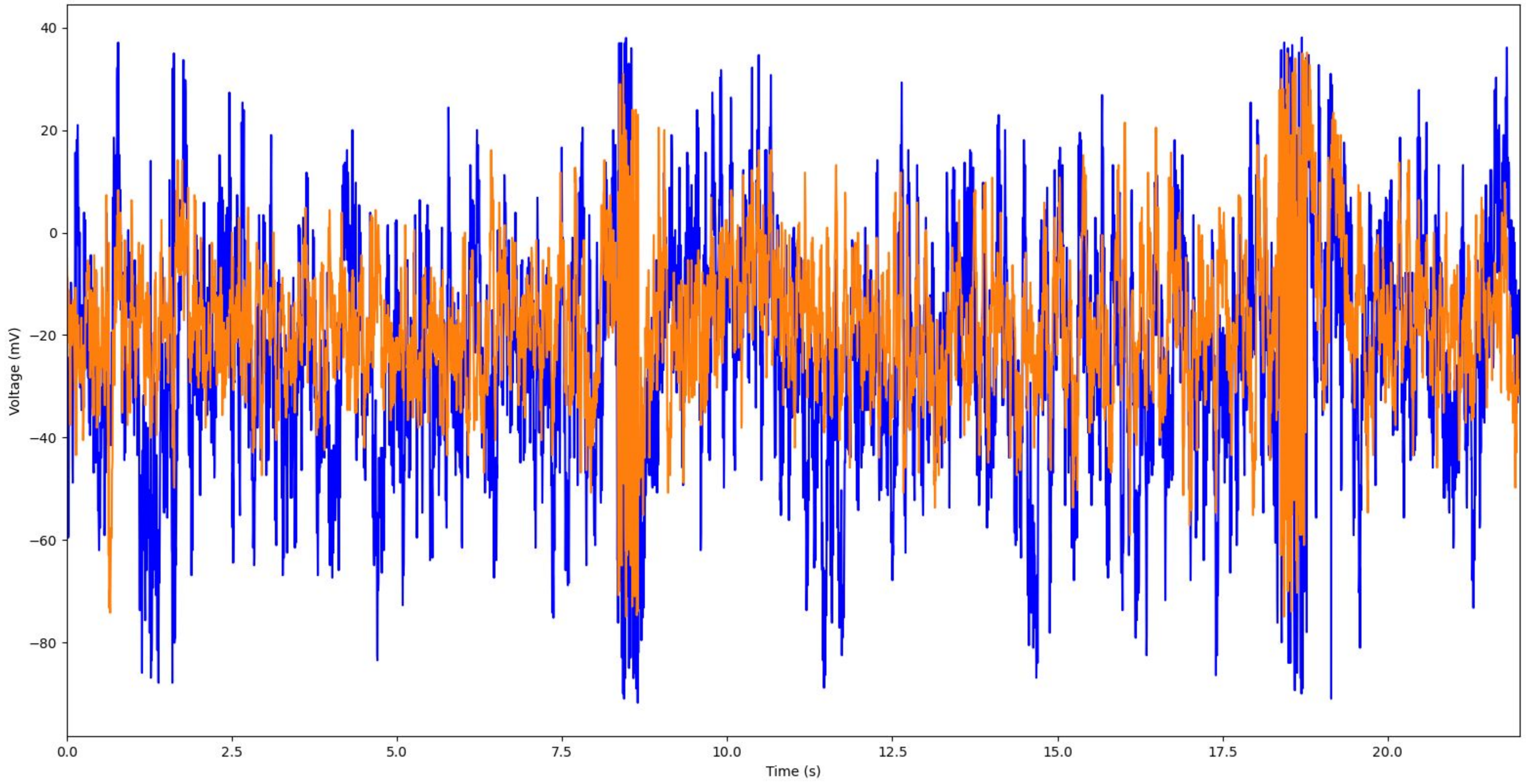




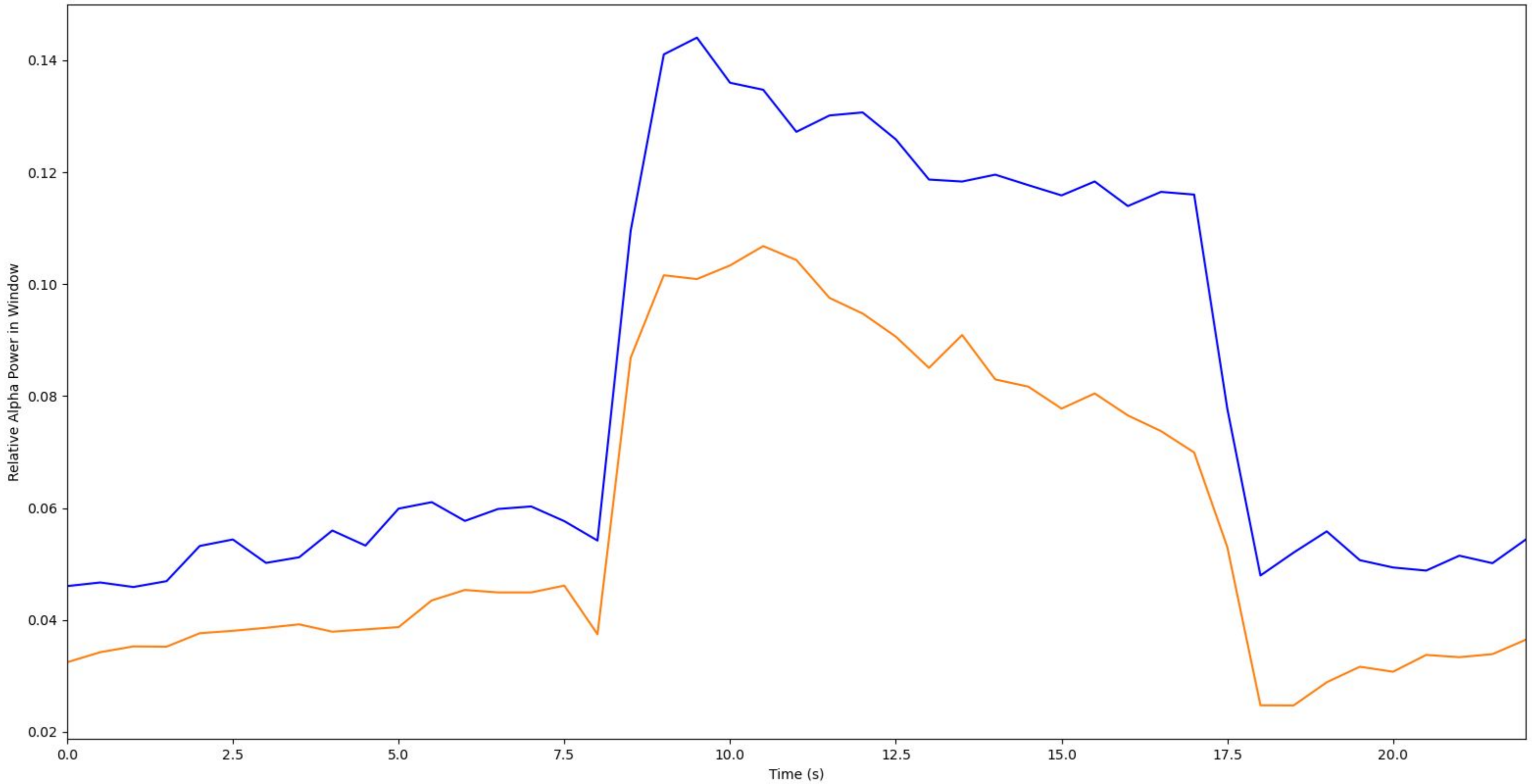
Signal Processing

- Raw EEG signal is erratic
  - Still contains meaningful information
- Best to look at avg power in established frequency bands
  - Theta (4-8 Hz), Alpha (8-12 Hz), and Beta (12-30 Hz)
  - Use existing research on each band
- Overlapped rectangular windows and FFT
  - relative band power of each window
  - small step size will form a plot of band power vs time

Signal Processing



Signal Processing



Machine Learning

Processed EEG signals → ML Algorithm → Awake / Approaching Drowsy / Critical Drowsy

- Supervised Classification
- Python
- Machine Learning Libraries: TensorFlow

ML Model: Naive Bayes
- Works well with large data sets
- Fast training
- Fast predicting

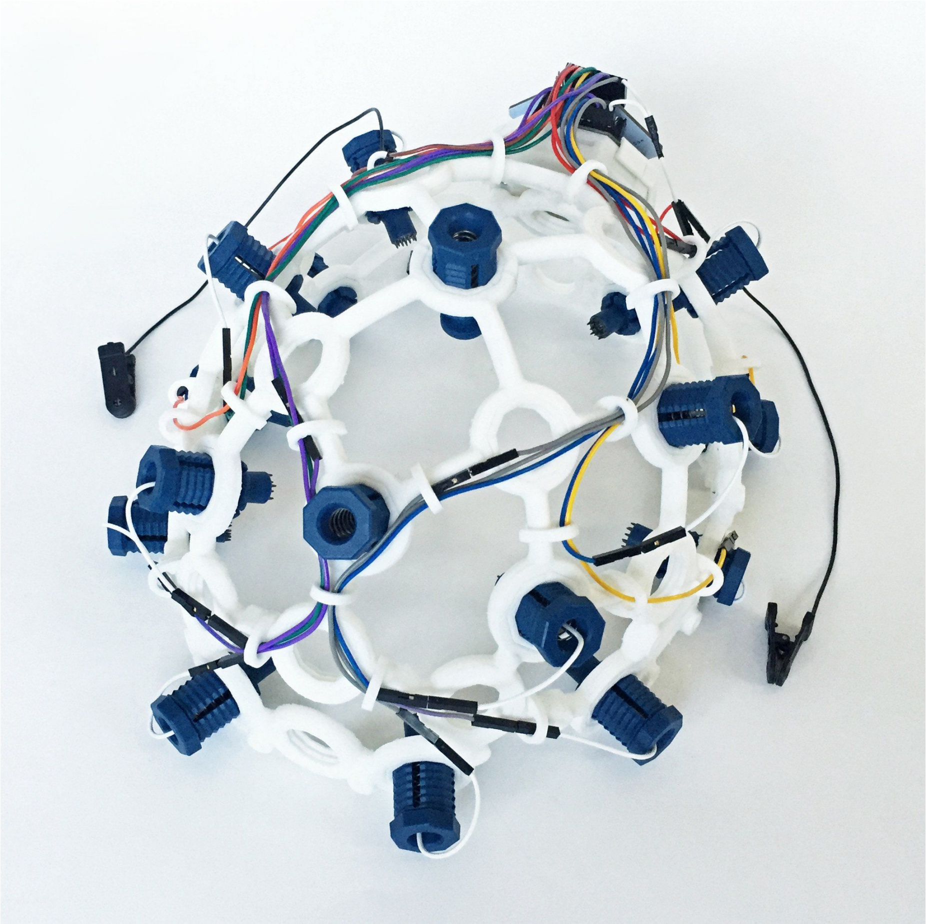
EEG Subsystem

Power System

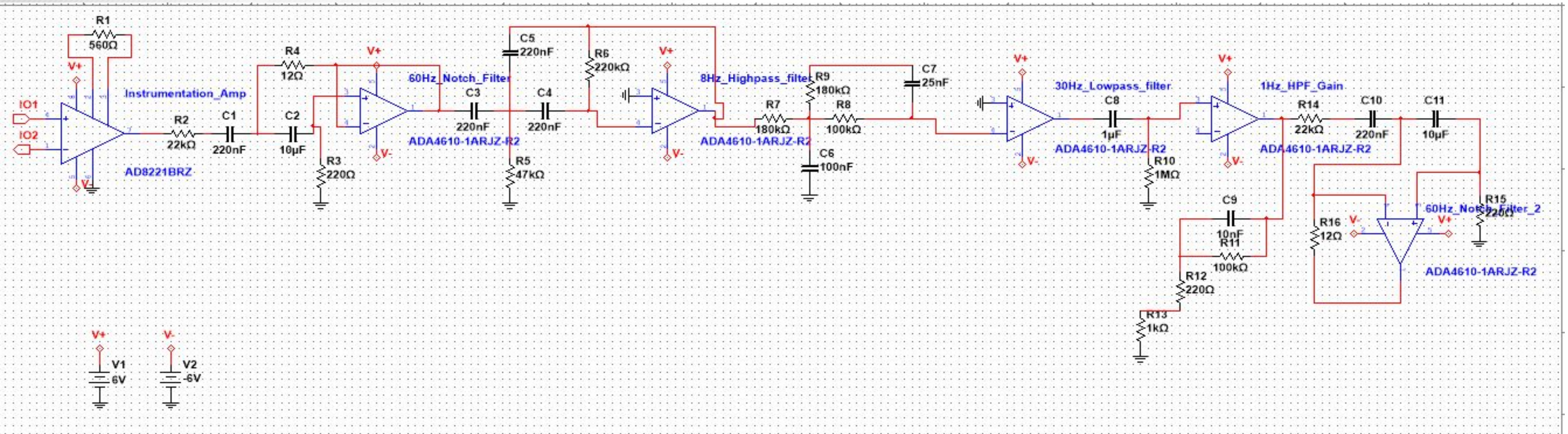
- 4 AA Batteries (6V total)
- Buck-boost convertor
- Use 5V for components

Main Components

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

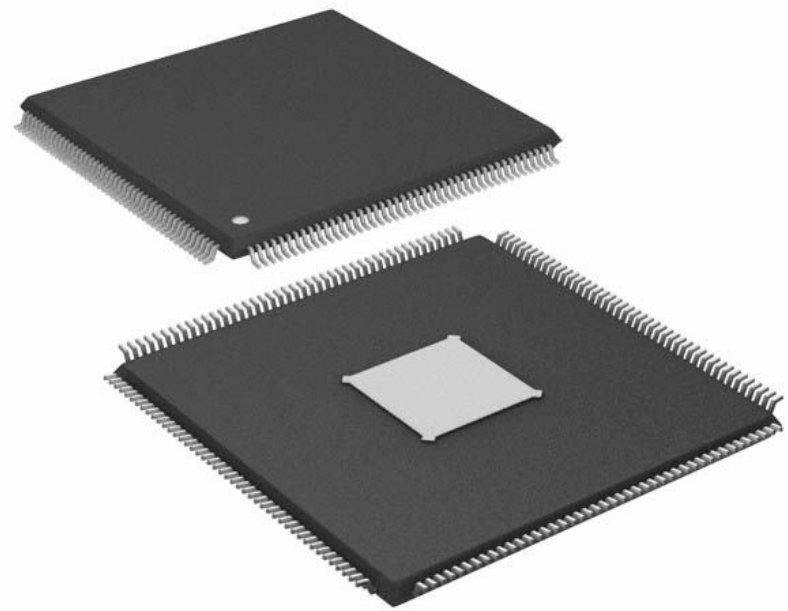


EEG Subsystem

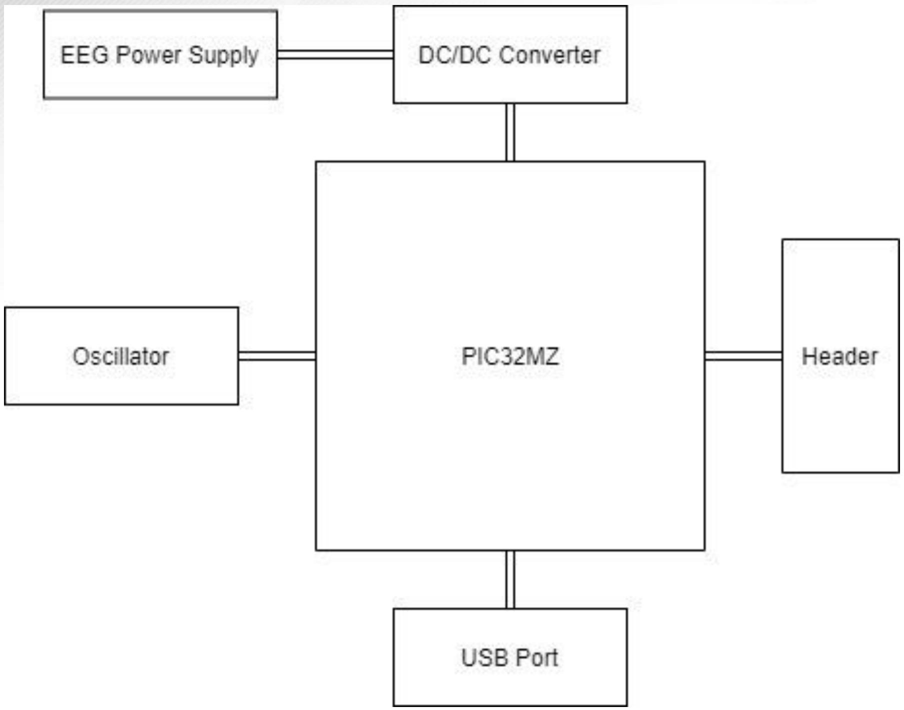


Microcontroller Subsystem

- PIC32MZ
- Will sample signal from EEG and send data to ML subsystem
- Communication with ML through USB via UART



Microcontroller Subsystem



- DC/DC Converter to drop voltage from 6V to 3.3V
- 33 MHz Oscillator
- GPIO 5V tolerant input
- USB A 2.0 output

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	
Have PCB Design Approved and Ready to Print	10/19/21	Sam	
Collect training data from simulator	10/19/21	All	
Test filtering program off of collected data	10/20/21	Ali, Coady	
Program MCU to sample EEG data	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	
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 sampling rate	Max: 200 MHz		Sam
MCU voltage input	3 V		Sam
MCU current input	200 mA		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