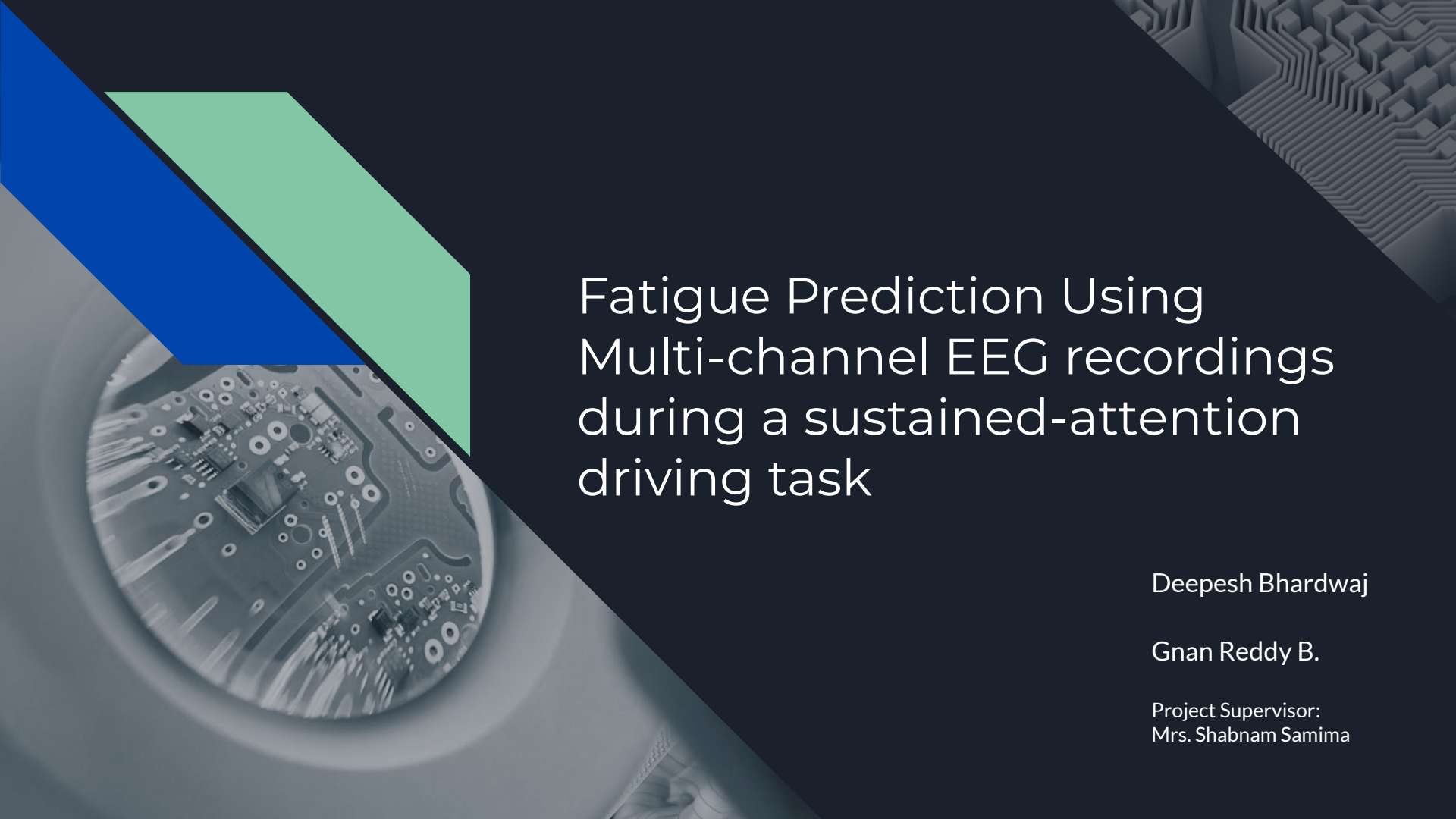


Fatigue Prediction Using Multi-channel EEG recordings during a sustained-attention driving task

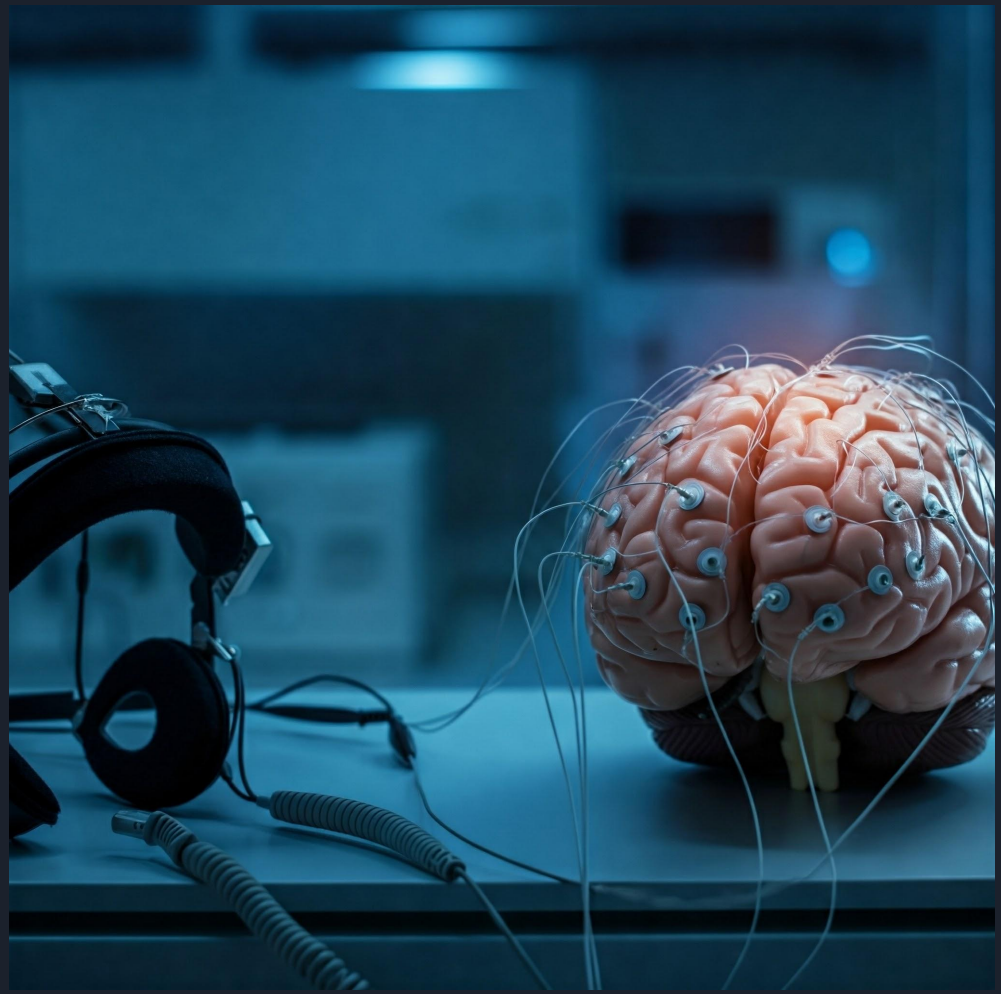
Deepesh Bhardwaj

Gnan Reddy B.

Project Supervisor:
Mrs. Shabnam Samima

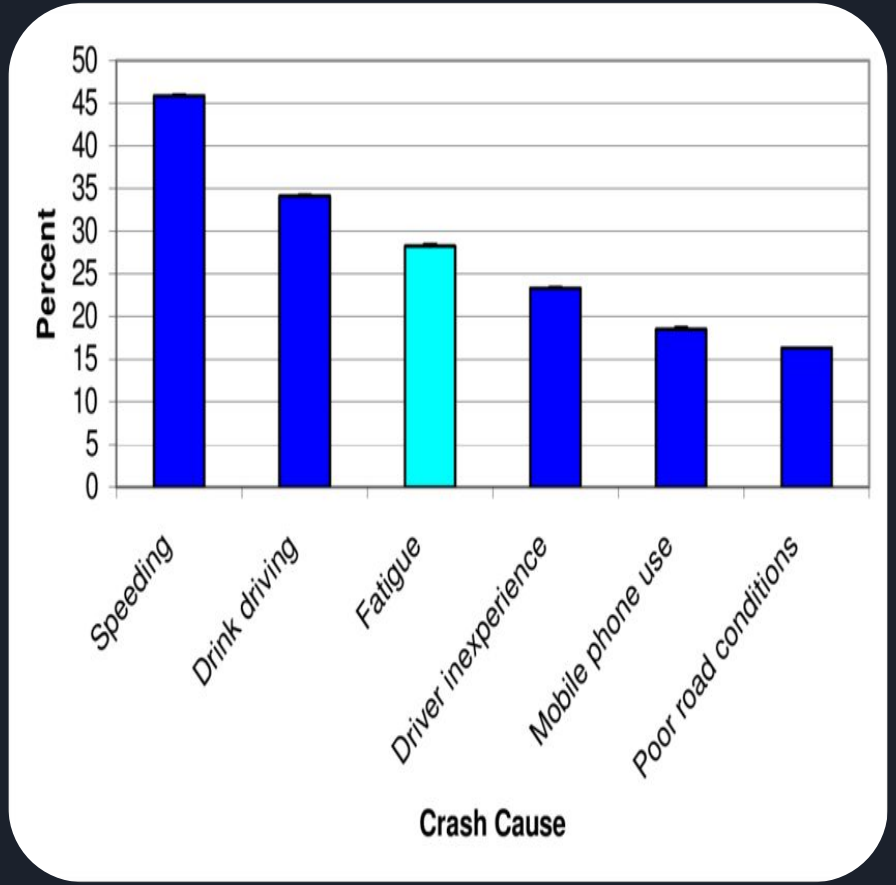
Overview

- Project Introduction
- Problem Statement
- Methodology
- Implementation
- Results
- Future Work



Introduction: Driver Fatigue

- Driver fatigue is a major cause of road accidents
- EEG-based detection can provide early warning
- Developing a real-time monitoring system
- Dataset: 62 sessions from 27 participants



The Problem

- How to effectively process EEG signals for fatigue detection?
- What EEG features best indicate fatigue?
- How to implement real-time monitoring?

Data Acquisition Setup

EEG Recording:

- 32-channel EEG System
- Edited International 10-20 Placement
- Impedance < 5kΩ
- Custom Channel Location Mapping

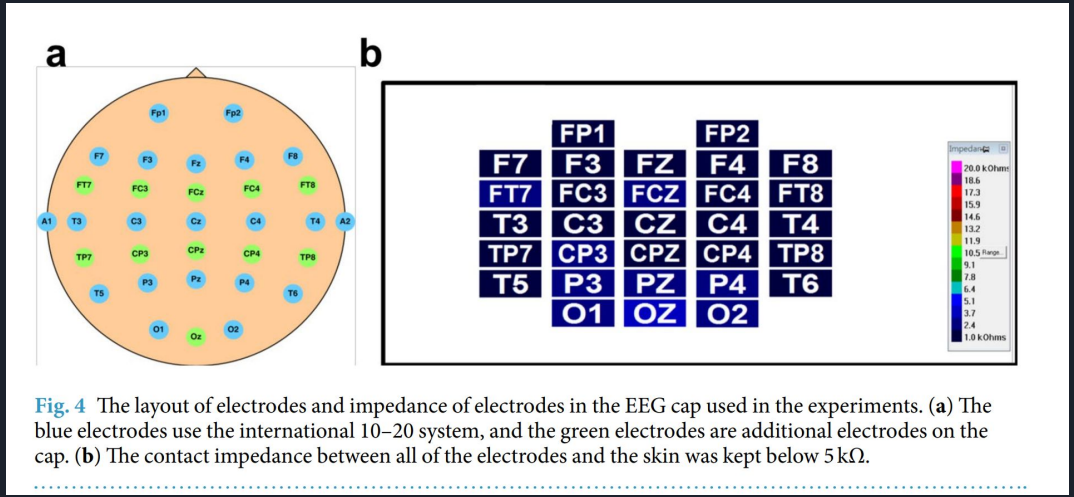


Fig. 4 The layout of electrodes and impedance of electrodes in the EEG cap used in the experiments. (**a**) The blue electrodes use the international 10–20 system, and the green electrodes are additional electrodes on the cap. (**b**) The contact impedance between all of the electrodes and the skin was kept below 5 kΩ.

Data Acquisition Setup

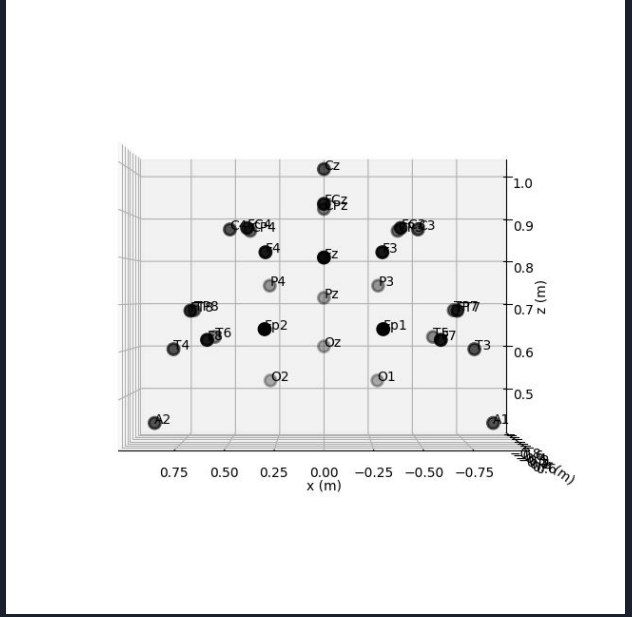
Dataset Scale:

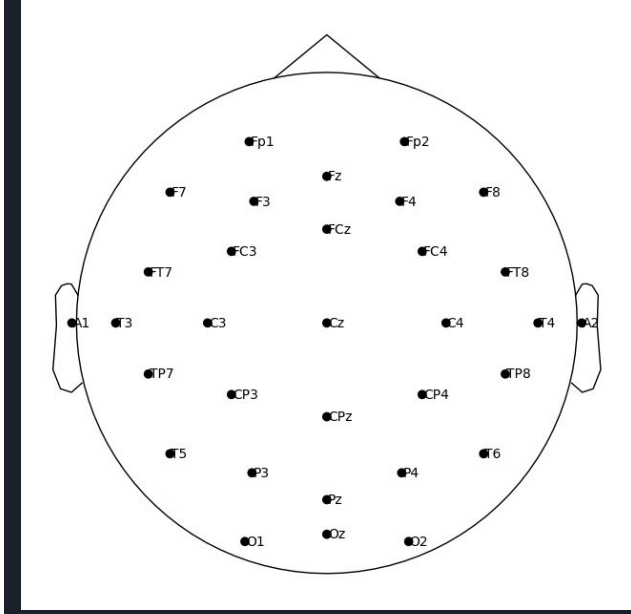
- 27 participants
- 62 recording sessions
- 81,576 total events
- Comprehensive coverage of fatigue states

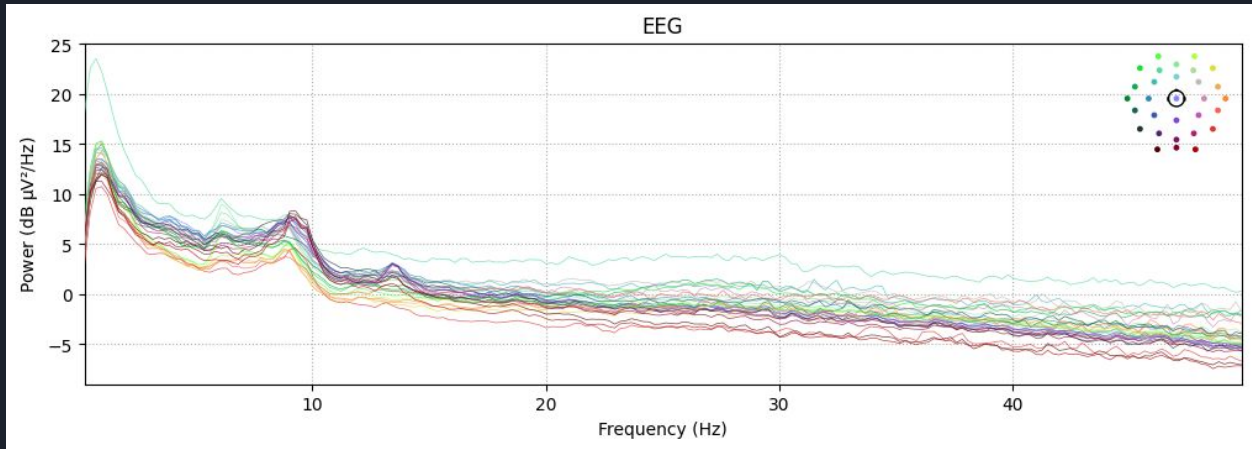
Subject No.	Number of Sessions	Numbers of Events
S01	5	4827
S02	2	2028
S04	1	1083
S05	4	6378
S06	1	1077
S09	3	2112
S11	1	1290
S12	2	1869
S13	2	2244
S14	2	2181
S22	4	5022
S23	1	1317
S31	2	3618
S35	2	3285
S40	2	3921
S41	5	6747
S42	2	2430
S43	3	5709
S44	4	7269
S45	2	4023
S48	1	1050
S49	3	3102
S50	2	2085
S52	1	717
S53	3	3654
S54	1	615
S55	1	1923
Total	**62**	**81576**

Data Acquisition Setup

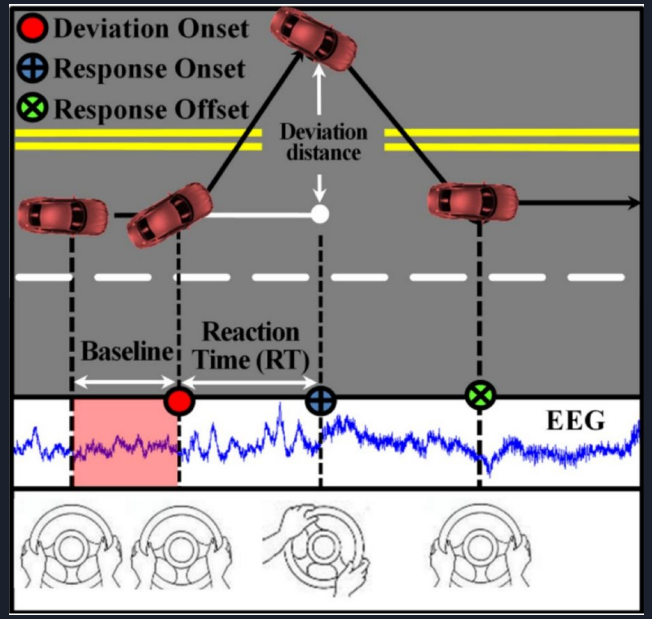
Plotted Power spectral density using custom 32 channel EEG location data.





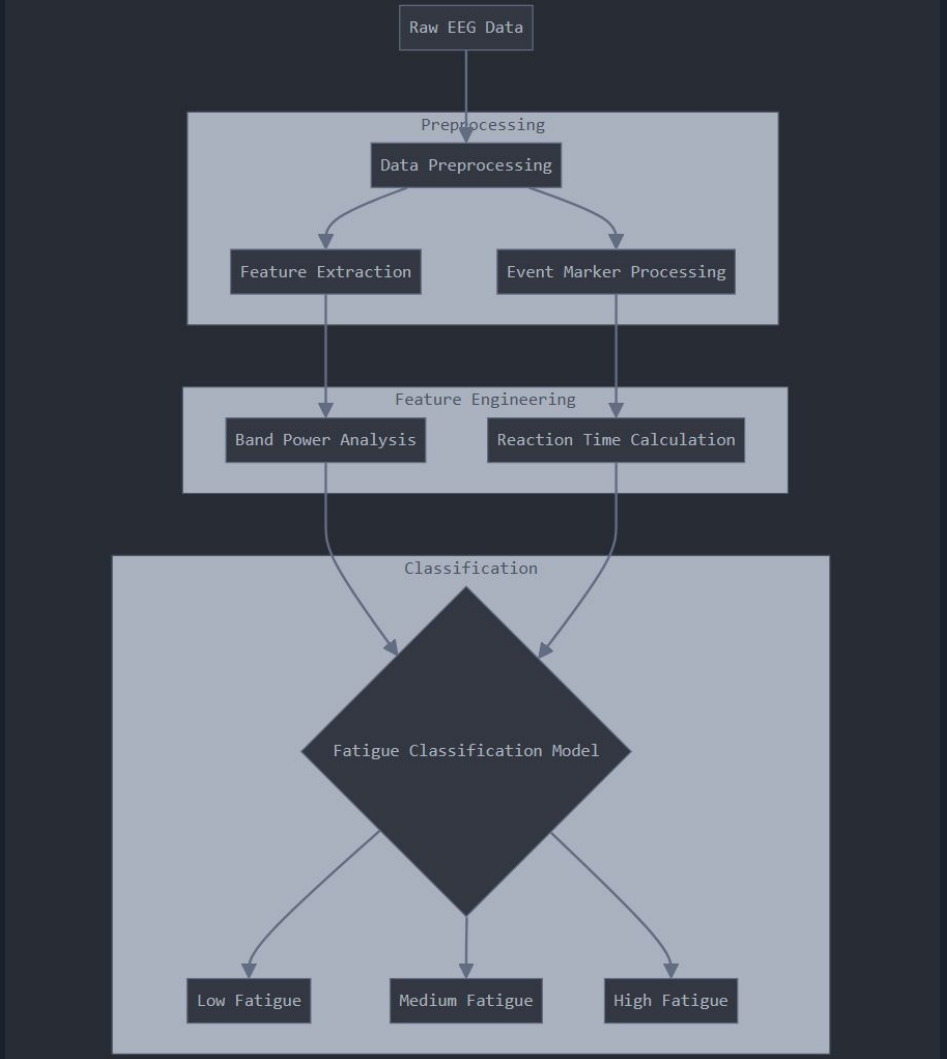


Fatigue Classification



- Low (0): Alert state
- Medium (1): Onset of fatigue
- High (2): Significant fatigue
- 32-channel EEG recordings
- Event markers for lane departures
    - Left (251)
    - Right (252)
- Response onset times
- 62 experimental sessions

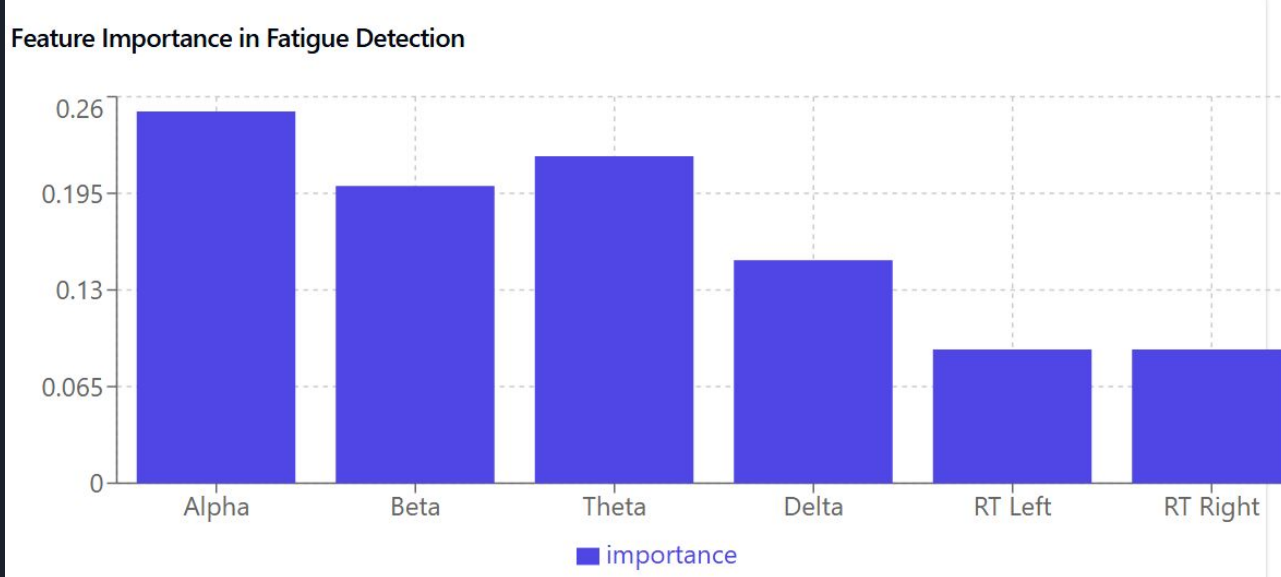
System Architecture



EEG Analysis & Feature Importance

Key EEG Features:

- Alpha band: Most significant (26% importance)
- Beta band: Second most important (20%)
- Theta band: Strong indicator (22%)
- Delta band: Moderate impact (15%)
- Reaction times: Supporting features (~8% each)



Fatigue Level Classification

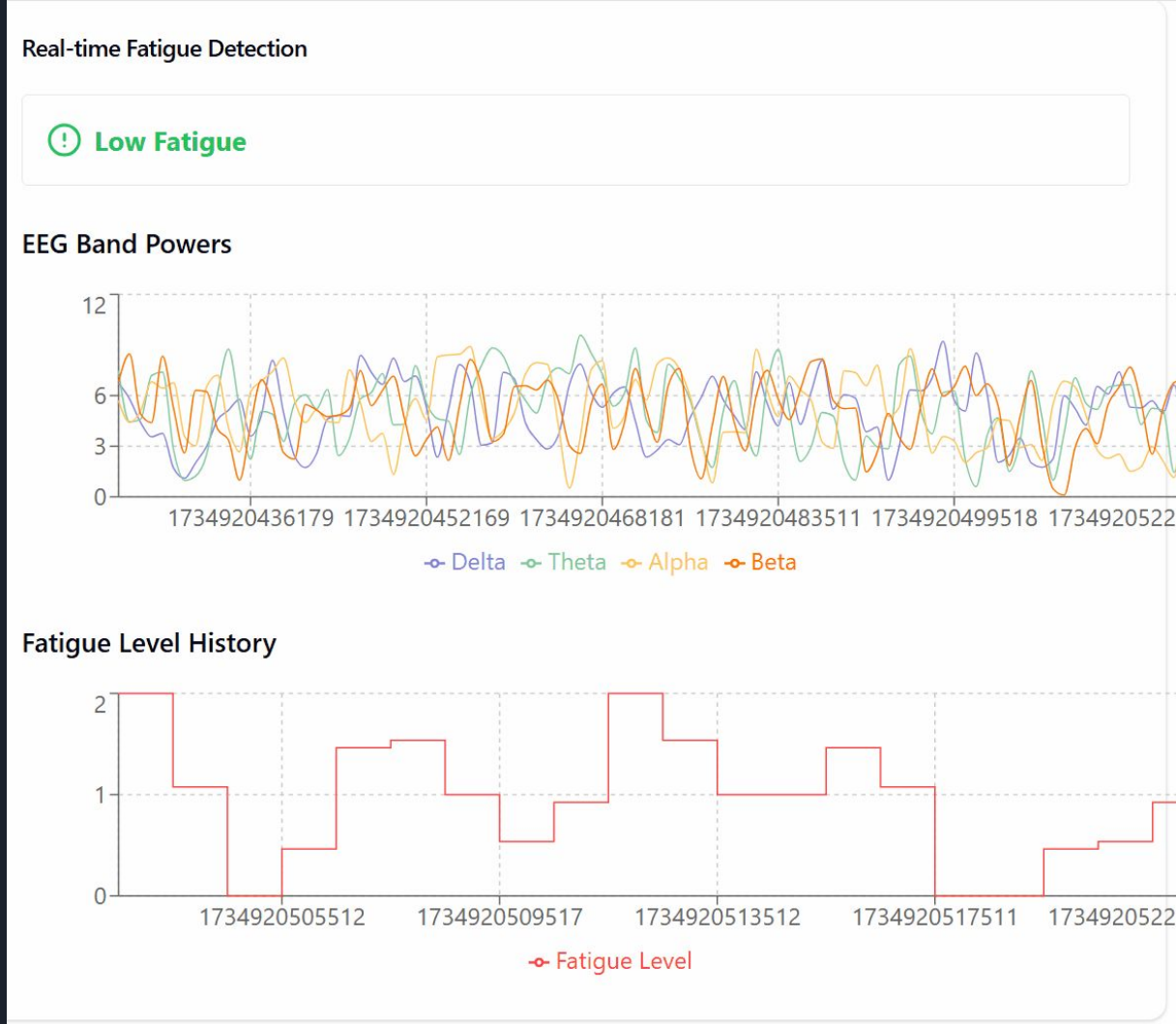
Low Fatigue (0)
- Low alpha/theta power
- High beta activity
- Fast reaction times

Medium Fatigue (1)
- Increased alpha power
- Decreased beta activity
- Moderate reaction delays

High Fatigue (2)
- High theta/alpha power
- Very low beta activity
- Significant RT delays

Real Time Monitoring

- Continuous EEG band power tracking
- Fatigue level history visualization
- Immediate state classification

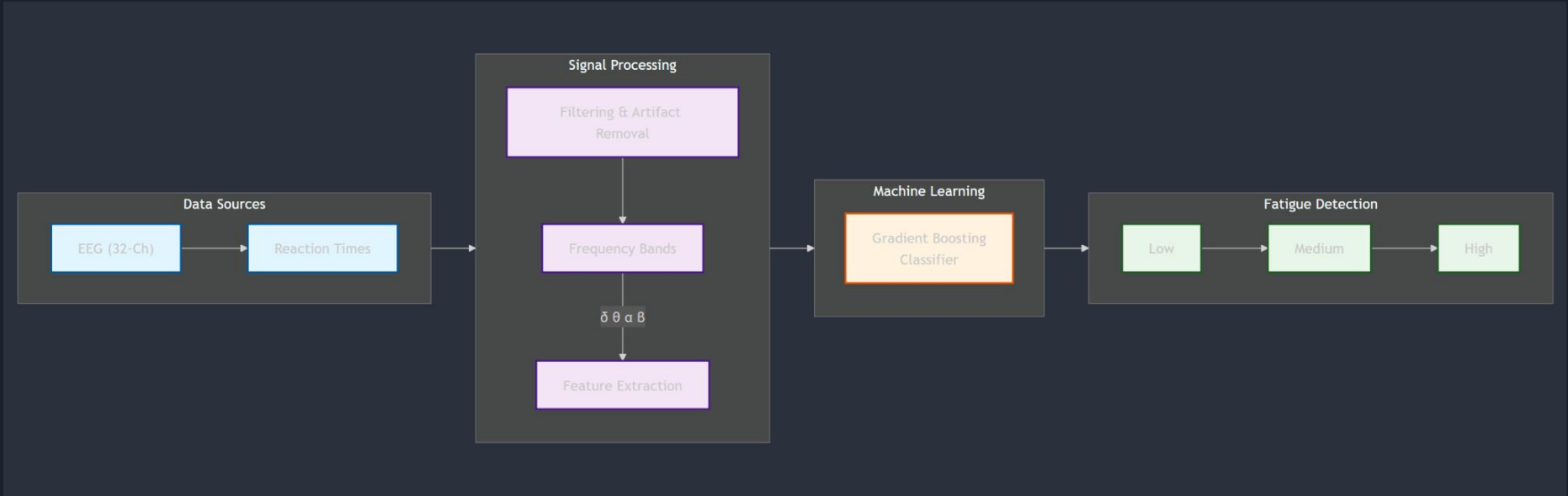


Implementation Details

- Data Preprocessing
- File splitting based on event markers
- Reaction time calculation
- Signal filtering
- Feature Extraction
- Band power calculation
- Statistical features

Model Development

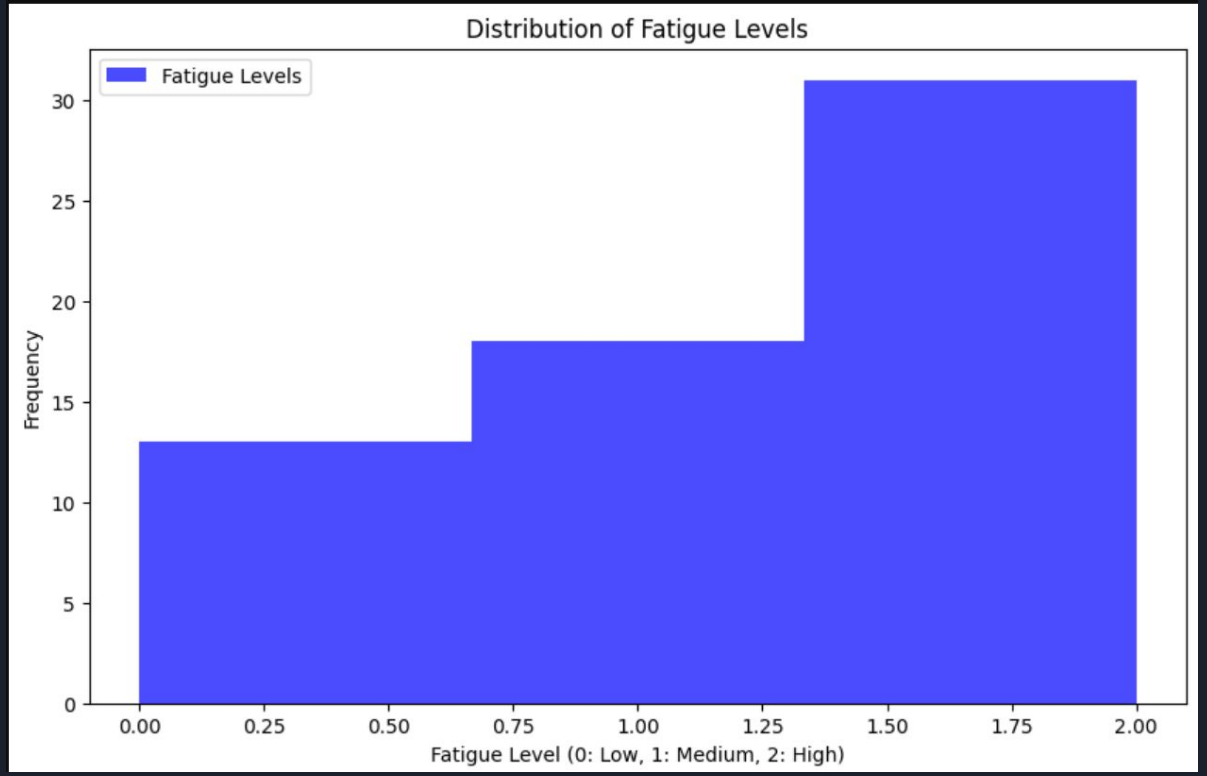
- Gradient Boosting Classifier
- Three-level classification:
  - Low fatigue
  - Medium fatigue
  - High fatigue



Results

Model Performance:

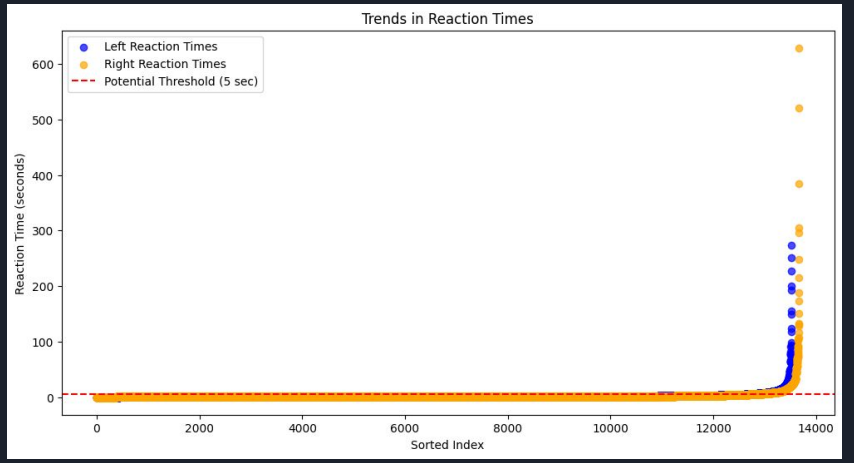
- Overall Accuracy: 95%
- Precision: 97% (macro avg)
- Recall: 93% (macro avg)
- F1-Score: 95% (weighted avg)

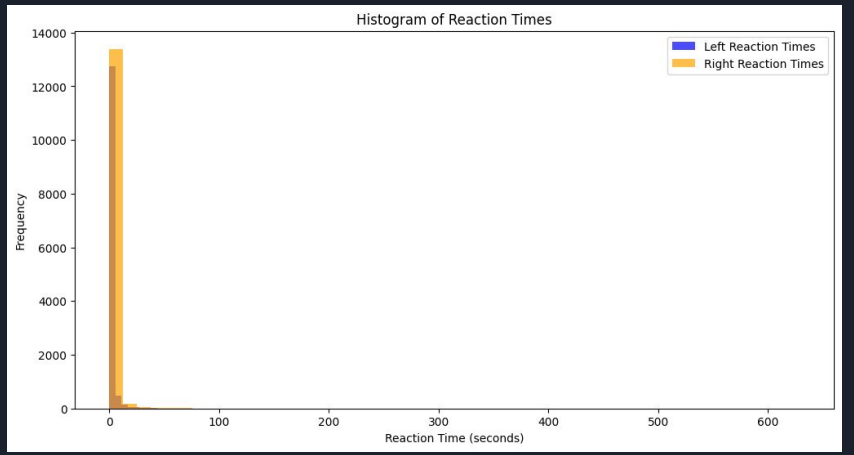


Results

Reaction Time Statistics:

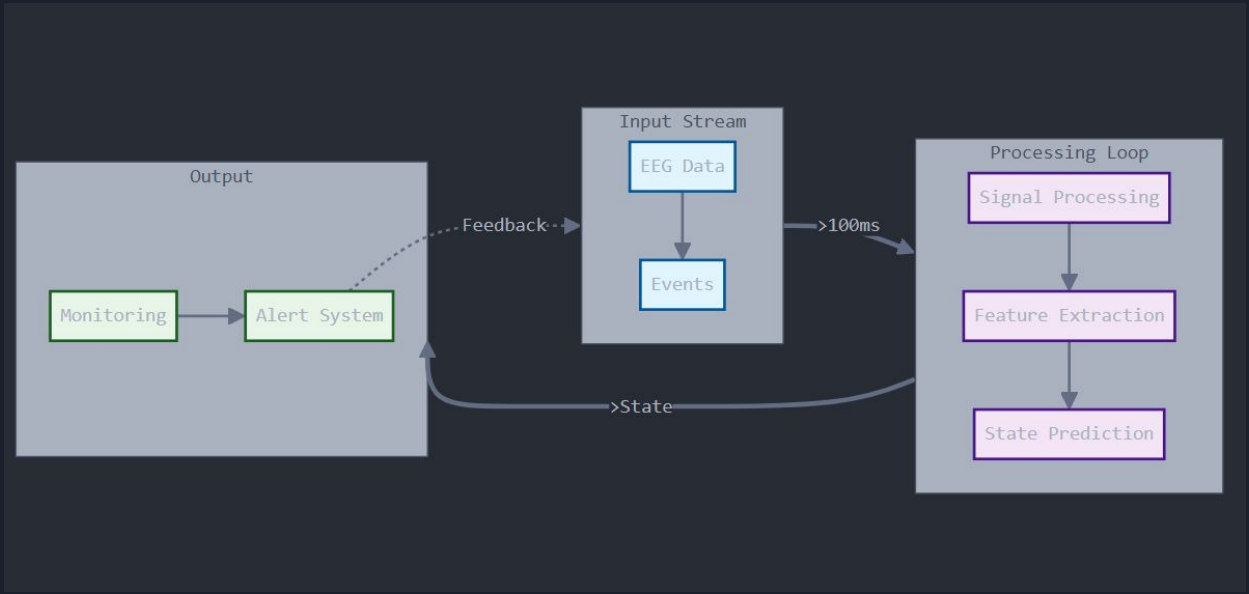
- Mean RT: 2.15 seconds
- Median RT: 0.96 seconds
- Standard Deviation: 8.91 seconds





Real-time Pipeline

- **Continuous EEG monitoring**
- **Feature extraction**
- **Fatigue classification**
- **Alert generation**



Future Work

- Enhanced feature extraction
- Mobile application development
- Integration with vehicle systems
- Multi-modal analysis

THANK YOU!