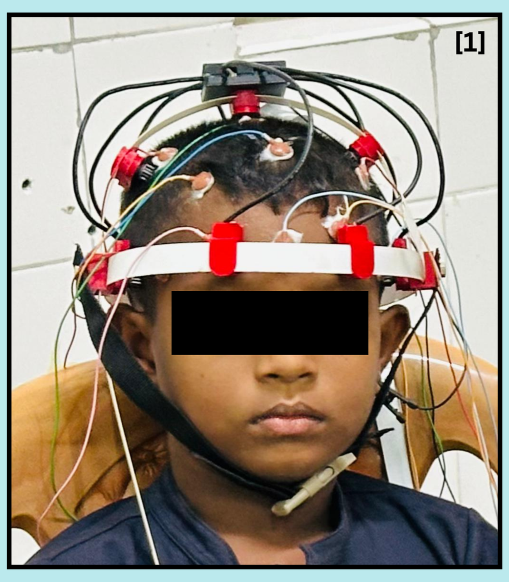
# AI-POWERED WIRELESS EEG AMPLIFIER FOR DETECTING NEONATAL SEIZURES

Abeyratne M.D.A.J. (190009U), Udayantha B.D.S. (190639B), Weerasinghe K.N. (190672T), Wickramasinghe N.L. (190688X)
Mr. Kithmin Wickremasinghe, Dr. Anjula De Silva, Prof. Jithangi Wanigasinghe, Dr. Chamira Edussooriya

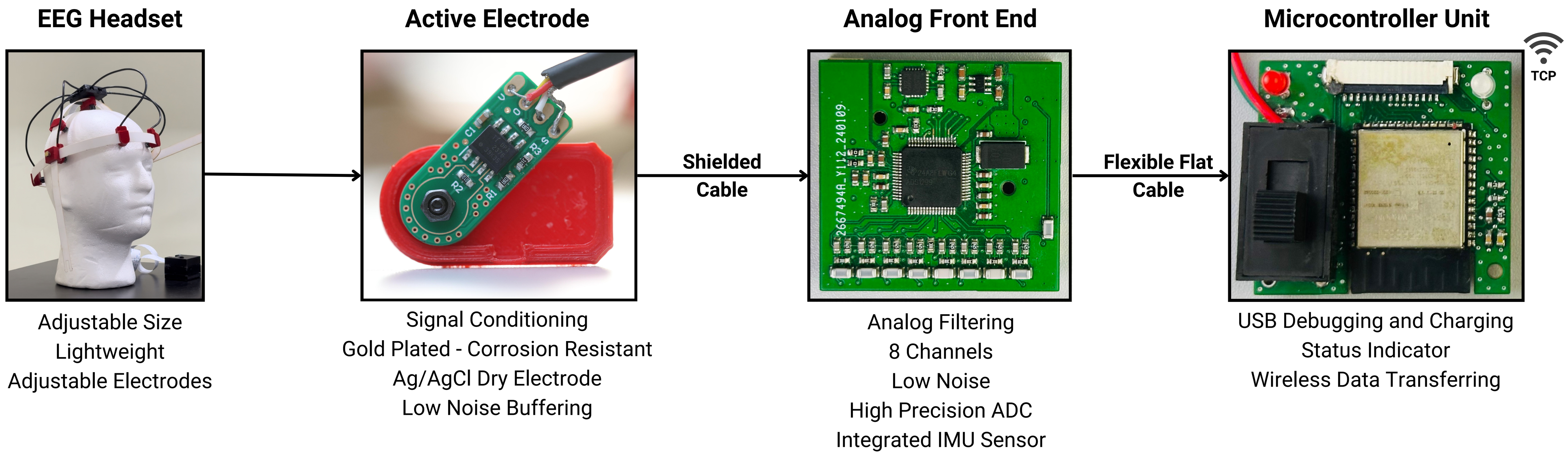
## INTRODUCTION



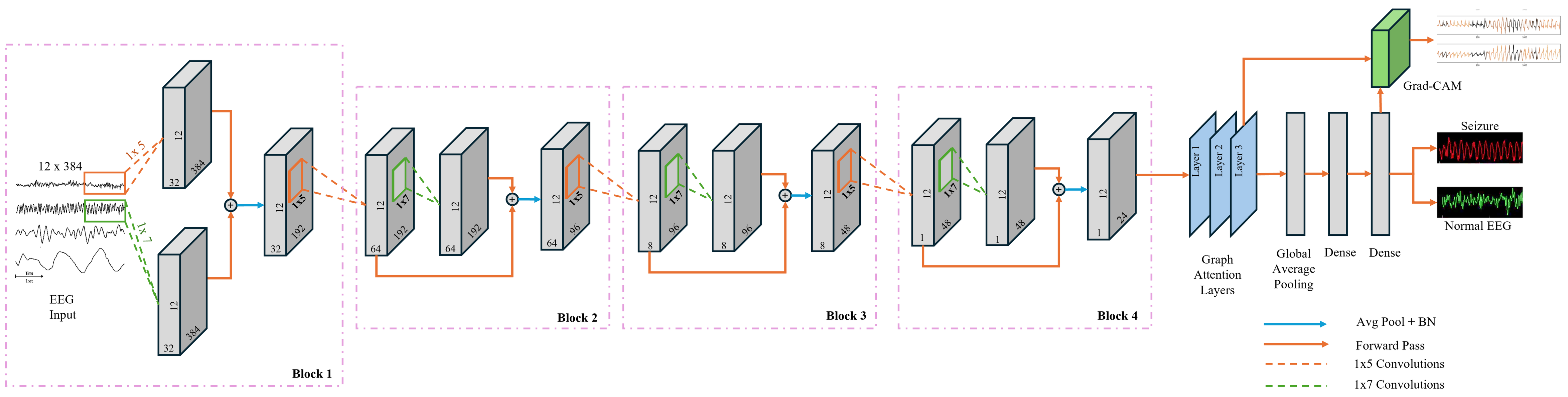

- **Neonatal Seizures** are epileptic seizures occurring in the neonatal period (first 4 weeks after birth)
- Occurrence:
  - 95 per 1000 live births - Preterm infants[2]
  - **3 per 1000** live births - Normal Infants
- Can cause **serious damage** to the immature brain
- Demands **urgent diagnosis** and management
- **Challenges**: Clinically subtle and difficult to recognize from the normal behaviours of the physiological phenomena
- **Existing methods**: EEG recording using wet electrodes is currently used in hospital settings for seizure diagnosis
- Neonatal EEG recordings and interpretations require the special skills of well-trained technologists and physicians
- **Problems with existing methods**:
  - Takes time to attach and detach
  - Inconvenience due to conductive gel
  - Costly

## METHODOLOGY

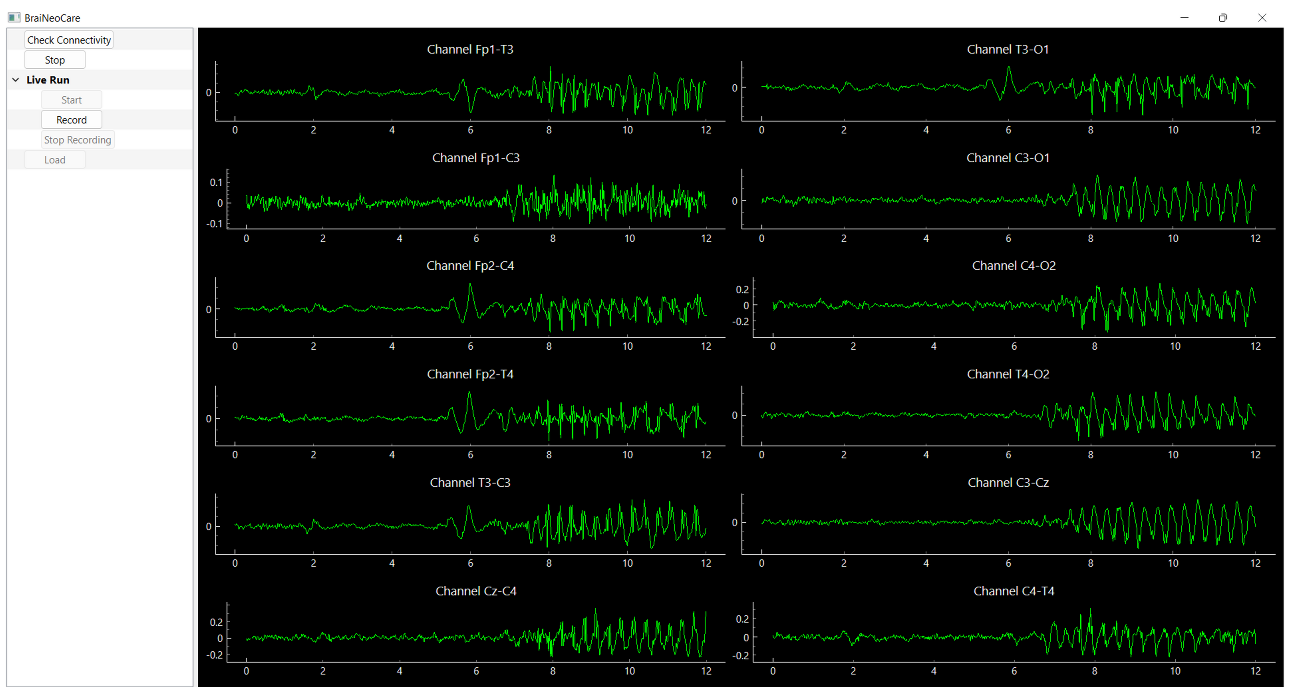
### HARDWARE BLOCK DIAGRAM



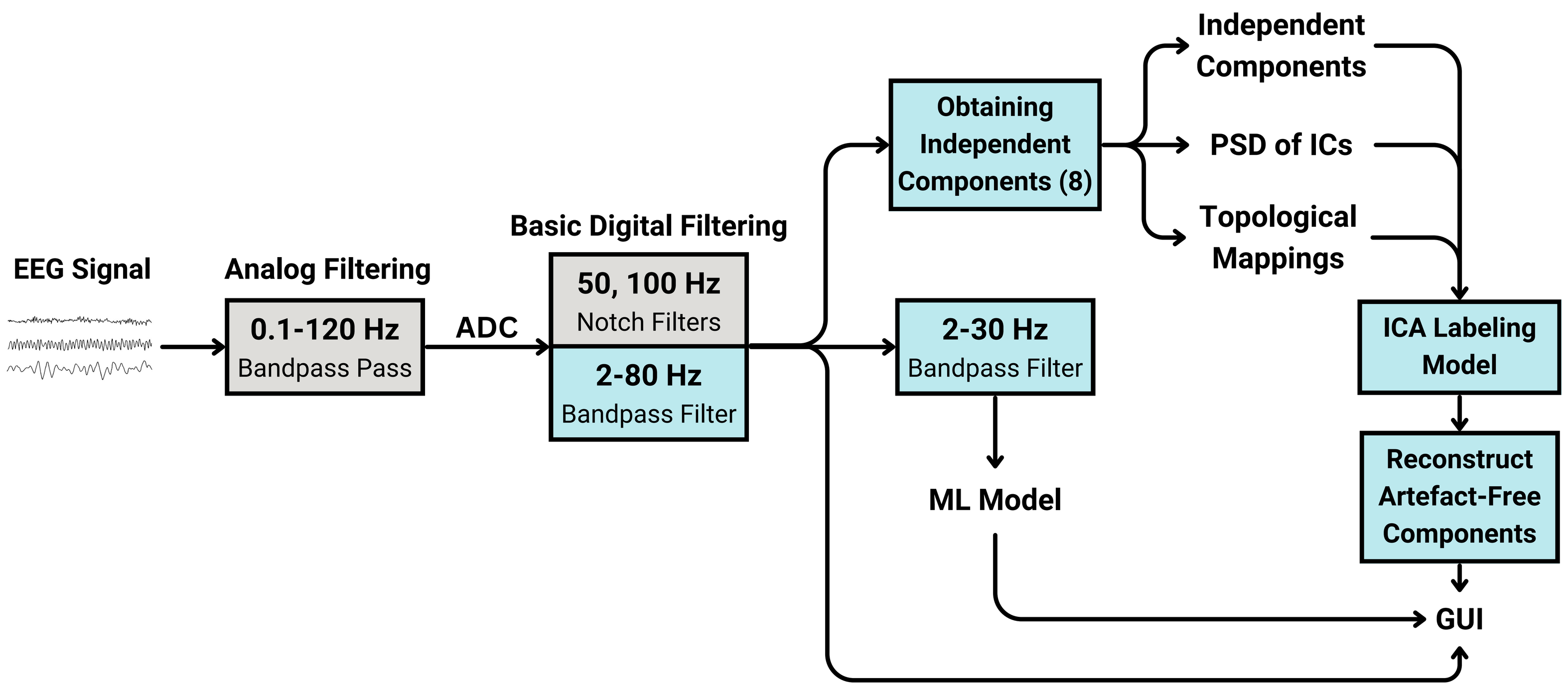

### MODEL ARCHITECTURE




### GRAPHICAL USER INTERFACE (GUI)



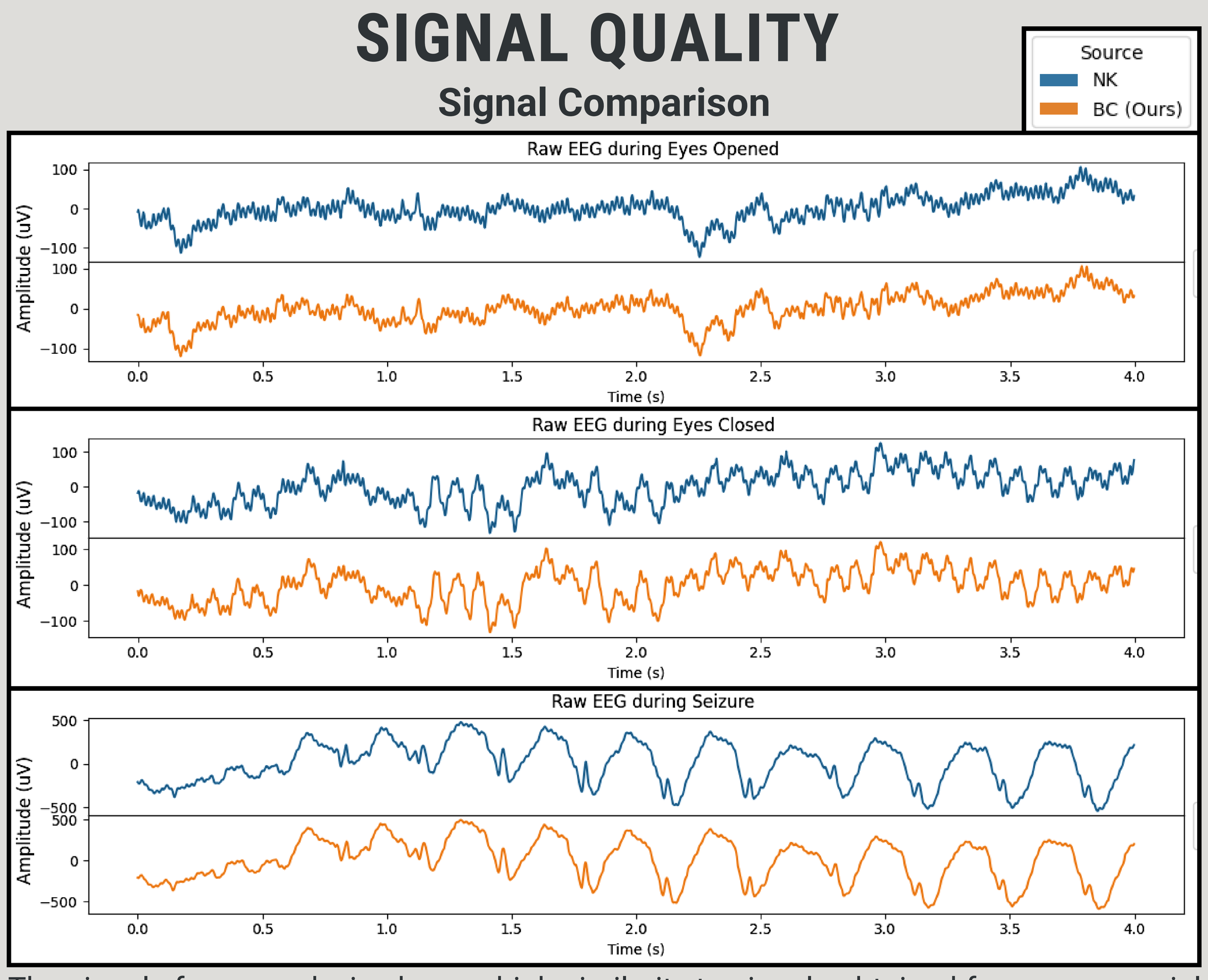
### SIGNAL PROCESSING PIPELINE




## RESULTS

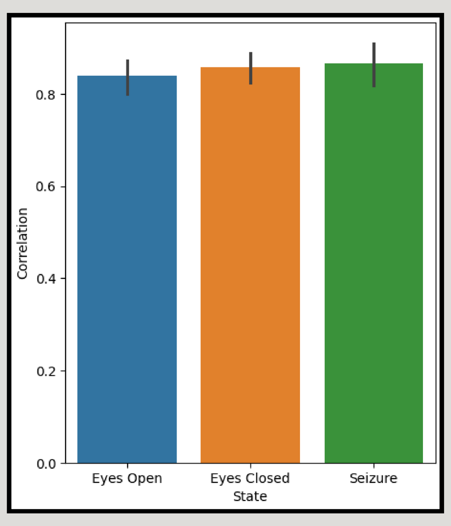
### SIGNAL QUALITY

#### Signal Comparison



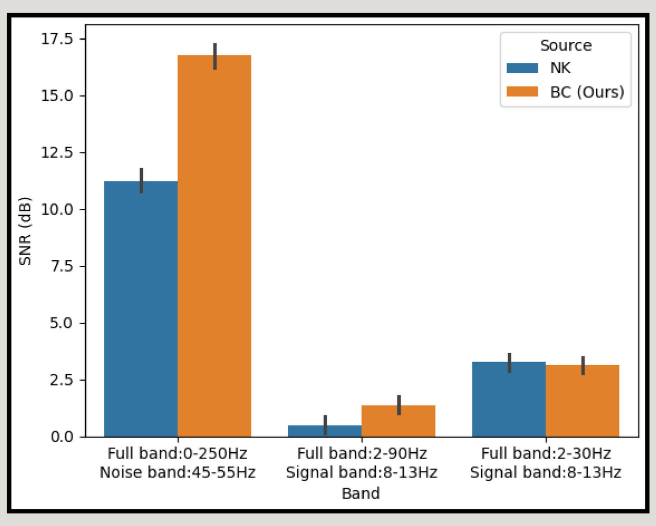

The signals from our device have a high similarity to signals obtained from commercial device and has lower powerline noise.

#### Correlation



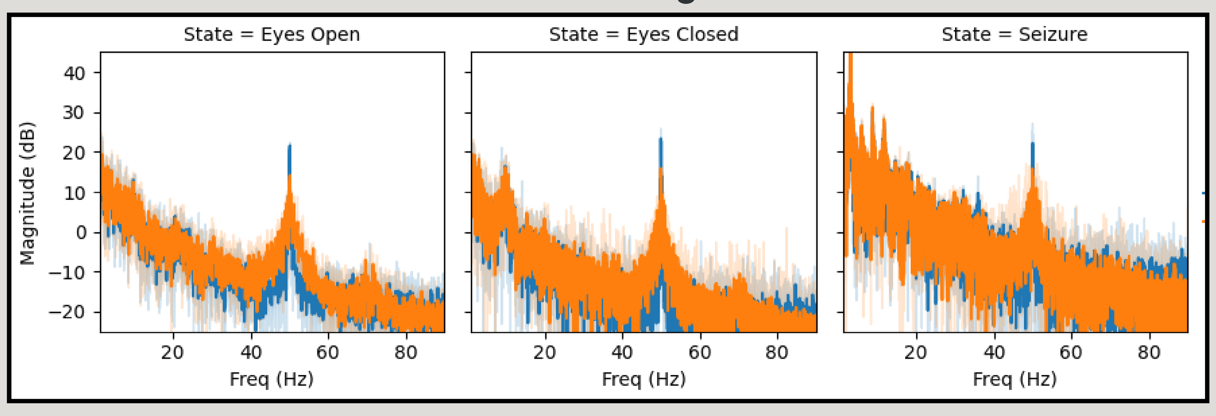

Signals from our device highly correlate with the signals from the commercial device.

#### SNR




SNR is calculated using various frequency bands for signal and noise. All methods match or exceed the SNR of the commercial device.

#### FFT of Raw Signals




The FFT shows the alpha waves (8-13 Hz) during Eyes Closed state and low frequency spikes during Seizure. Our device shows lower powerline noise (50 Hz).

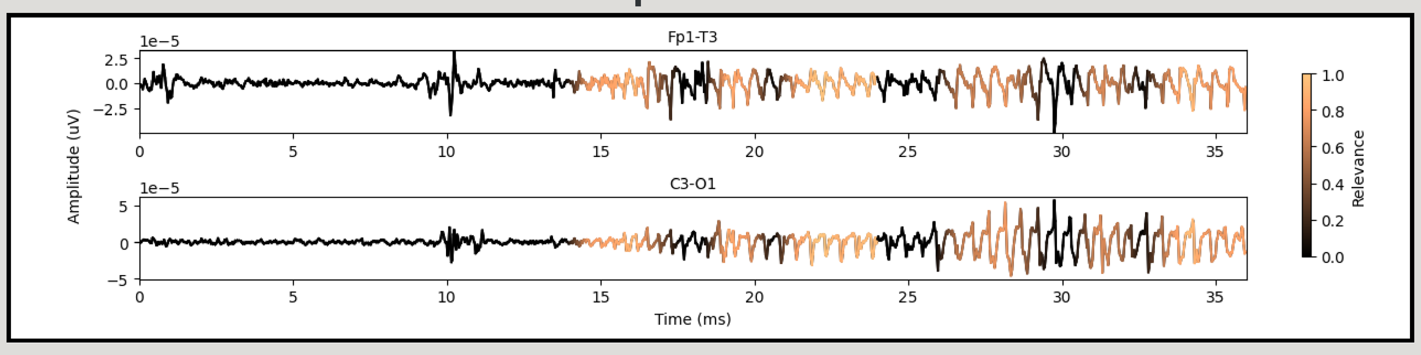
### SEIZURE CLASSIFICATION

#### Comparison with Previous Methods

| Number of EEG channels | Method | Accuracy | AUC | | Recall | Precision | Kappa |
|---|---|---|---|---|---|---|---|
| | | mean± std | Median (IQR) | Mean±std | | | |
| 18 | MSC-GCNN | - | 99.1 (96.8,99.6) | 94.7±10.9 | 96.71 | - | 0.8 |
| | PLV-GCNN | - | 99.0 (95.2,99.7) | 94.1±10.5 | 95.3 | - | 0.79 |
| | SD-GCNN | - | 97.3 (86.3,99.6) | 90.09±13.5 | 96.68 | - | 0.71 |
| | ST-GAT(FL) | - | 99.3 (96.4,99.5) | 96.6±8.9 | 98 | - | 0.88 |
| 12 10-fold CV | ST-GAT(FL) | 80.29±9.48 | 83.98 (77.8,90.9) | 83.15±8.85 | 39.98 | **94.91** | 0.43 |
| | Our method | **89.02**±2.91 | **91.84** (88.57,95.21) | **91.46**±4.36 | **82.84** | 94.23 | **0.89** |
| 12 (80%-20%) | ST-GAT(FL) | 88.8 | 91.71 | | 66.89 | **95.17** | 0.71 |
| | Our method | **91.56** | **94.42** | | **83.22** | 88.61 | **0.80** |

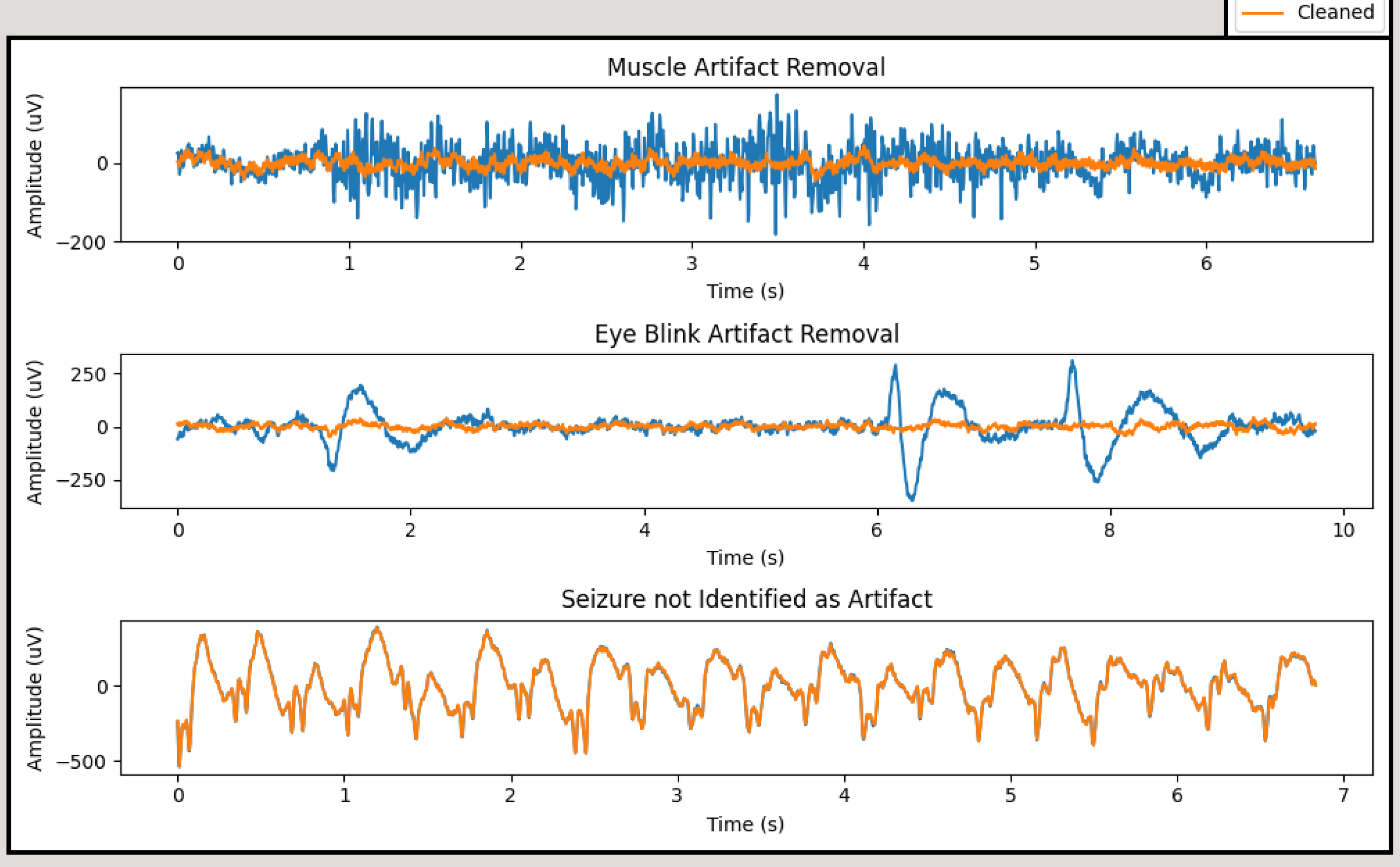
Our model was evaluated on both 10-fold cross-validation and dividing the dataset to 80% for training and 20% for testing datasets.This model architecture outperforms all of the existing methods.

#### Explainable AI




The interpretable model is able to identify the required channel and area which the model has used to identify the seizure.

### ARTIFACT REMOVAL




Independent component analysis (ICA) is used to decompose EEG into different sources, and the ICA labelling model (trained using the EPIC dataset) is used to label and remove artifactual ICs, which reduces the time taken to manually label the noisy ICs. Since the EPIC dataset contains ICs of patients having seizures, artifacts are only labeled while seizures are not occurring.

[1] All clinical tests were performed with ethical clearance from the University of Moratuwa Ethical Clearance Committee, at Lady Ridgeway Hospital for Children under professional supervision.

[2] Krawiec, C., & Muzio, M. R. (2024). Neonatal Seizure. PubMed; StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK554535

GROUP 13