# Machine Learning-based Amyloid Pathology Screening Model Using QEEG Sensor Level Imaginary Coherence

Taegyun Jeong[1], Ukeob Park[1], Sohyeon Jeon[1,2], Seung Wan Kang[1,3]

1. iMediSync Inc., Seoul, South Korea
2. Department of Software Engineering, Samyuk University, Seoul, South Korea
3. National Standard Reference Data Center for Korean EEG, Seoul National University College of Nursing, Seoul, South Korea

## Introduction

- β-Amyloid is a peptide found in patients with Alzheimer's disease, which from amyloid plaques in the brain.
- The composition and population of β-Amyloid peptides correlates to the clinical status of the patients.
- Thus, detection of the β-Amyloid peptide is crucial for early screening and prevention of Alzheimer dementia.
- Amyloid Positron Emission Tomography (Amyloid PET) employing 18-F labelled radiopharmaceuticals is popularly adopted for screening of the peptide/plaques.
- There are several disadvantages of Amyloid PET, the imaging process exposes the patient to a high dose of harmful ionizing radiation and could be very costly.
- This research aims to develop a novel β-Amyloid screening method overcoming the disadvantages.

## Methods

- The EEG signal employed in this research has been measured at 19 electrode locations in correspondence to the 10-20 system.
- iSyncBrain® platform was used for preprocessing procedures, which includes Independent Component Analysis (ICA) and bad epoch rejection.
- Preprocessed signals were then band pass filtered into eight different frequency bands: Delta (1-4Hz); Theta (4-8Hz); Alpha1 (8-10Hz); Alpha2 (10-12Hz); Beta1 (12-15Hz); Beta2 (15-20Hz); Beta3 (20-30Hz); Gamma (30-45Hz).
- Signals which fall under Delta and Gamma frequency bands were excluded from the scope of interest due to a high chance of noise contamination.
- The imaginary coherences were selected as feature values which represent phase differences among the signals at locations specified by the 10-20 system.
- The feature values were then normalized at each frequency bands.
- Sensor-level imaginary coherence feature map (see figure 1 below) was yielded through horizontal concatenation of the normalized matrices.

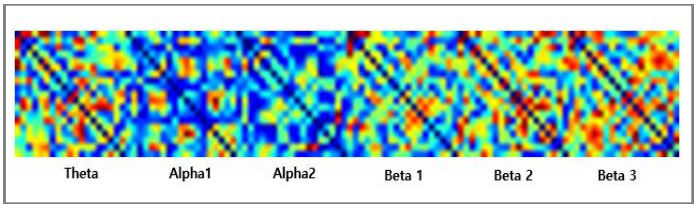


Figure 1: The sensor level imaginary coherence feature map employed for training/testing of the model

- The class labelling was done through Amyloid PET results.
- Data augmentation was performed on β-Amyloid positive class through splitting of the data in time series, with the aim to overcome the class imbalance.
- Sensor-level imaginary coherence feature maps were produced for each subjects, comprising the augmented dataset.
- The final training dataset consists of 138 β-Amyloid positive data and 143 β-Amyloid negative data.
- The final test dataset consists of 61 β-Amyloid positive data and 33 β-Amyloid negative data.

## Results

| | Pred Amyloid + | Pred Amyloid - |
|---|---|---|
| **Real Amyloid +** | 57 | 4 |
| **Real Amyloid -** | 2 | 31 |

Table 1: Confusion matrix for test set classification

- The β-Amyloid screening model adopting machine learning algorithm has yielded test sensitivity at 0.934 and specificity at 0.939.
- 5-fold cross validation was performed on the training dataset, which returned the sensitivity at 0.884 and specificity at 0.923.

## Conclusions

- The machine learning model developed in this research achieved outstanding classification results.
- Such QEEG based model may sufficiently replace Amyloid PET for screening of the β-Amyloid plaque, resolving previously discussed disadvantages.
- Sensor level imaginary coherences are statistically more robust than source level imaginary coherences, free from errors accumulated during source location calculation process.
- Therefore, correct and appropriate application of the sensor level imaginary coherences may aid screening of several other neurological diseases.

Acknowledgement

This study was supported by the fund from the Korea Health Industry Development Institute(No. HU20C0511010020)