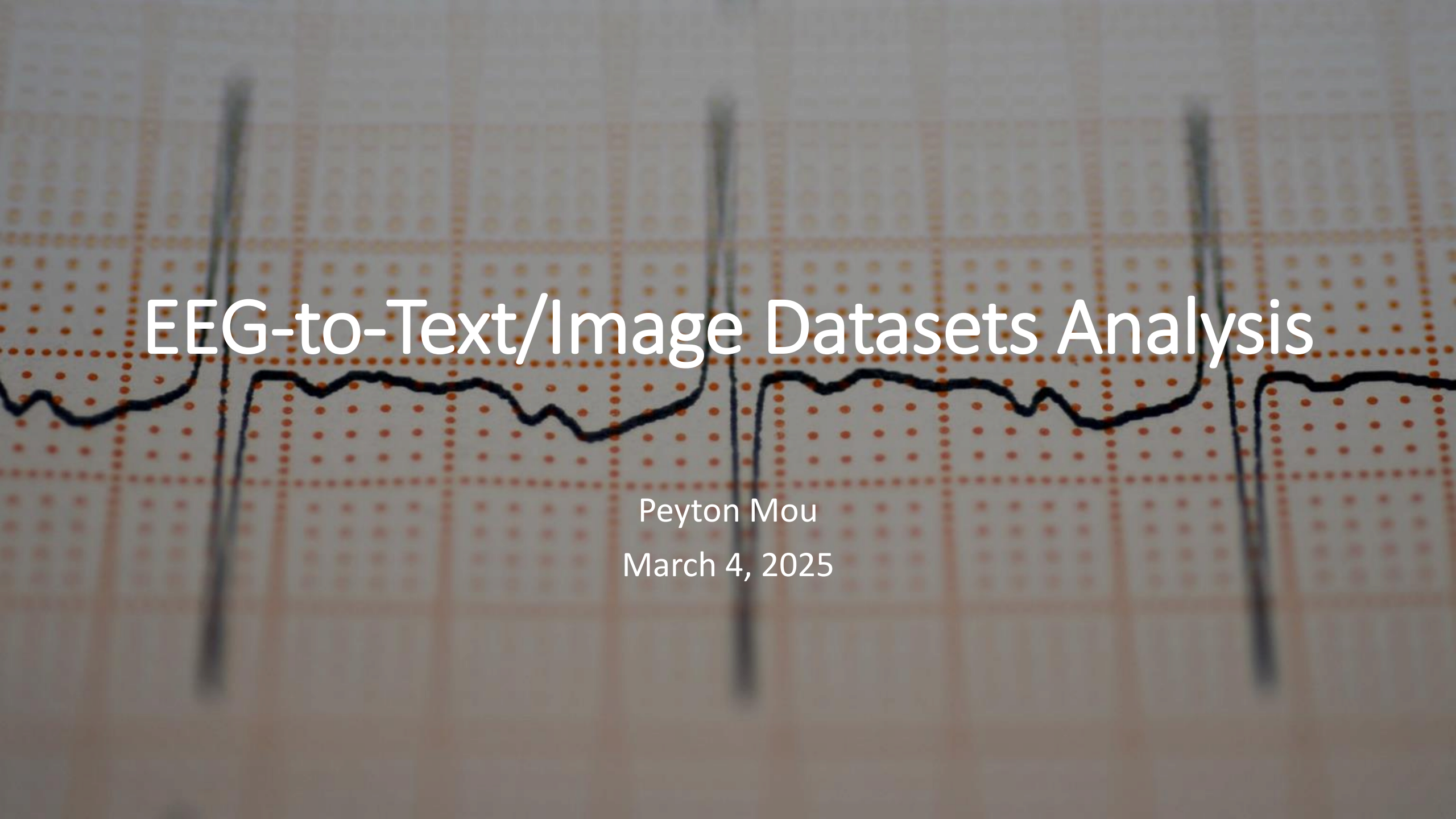

EEG-to-Text/Image Datasets Analysis

Peyton Mou

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Agenda

I. What is EEG?

II. Kumar's EEG Datasets Frequency-Domain & Time-Domain Analysis

a) Topomap of Five Frequency Bands (EEG-to-Char/Digit/Image)

b) Line Plots of Amplitude Over Time (EEG-to-Char: Channel O2, P7, F3, FC6, T8)

Electroencephalography (EEG)

Pros:

- Non-invasive and portable BCI
- High temporal resolution

Cons:

- Low spatial resolution
- Low signal-to-noise ratio

Frequency Bands:

- Delta: 0.5-4 Hz
- Theta: 4-8 Hz
- Alpha: 8-13 Hz
- Beta: 13-30 Hz
- Gamma: 30-100 Hz or higher

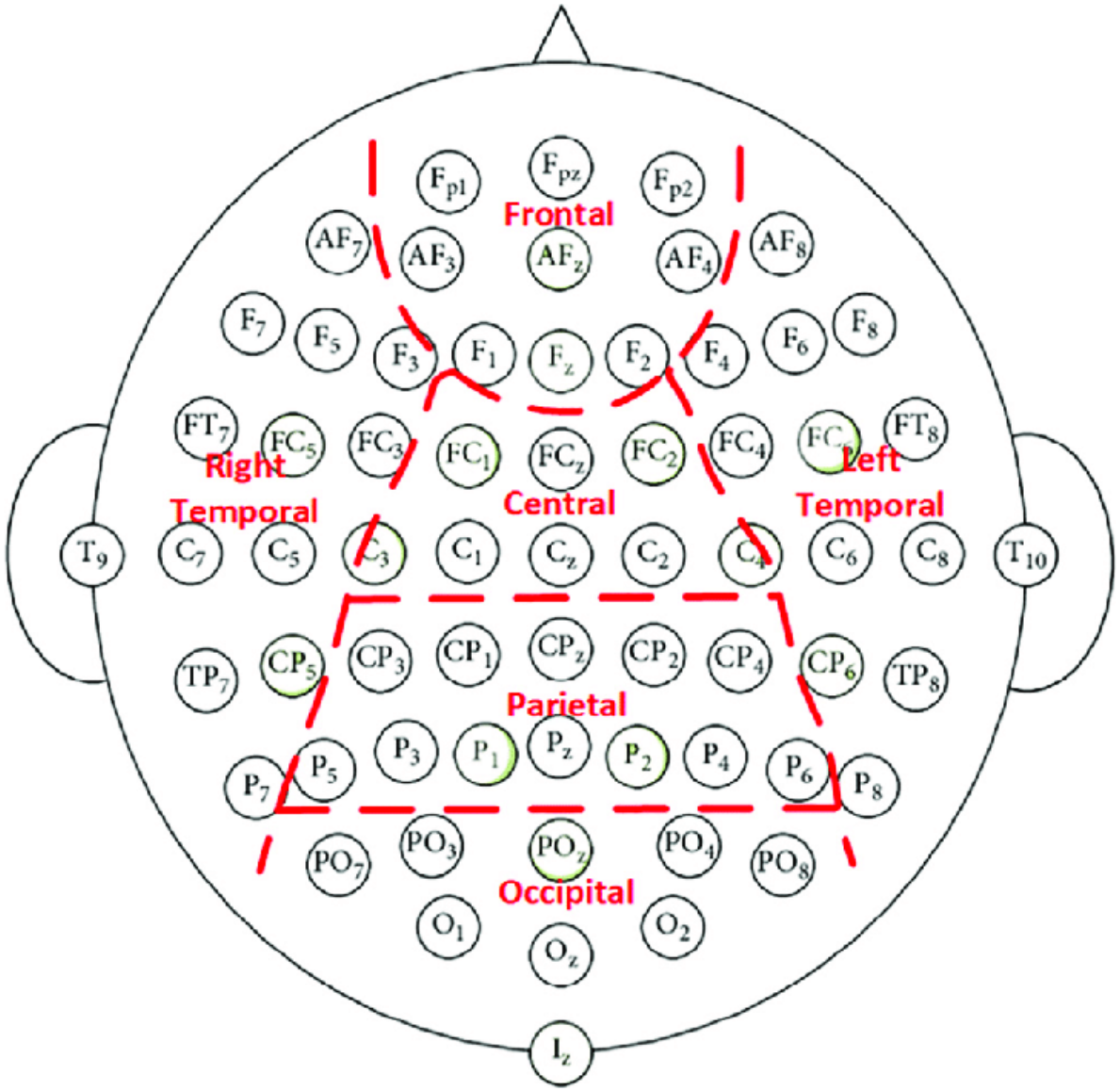


Fig.1. The distribution of EEG electrodes and brain regions

Figure source: Detecting fatigue in car drivers and aircraft pilots by using non-invasive measures: The value of differentiation of sleepiness and mental fatigue - ScienceDirect

Kumar's EEG Imagined Speech (Char, Digit, Image)

Envisioned speech recognition:

view the object 10s. eyes closed resting state and imagine the object 10s, then gap 20s

- ⊗ Block design
- ✓ Portable device

- Number of Subjects: 23
- Sampling frequency: 128 Hz
- **Number of EEG channels: 14**
- Number of classes: 10
- Max time of sample : 10 seconds
- Window size: 32
- Stride: 8
- Input shape: 32*14
- Training 28888, Test 7222
- Device: Emotiv EPOC+ Sensor

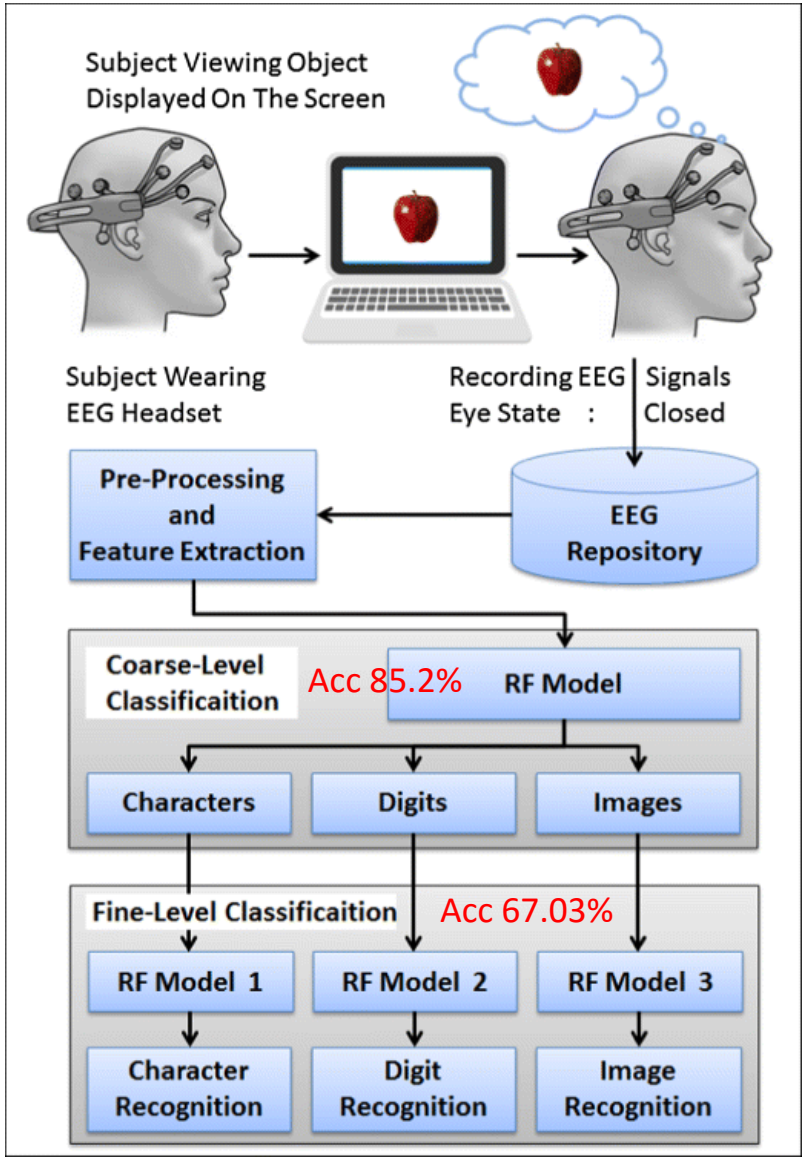


Fig.2. Pictorial representation of all text and non-text classes involved in the dataset

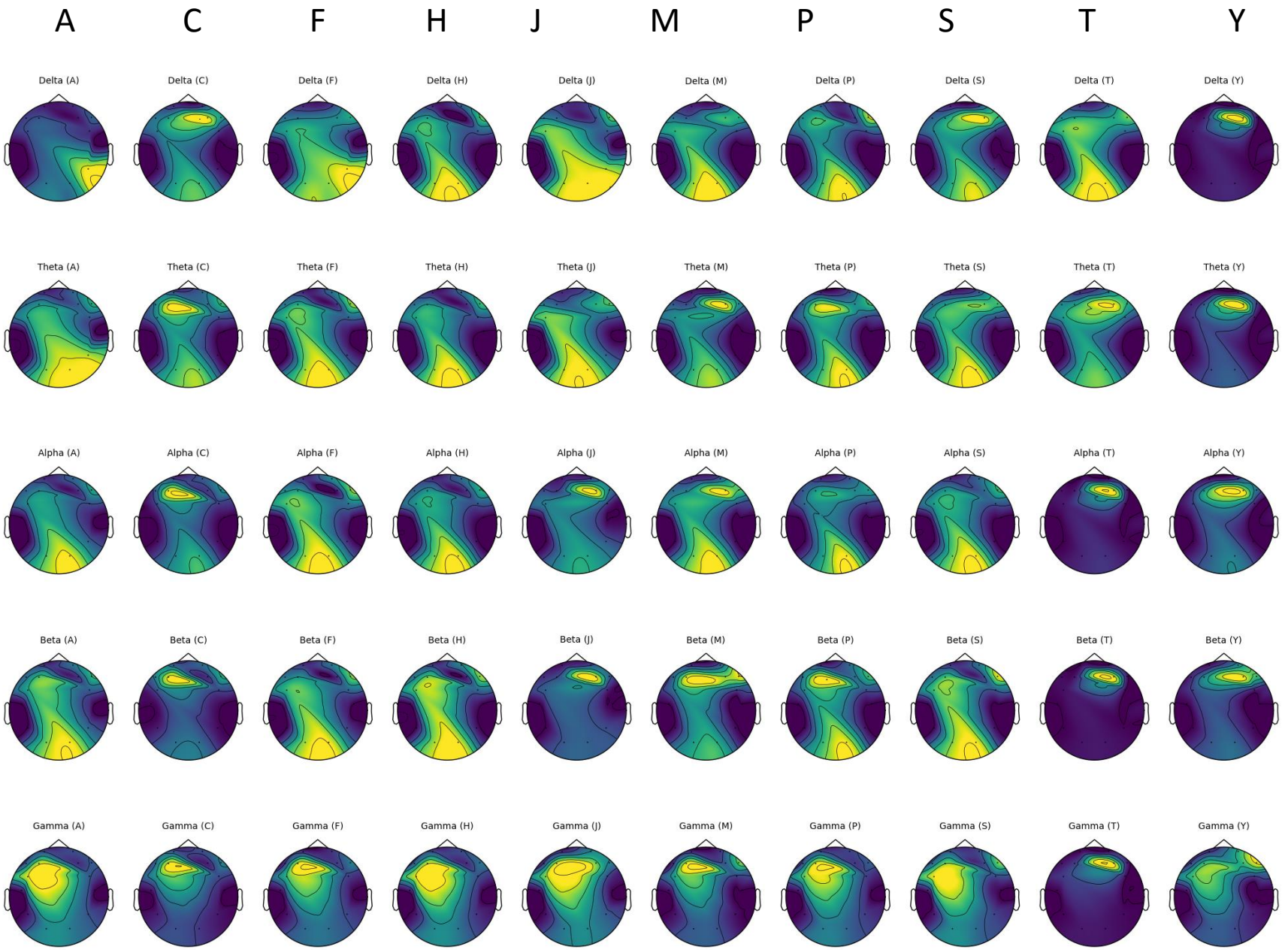
Fig.3. Flow diagram of the proposed envisioned speech recognition framework

Figures source: Envisioned speech recognition using EEG sensors | Personal and Ubiquitous Computing

EEG to Char:

Five-Frequency Bands Topomap

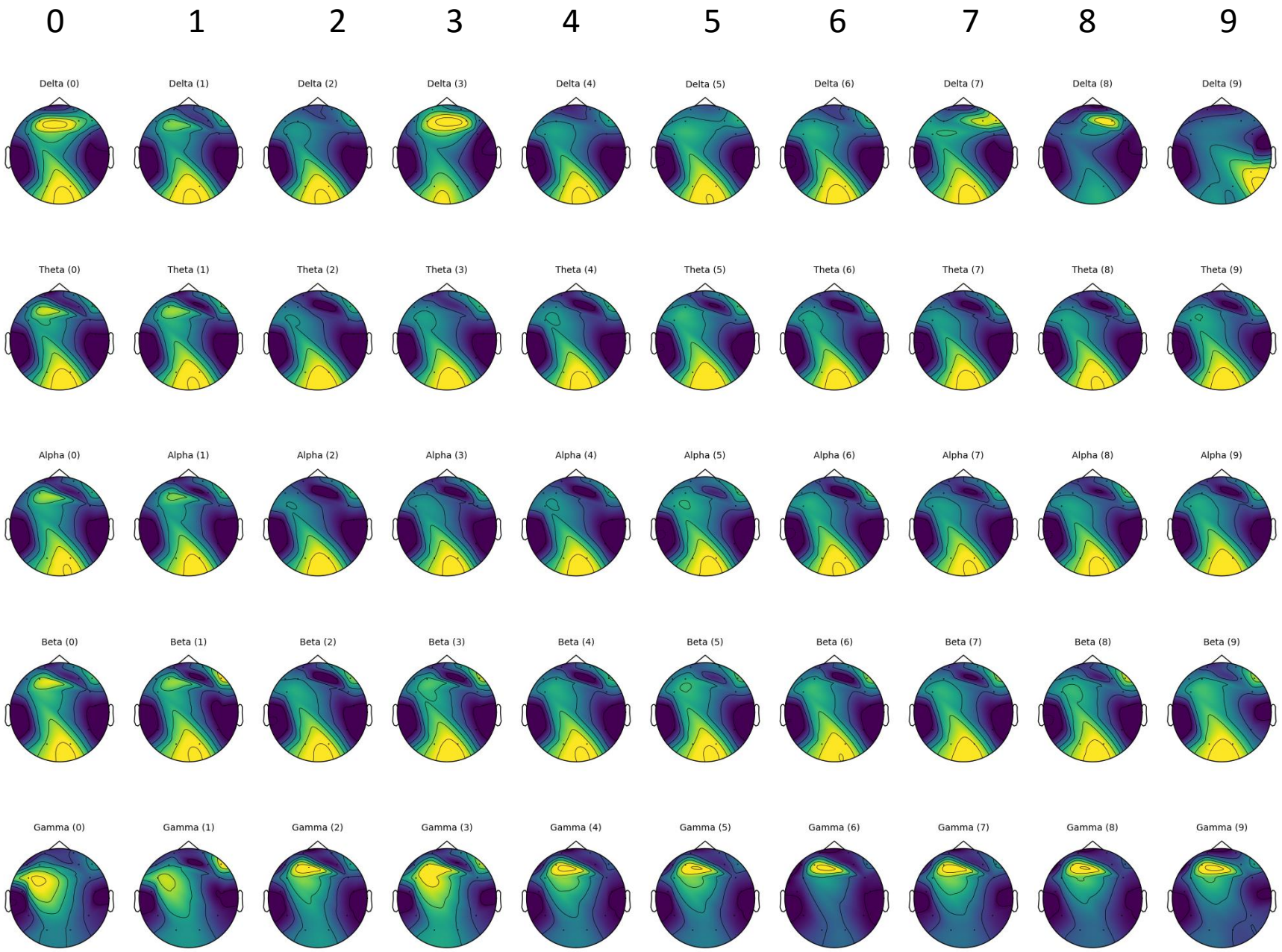
- A, F, H, P, S: stronger power across multiple bands
- C, J, M: medium power
- T, Y: weaker power
- Frontal, parietal and occipital regions show the most distinctions
- Every frequency band performs variously across letters



EEG to Digit:

Five-Frequency Bands Topomap

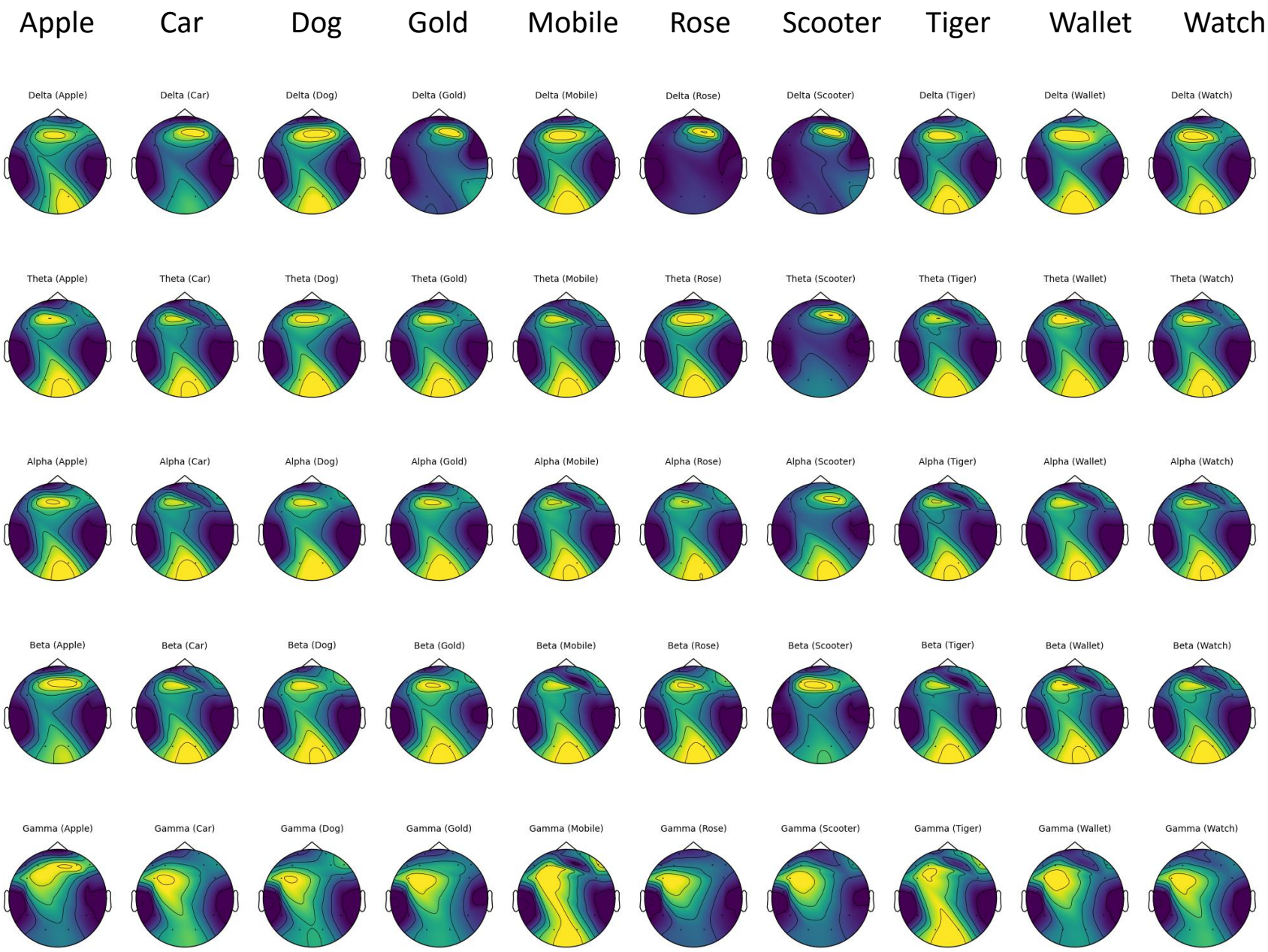
- 0, 3, 7: stronger power across multiple bands
- 1, 2, 4, 5: mediumly active power
- 6, 8, 9: slightly lower but still active power
- Theta, alpha, beta perform similar, delta and gamma show more variations across digits



EEG to Image:

Five-Frequency Bands Topomap

- Apple, Car, Dog, Mobile, Tiger: high activation across multiple bands
- Gold, Wallet, Watch: medium power
- Rose, Scooter: slightly weaker but still active responses
- Frontal and occipital regions are more active for image than char/digit

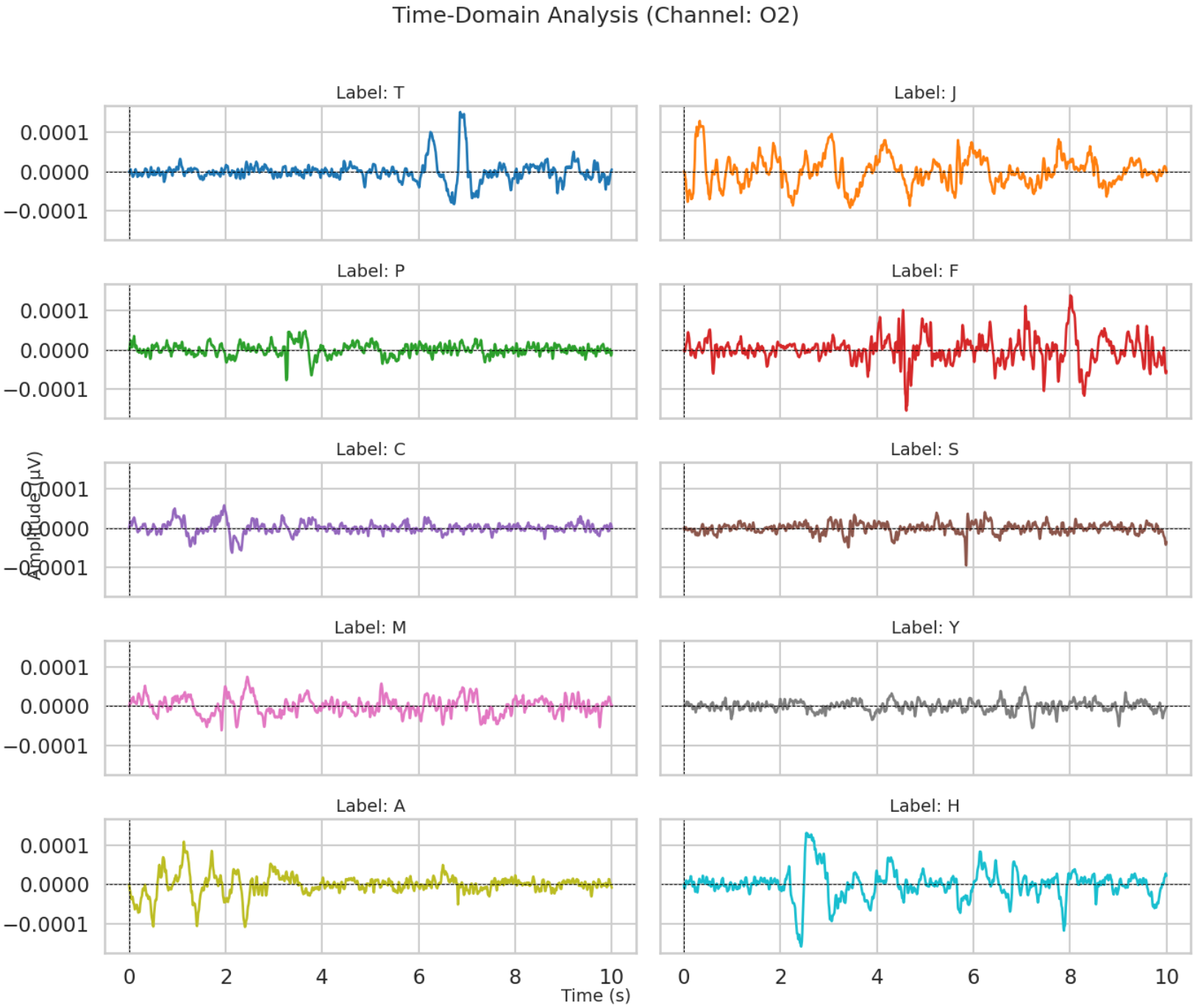


EEG to Char:

Channel O2 (Visual Processing)

Amplitude Over Time

- T, H: small peaks
- J, F: higher fluctuations
- P, C, M, A: moderate changes
- S, Y: relatively stable

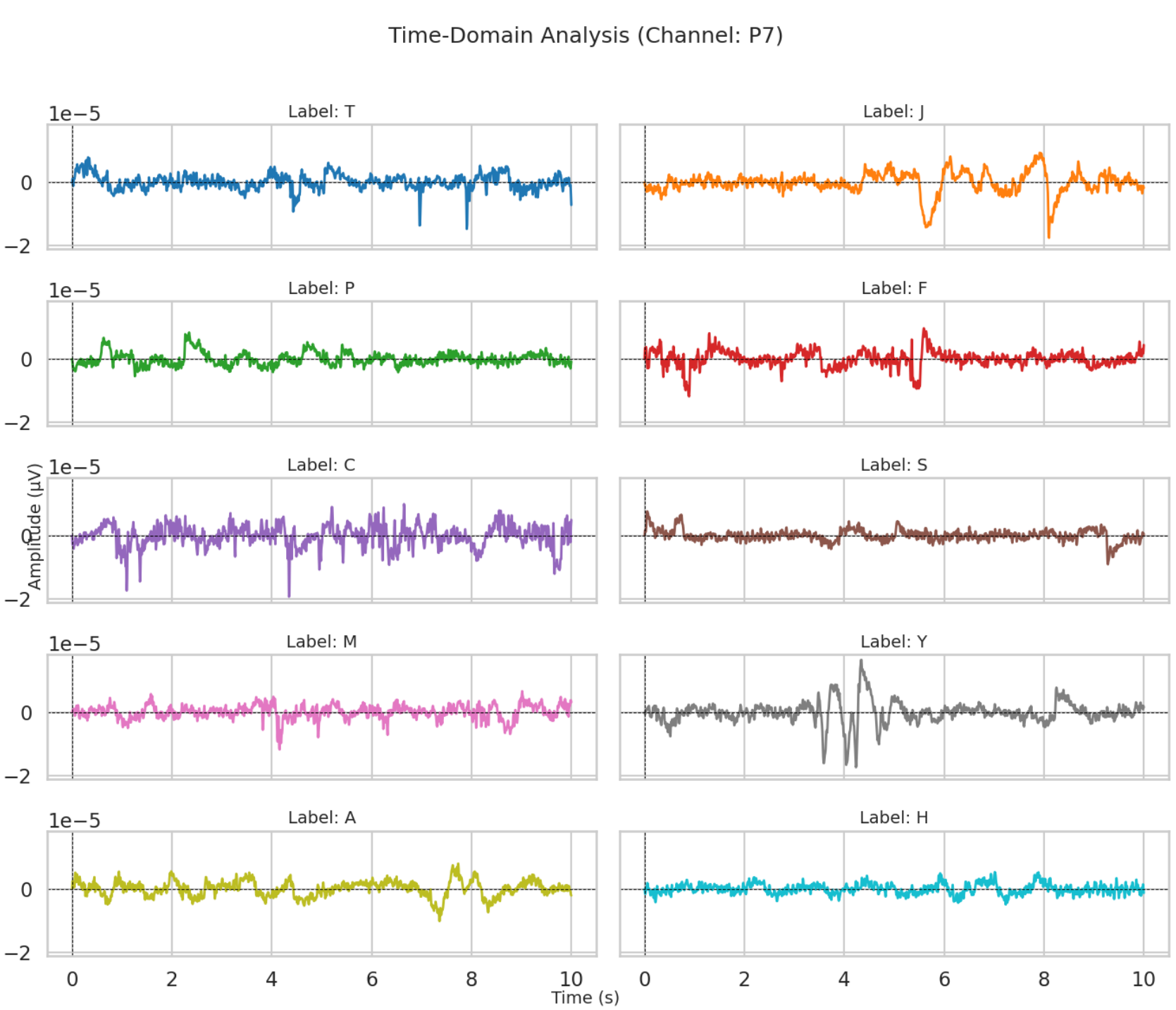


EEG to Char:

Channel P7 (Spatial Awareness & Sensory Integration)

Amplitude Over Time

- Y: notable fluctuation 3~5s
- C, J: more fluctuation and peaks
- S, H: relatively stable
- Other letters: medium changes

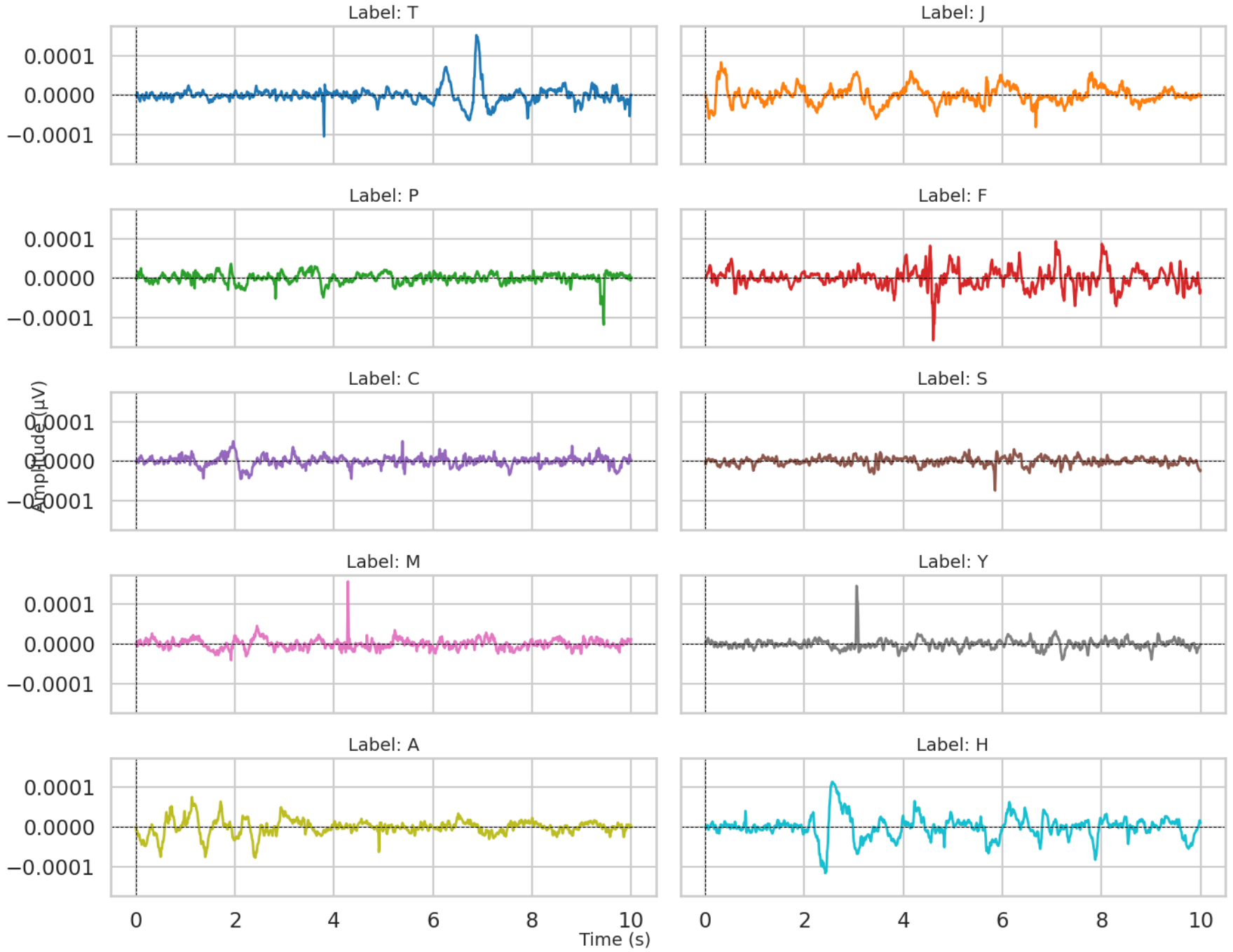


EEG to Char:

Channel F3 (Decision Making & Executive Control)

Amplitude Over Time

- T, J, F, H, A: noticeable oscillations and peaks
- S, C, P: fewer sharp changes
- M, Y: steady, sudden spikes might indicate noise



EEG to Char:

Channel FC6 (Motor Imagery & Cognitive Processing)

Amplitude Over Time

- J: distinct waveform and more oscillatory activity
- T, F, H, A: more fluctuations and notable spikes
- P, S, Y: more steady

EEG to Char:

Channel T8 (Language & Memory)

Amplitude Over Time

- J, F, C, A: more peaks and dips
- Other letters: more stable
- Compared to other channels, T8 has more rapid oscillations and smaller value of amplitude (microvolts)