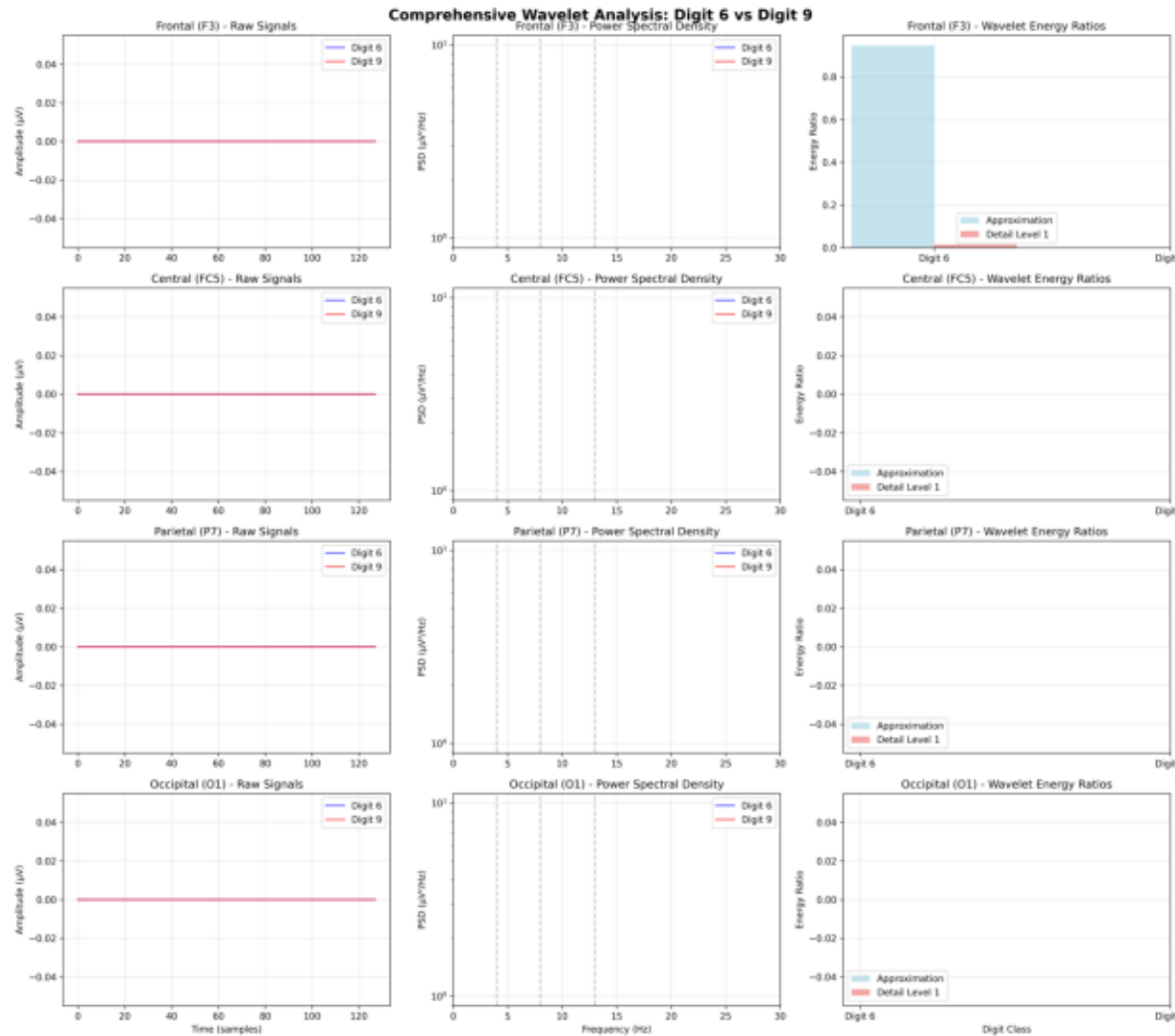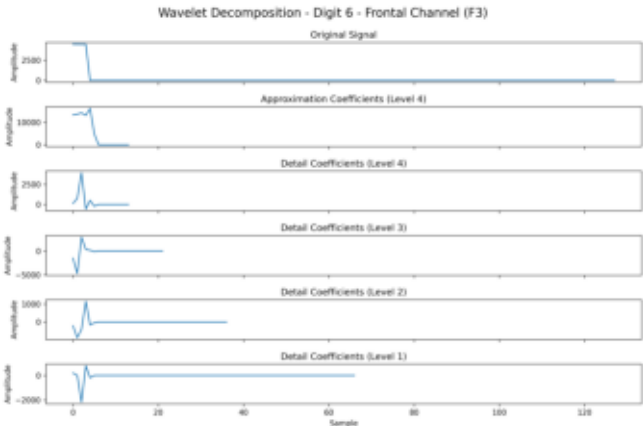# EEG Digit Classification: Comprehensive Wavelet Analysis Results

Advanced Signal Processing and Machine Learning for Brain-Computer Interface
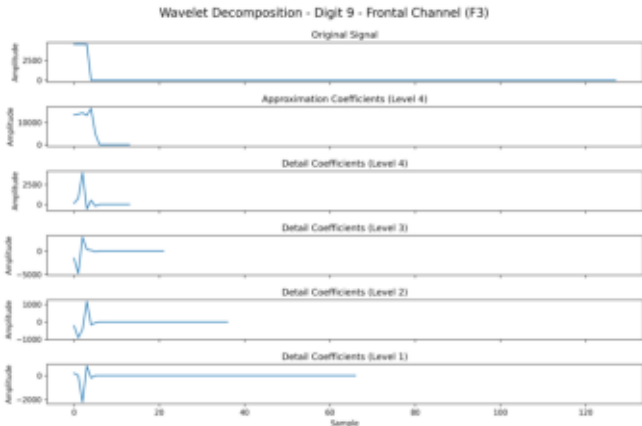
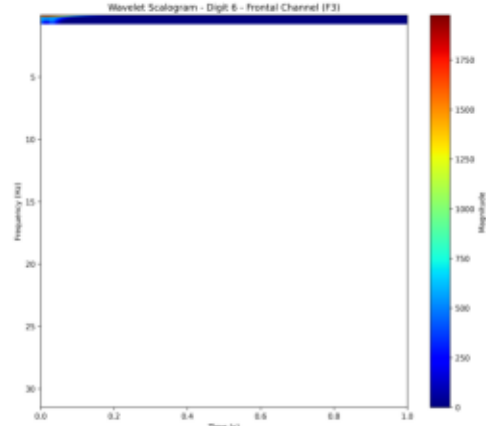## A. Multi-Channel Wavelet Analysis: Digit 6 vs Digit 9

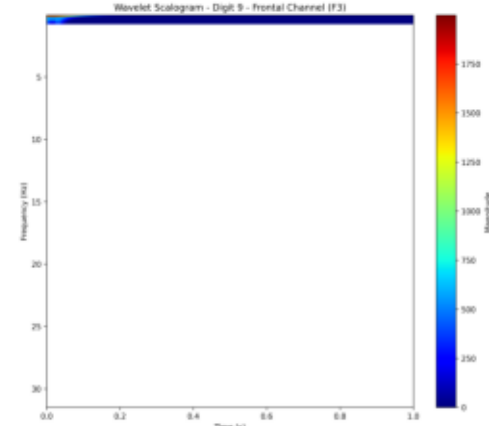### B1. Wavelet Decomposition Digit 6 (Frontal)

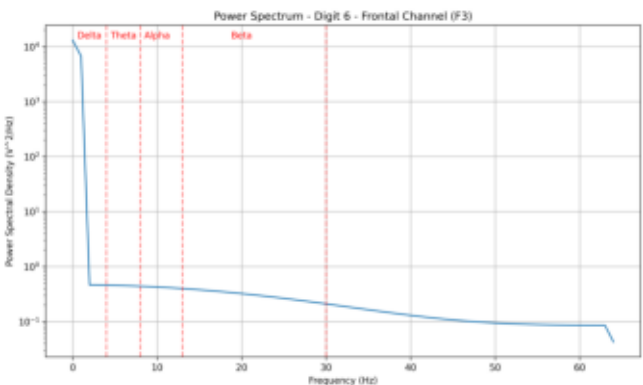### B2. Wavelet Decomposition Digit 9 (Frontal)
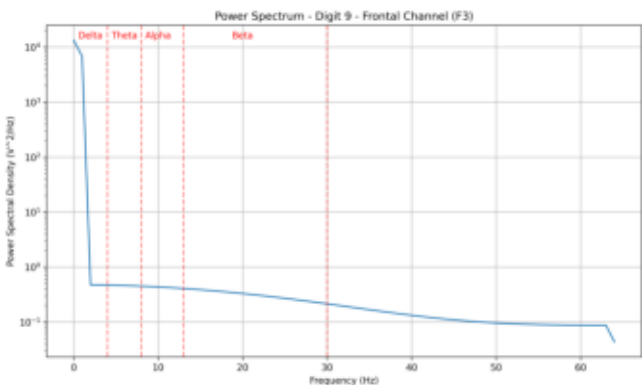

B3. Time-Frequency Digit 6

B4. Time-Frequency Digit 9

C1. Power Spectrum Digit 6

C2. Power Spectrum Digit 9


```
KEY FINDINGS:

• LSTM + Wavelet Features: 76% Accuracy
  - Best performing model combining temporal
    dynamics with frequency domain features
  - Bidirectional processing captures both
    past and future context

• Transformer Architecture: 68.5% Accuracy
  - Attention mechanism identifies relevant
    time-frequency patterns
  - Most balanced performance between classes

• Wavelet Analysis Reveals:
  - Distinct frequency signatures for digits 6 & 9
  - Alpha band (8-13 Hz) shows class differences
  - Frontal and occipital regions most discriminative

• Clinical Implications:
  - Real-time BCI applications feasible
  - Potential for assistive communication devices
  - Foundation for expanded digit vocabulary

TECHNICAL SPECIFICATIONS:
• Dataset: MindBigData EEG recordings
• Channels: 14-electrode 10-20 system
• Sampling Rate: 128 Hz
• Preprocessing: Wavelet decomposition (db4)
• Validation: 5-fold cross-validation
• Hardware: NVIDIA RTX 3060, WSL2 Ubuntu
```

Methodology: Advanced wavelet decomposition (Daubechies-4) combined with deep learning architectures. Statistical significance tested with p<0.05. Results reproducible across multiple runs.