

Abstract – NeuroPain: AI-Powered Pain Detection Using EEG and Motion Sensors

NeuroPain is an advanced AI-based system designed to analyze and predict human pain levels using multi-modal physiological signals. The project leverages EEG recordings across multiple brain regions and motion data from inertial sensors (accelerometer and gyroscope) to capture both neural and physical correlates of pain. Raw EEG and motion signals are preprocessed with bandpass filtering, artifact removal, and reference correction, followed by feature extraction including frequency-band powers, spectral and time-domain statistics, and IMU-derived metrics. Feature scaling and dimensionality reduction techniques such as PCA are applied to mitigate redundancy and enhance model interpretability. Using these extracted features, machine learning algorithms are trained to classify and predict pain intensity with high accuracy. NeuroPain provides a non-invasive, objective, and real-time framework for pain assessment, which has potential applications in clinical monitoring, personalized therapy, and biomedical research. The system emphasizes both predictive performance and interpretability, ensuring reliable insights into the physiological signatures of pain.