ABSTRACT

Advancements in Artificial Intelligence techniques have opened up new possibilities for analyzing non-invasive brain signals and extracting valuable insights related to psycho-physiological characteristics. This thesis investigates emotion recognition with EEG signals, epilepsy identification with EEG signals, and autism spectrum disorder (ASD) detection with rs-fMRI data. The goal is to advance the field of neuroscience and healthcare by developing unique tools and procedures based on neurophysiological data to reliably identify emotions, detect seizures, and diagnose ASD.

In the first section of the study, The handcrafted features have been taken into consideration for emotion recognition using EEG signals. To discover the most successful approach for emotion categorization, extensive data analysis was undertaken, and various machine learning and deep learning algorithms were tested. To determine the optimal feature subset, two novel ensemble feature selection methods were proposed that incorporated several feature selection techniques and then ensembled them in such a manner that the features that would be selected by the algorithm would be the best subset for the model. The final model performed admirably, capable of classifying a wide range of emotions precisely and accurately. It outperformed most of the existing methods, making it a promising tool for emotion recognition applications.

The second section focused on hybrid multidomain features, which include functional connectivity features and Empirical Mode Decomposition domain features to detect emotion from Electroencephalography signals. Through this work, the best frequency band among alpha, beta, theta, and gamma to detect emotion was also explored. To increase classification performance, a multidomain feature subset has been offered that combines connectivity domain features with Empirical Mode Domain features. Advanced correlation-based and hybrid Fisher score-based Support Vector Machine feature selection approaches were implemented for several domains to achieve optimal feature selection. A Multilevel Stacked Ensemble Model classifier was intended to combine data from both domains to obtain maximum emotion categorization accuracy. When compared to standard methods, the proposed feature selection method and the classifiers utilized the strengths of the individual domains, resulting in improved overall classification performance.

The next section of the study addressed the vital challenge of identifying essential Electroencephalography channels for efficient diagnosis in the context of neurological disorders like epilepsy. For channel selection, a unique Genetic algorithm, and Support Vector machine-based model, and a Sequential Channel Selection Model were proposed, which greatly decreased computational time and simplified the approach. The algorithm enhanced accuracy even more by reducing muscular artifacts. The study demonstrated that categorizing epileptic seizures using an electroencephalogram was critical for assessing brain conditions. The proposed method had the potential for long-term monitoring with a customized portable Electroencephalography unit, but the actual application necessitates overcoming some obstacles.

Finally, a novel technique has been proposed for detecting another neurological disorder named autism spectrum disorder using rs-fMRI data based on functional brain connection analyses. The method took into account the underlying topological similarities across subjects and used a low-estimated rank tensor (LERT) methodology to estimate functional connectivity networks (FCNs). The increased accuracy in prediction was observed by testing the algorithm on different brain atlases. The integration of FCNs from different atlases improved the classifier's performance, opening up a new path for ASD diagnosis.

Keywords: *Electroencephalography, functional Magnetic Resonance Imaging, Artificial Intelligence, Emotion, Autism Spectrum Disorder, Epilepsy, Psycho-physiological characteristics assessment, Neural Disorder Detection*