Electrical & Computer Engineering

D E F E N S E

Louisiana State University

Exploring Longitudinal Stability of Spatiotemporal Sequential Patterns by Means of Autoencoder Schemes for EEG Personal Identification

a dissertation to be defended by

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Abstract—Robust personal identification remains a critical and challenging task in the digital era. Electroencephalography (EEG) offers a unique biometric modality that captures individual brain dynamics through complex neural signals. This dissertation proposes autoencoder (AE) based feature extraction and subject identification through these features. EEG recordings are first transformed into topographic maps to represent spatial brain activity. Consecutive topomaps are then concatenated to capture temporal transitions across frames. Convolutional autoencoders (CAEs) are used to learn spatial and temporal patterns, while domain-adaptive AEs are designed to model evoked potential based responses. Additionally, self-attention mechanism is incorporated to enhance feature representation. To analyze sequential dependencies between topomap frames, a gated recurrent unit (GRU)-based AE is developed. For realistic evaluation, models are trained and tested on EEG data obtained from separate recording sessions. The extracted features are classified using various machine learning algorithms, including Artificial Neural Networks (ANN), k-Nearest Neighbors (KNN), Support Vector Machines (SVM), and Random Forests. The effect of subject identifiability is also investigated through pairwise classification, highlighting the varying degrees of difficulty in distinguishing individuals. Furthermore, inter-subject and intra-subject similarity analyses are conducted to assess the permanence and uniqueness of EEG signals as brain signature. Experimental results demonstrate the effectiveness of AE-based models in capturing meaningful EEG patterns and highlight their potential for reliable EEG-based personal identification.

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