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A Pilot Study for SSVEP-based Person Recognition

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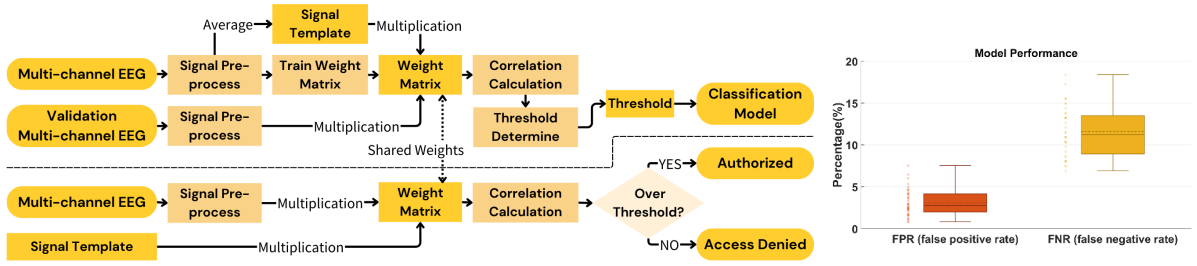
Introduction: Steady-state visual evoked potential (SSVEP) is widely used in brain-computer interfaces (BCI) due to its high signal-to-noise ratio (SNR). Although many studies focus on optimizing decoding algorithms to maximize the information transfer rate (ITR) in target classification tasks [1], there is still no universal decoding model due to inter-subject differences. In other words, using individual decoding models as classifiers for person recognition seems to be a feasible research direction. In this proof-of-concept study, we use state-of-the-art decoding algorithms to evaluate the false positive positives (the model mistakenly recognizes others as me) and the false negatives rate (model mistakenly identifies me as someone else) on a public dataset. The preliminary result highlight the potential of utilizing personalized decoding models for person recognition, taking a step toward in addressing the challenges of biometric recognition based on brain activity.

Material, Methods and Results: Thirty-five healthy participants volunteered for a 40-stimuli SSVEP study [1]. EEG data were recorded from 8 channels around the Oz region, with a 50 Hz notch filter and a 1-50 Hz band-pass filter applied for data preprocessing. Only the 0.5 to 4.5 second segment of the EEG data was retained for further analysis. Task-Related Component Analysis [2] and Canonical Correlation Analysis were combined (referred to as TRCCA) into a unified data processing pipeline to extract features in both the spatial and temporal domains. Specifically, TRCCA computes a weight matrix to extract the most relevant features from the multichannel EEG data, compares the feature templates with the testing features using the same weight matrix, and generates a correlation score for classification. The data processing pipeline is illustrated in Fig. 1a. Fig. 1b presents the decoding accuracy of the proposed model. The mean accuracy achieved 96.59%, with a mean false positive rate of 3.1% and a mean false negative rate of 11.6% among the 35 participants.

Conclusion: SSVEP is widely recognized for its high SNR and relatively short training time. However, numerous studies indicate that there is no universal decoding model for the general population. This proof-of-concept study proposes that an individualized SSVEP decoding model could serve as a classifier for person recognition. Our results (FPR of 3.1% and FNR of 11.6%) are close to a fingerprint-based recognition system, which typically exhibits an FPR ranging from 0.1% to 3% and an FNR between 1% and 10%, depending on image quality [4]. Future work will focus on optimizing the decoding pipeline to achieve the performance comparable to other biometric-based mechanisms.



(a) *Block diagrams of training process (top) and testing process (bottom).*

(b) *False positive rate and false negative rate among 35 participants. Each dot represents one participant.*

Figure 1: *The proposed data pipeline and the decoding accuracy of person recognition using a public dataset [1].*

References:

[1] Y. Wang, X. Chen, X. Gao, and S. Gao. A benchmark dataset for SSVEP-based brain-computer interfaces. In *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, vol. 25, no. 10, pp. 1746–1752, 2017.

[2] H. Tanaka, T. Katura, and H. Sato. Task-related component analysis for functional neuroimaging and application to near-infrared spectroscopy data. In *NeuroImage*, vol. 64, no. 1, pp. 308–327, 2013.

[3] Nakanishi, M., et al. Task-related component analysis for brain-computer interface applications. In *IEEE Transactions on Biomedical Engineering*, 2017

[4] Temirlan Meiramkhanov and Arailym Tleubayeva. Enhancing Fingerprint Recognition Systems: Comparative Analysis of Biometric Authentication Algorithms and Techniques for Improved Accuracy and Reliability in *arXiv*, 2024

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