DOI: 10.3217/978-3-99161-050-2-007

Subject-Transfer Approach based on Convolutional Neural Networks for Classifying Gait-related Motor Imagery

Keun-Tae Kim[1*]
[1]Department of Artificial Intelligence Convergence, Hallym University
*P.O. Box 24252, Chuncheon, Republic of Korea. E-mail: ktkim@hallym.ac.kr

Introduction: Recently, electroencephalography (EEG)-based brain-computer interfaces (BCIs) for controlling a lower-limb robotic exoskeleton have been developed in several research groups [?]. In particular, gait-related motor imagery-based BCIs have been developed to assist gait in individuals with Spinal Cord Injury. However, the accuracy of classifying gait-related motor imagery needs to be improved to ensure safety. Therefore, we applied the subject-transfer approach, as an advanced algorithm, and compared the performance with the previous algorithm.

Material, Methods and Results: In this study, publicly available gait-related data [?] which is from a total of nine healthy subjects was used to investigate the performance of a subject-transfer approach. The subjects performed gait-related motor imagery while wearing the lower-limb robotic exoskeleton (resting task for 15 sec, and motor imagery task for 24 sec according to voice commands). The subjects repeated the tasks 16 times and the EEG signal was acquired on the 27 electrodes based on the International 10-10 system.
Principal component analysis (PCA)-based spectral feature was firstly extracted and reshaped into a 5×5 matrix for input to the convolutional neural network [?]. The simple CNN classifier was designed (see Fig. 1A) and trained using other subjects' whole data. Then, the trained CNN was fine-tuned using the target subject's training data (see Fig. 1B).
As the results of the cross-validation, the subject-transfer approach showed 87.1±6.4% on average, approximately 6% higher performance than the previous algorithm which consists of the common spatial pattern filtering and linear discriminant analysis classifier [?].

Conclusion: Based on our results, we can confirm that the subject-transfer approach can improve the accuracy of classifying the gait-related motor imagery. As further research, we plan to verify its efficiency via a real-time control experiment of a lower-limb robotic exoskeleton.

Acknowledgments: This work was supported in part by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (No. 2021R1C1C2008446) and in part by the National Research Foundation funded by the Korean government (Ministry of Science and ICT, Project Number: RS-2024-00417959).

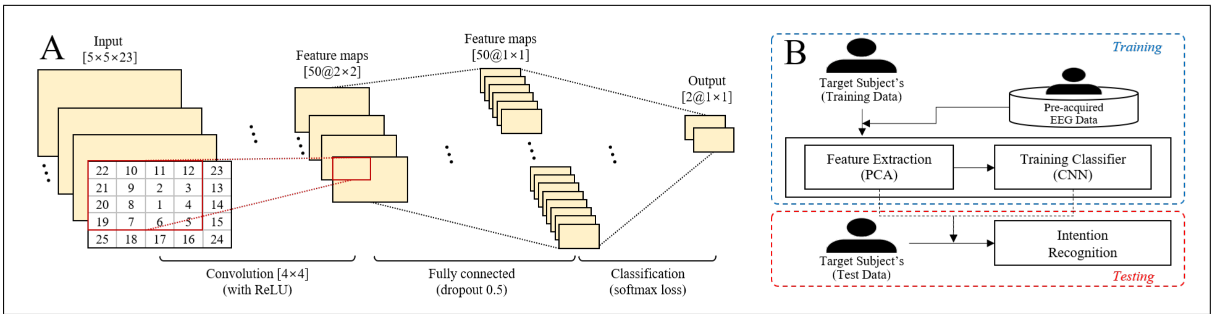

Figure 1: Gait-related motor imagery-based EEG signal processing. (A) CNN structure and (B) Subject-transfer approach

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