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Mental Task Classification Using Deep Transfer Learning with Random Forest Classifier

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ABSTRACT

A BCI theoretical idea is to construct an output feature or task for a user using brain signals. These signals are then transmitted to the machine where the required task is performed. In this work, the authors present a mental task classification model that focuses on the notion of transfer learning and addresses the issues of data scarcity, choice of model selection, and low-performance measure. To decide the optimal network for feature extraction, they used five different pre-trained networks including VGG16, VGG19, ResNet101, ResNet18, and ResNet50. For the classification, the suggested model experiments with three baseline classifiers, namely support vector machine, decision tree, and random forest. The model's experimental evaluation is done on the publicly available Keirn and Aunon databases. From the experiment, it is observed that features extracted from the transfer learning models help to identify the five different mental tasks efficiently. The highest average accuracy of 81.25% is attained on ResNet50-based features with a random forest classifier.

KEYWORDS

Convolutional Neural Network, Deep Learning, Mental Task, Segmentation

1. INTRODUCTION

A BCI is an interface or connection between a brain and a computer. This connection can go both ways: brain activity used to control can influence a computer or training in the brain via stimulation of brain tissue. BCIs in humans are typically divided into invasive, non-invasive, and partially invasive. Investigative BCIs are devices that record or stimulate the brain or nervous system and interact with an external device. Non-invasive BCIs generate outputs by measuring brain activity. For instance, the EEG detects electrical activity, the MEG measures magnetic field changes, and the MRI measures changes in blood flow. Partially invasive BCIs include

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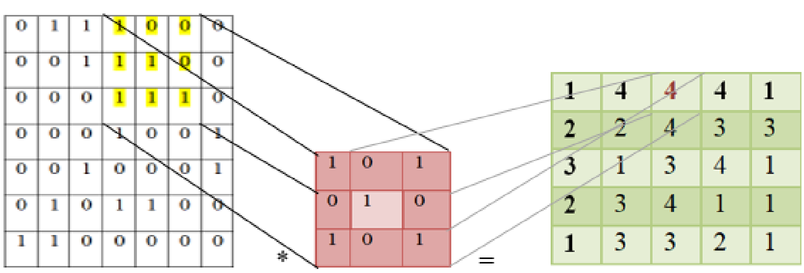
ECoG, or Electrocorticography, a relatively recent invention in which the recording device is inserted within the skull but above the brain. That can remove noise from the skull and skin and produces higher-quality signals than non-invasive BCI; it has a higher spatial resolution, a wider signal bandwidth, and a larger amplitude. Invasive and non-invasive BCI technologies aim to extract and use brain signals. Both technologies have pros and cons; invasive BCI is surgically and technically complex; it can become unstable over time but can be very rewarding. At the same time, non-invasive BCI is relatively safer and easy to implement but has limited capacity in replacing or enhancing the lost bodily functions. This paper focuses on the improvement of non-invasive BCI task classification.

Deep learning (DL) is a subset of the machine learning approach that enables computers to learn how people do: through example. Deep learning is a critical component of autonomous automobiles since it enables them to identify stop signs and discriminate between pedestrians and lampposts. It allows voice control in consumer electronics such as smartphones, tablets, televisions, and hands-free speakers. Deep learning has garnered much interest during the last few decades. It is achieving remarkable and significant results compared to conventional learning techniques—the popular methods in deep learning in a convolutional neural network. Deep Convolution Neural Network consists of a sequence of layers, and each layer consists of CNN translating a differentiable function from one activation function to another. There are three major layer types to construct a CNN-based model: Completely Connected Layer Convolutional Layer and Pooling Layer. ConvNet is a deep neural network optimized for image recognition. Deep layer improvement is crucial for information (image) processing. The example code is now complete. While the sample uses only one pair of convolution and pooling layers, typical applications use numerous pairs: the better the recognition performance, the smaller images with the network's primary properties.

- The convolutional layer is a mechanism used by phase and padding windows to extract the recognition function from input data—filter and input data calculated by the dot method. Max pooling is the most valued Philtre in the Philtre region. The Philtre is made in the same way as the function.

- Convolutional layer extraction, the highest value on the Philtre is added to the data, and the new result is picked. The neurons in the completely connected layer have complete contact with all activation in the previous layer. Layer, as seen in typical neural networks. Then feed extracted data from this layer to the classification layer.

Figure 1. Convolutional Layer



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