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THE IMPACT OF ELECTRODE SHIFTS ON BCI CLASSIFIER ACCURACY

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ABSTRACT
We investigated electrode shifts of the recording EEG (electroencephalogram) on the scalp. We used simulated data to assess the influence of electrode shifting on the classification accuracy of a Brain-Computer Interface (BCI, [1]).

INTRODUCTION

Many BCI approaches use spatial filters to weight the EEG electrodes according to their importance for classification. For example: a common BCI approach is motor imagery, where the participant imagines left and right hand movements to control a cursor. For this approach, the right and left motor cortex are most relevant for classification. These areas are typically represented by electrodes C3 and C4. Thus, a spatial filter may assign high weights to these electrodes. If these important electrodes shift on the scalp, the recorded data changes. In general, we assume that a shift of relevant electrodes has an impact on the classification accuracy of any BCI. Our research questions are:

1. Does electrode shifting influence the classification accuracy?
2. Is the impact of shifting more important (in terms of the spatial filter) electrodes higher than shifting less important electrodes?
3. The recorded EEG activity for a single time point composes an activation pattern which displays projection intensities on the scalp [2]. Does an electrode which shifts within the same area of activation have a lower influence on classification accuracy than an electrode which changes areas of activation?

METHODS

With the toolbox SEREEGA [3], we simulated EEG data that would result from participants who completed an oddball paradigm [4]. We varied source locations and projections to simulate 20 artificial subjects and added random noise. The data was separated into a part used to train the classifier and a part to test it (see fig.1). Simulated data allowed us to have identical source activations in different copies of the test set. Electrode shifts were implemented in each copy and varied in terms of direction, magnitude and which electrode was shifted. For classification, a windowed means approach was trained on 8 consecutive 50ms windows of the training data and then applied to the test data with and without shift. The obtained accuracies were compared.

RESULTS

The classification accuracy after calibration varied between subjects between 84% and 99%. Electrode shifts lead to an accuracy change of -8% to 2%, mean -1.04%, standard deviation 0.7%. The research questions were answered as follows:

1. A t-test of mean accuracies (with and without shift) determined that there is a significant effect ($t=12.775$, $p<<0.01$) of electrode shift on the classification accuracy.
2. A regression analysis between filter weight and impact on the classification accuracy yielded a significant ($t=6.252$, $p<<0.01$) positive relation: shifting an electrode with a higher (positive or negative) weight has a stronger effect.
3. An ANOVA with factors weight and pattern deviation revealed that there is a strongly significant interaction effect of the factors ($F(1,39)=8.674$, $p<<0.05$), but no single effects.

OUTLOOK

The next step to further research the problem of electrode shifts in BCI is to shift multiple electrodes, as well as testing the findings in real, non-simulated data.

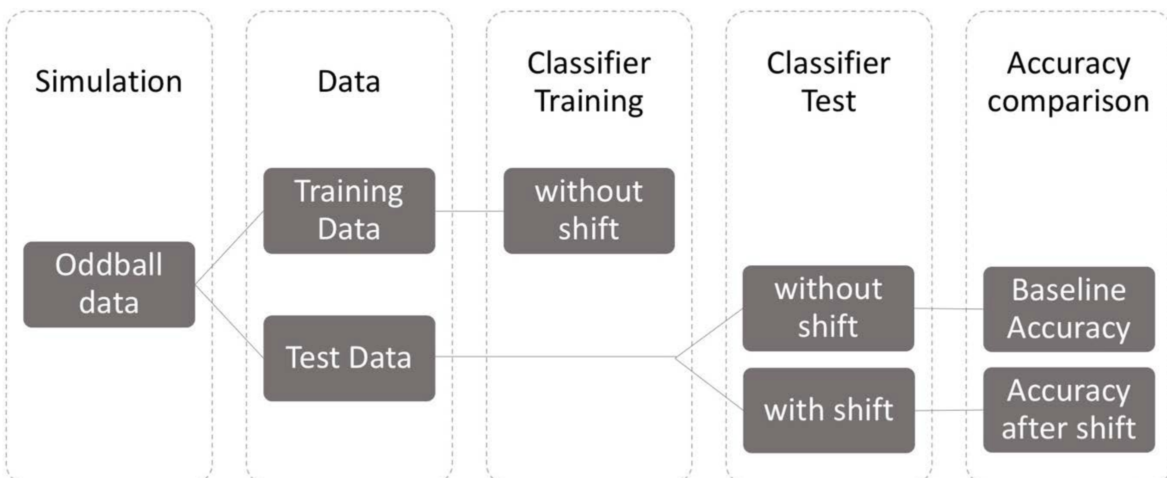

Fig. 1 Experiment structure.

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