Network Based Complexity Analysis in Tactile Brain Computer Interface Task

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***Abstract*— We study the extent to which network based brain complexity analysis methods for EEG feature extraction could result with improved brain state classification accuracy in a tactile Brain Computer Interface (tBCI) paradigm. The state–of–the–art feature extraction and classification methods do not utilize brain network dynamics techniques as a possible way to capture and elucidate with non–invasive, high temporal resolution methods such as EEG. We propose to employ the brain network dynamics and information transfer evaluation methods to create the new EEG feature extraction in the tBCI paradigm. The feasibility of such approach is discussed together with the obtained results and evaluated in comparison with the contemporary methods.**

I. INTRODUCTION

State of the art BCI solutions are based mostly on mental visual and motor imagery prototypes, which require extensive user training and good eyesight of the subjects. Recently alternative solutions have been proposed, to make use of spatial auditory or tactile (somatosensory) modalities, in order to enhance brain-computer interface comfort, and to increase the information-transfer-rate (ITR) achieved by users.

The classical BCI applications rely mostly on the so-called P300 response, which is a positive EEG event related potential (ERP) deflection starting around 300 ms and lasting for $200 - 300$ ms after the expected stimuli, in a random series of distractors (the so-called oddball EEG experimental paradigm) [1]. The P300 responses are commonly used in contemporary BCI approaches and are considered as the most solid ERPs [2], without necessity for a training from the subjects. P300 responses classification methods only employ brain–wave derived features or patterns that don't employ connectivity or information transfer related properties [3], [4].

The presented concept, of employing network based brain complexity analysis to brain somatosensory (tactile) modality, opens up the attractive possibility of targeting a very practical application of a the novel tactile sensory domain tBCI method with the novel brain state decoding techniques.

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II. METHODS

In the experiments reported in this presentation, eleven BCI–naive subjects took part (mean age 21.82 years old, standard deviation of 0.87; ten males and one female - no gender related response difference were observed). The classical P300 response classification method has been compared with the partial directed coherence, Granger causality [3], and transfer entropy [5] based topological network properties.

III. CONCLUSIONS

We report on results comparison obtained from the classical and the novel brain network information transfer evaluation based features in the offline paradigm with eleven novice subjects performing interactive ten–commands tactile brain computer interface prototype.

The novel enhanced results are a step forward in neurotechnology application and network network based complexity analysis tools at EEG feature extraction level.

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