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CLASSIFYING MENTAL ACTIVITIES FROM EEG-P300 SIGNALS USING ADAPTIVE NEURAL NETWORKS

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Abstract. *In this paper, a new adaptive neural network classifier (ANNC) of EEG-P300 signals from mental activities is proposed. To overcome an overtraining of the classifier caused by noisy and non-stationary data, the EEG signals are filtered and their autoregressive (AR) properties are extracted using an AR model before being passed to the ANNC. For evaluation purposes, the same data in Hoffmann et al. (2008) were used. With and without the AR property extraction, the proposed ANNC could achieve 100% accuracy for all the subjects. To verify the performance improvement of the proposed classification scheme, a comparison of the ANNC and the conventional back-propagation neural network classifier was performed as well.*
Keywords: Adaptive high order neural network, EEG-P300 potentials, Feature extraction, Classification, Brain computer interface

1. **Introduction.** A Brain Computer Interface (BCI) is a direct communication pathway between a user's brain and an external device [1]. The BCI system utilizes what are already known about brain signals to detect the messages that the user has chosen to communicate. These systems operate on the principle that the brain reacts differently to different stimuli based on the level of attention given to the stimuli. Thus, brain activities must be monitored. Today there exist various techniques by which this can be accomplished. Among these, EEG is preferred for BCI, owing to its non-invasiveness, cost effectiveness, easy implementation, and superior temporal resolution [1-8]. The current BCI schemes typically incorporate five main steps as shown in Figure 1. Brain signals are acquired and analyzed in segments (trials) for a given duration, according to the operation modes and the types of mental tasks or activities. The acquired signals are preprocessed to reduce external noises and detected artifacts. The filtered signals are then sent to the feature extraction and classification steps, respectively.

An event-related potential (ERP), which can be generated in the EEG during a stimulation paradigm, is a brain response directly resulted from a perception or a thought. Particularly, the P300 component refers to the wave peaking around 300 ms after a task-relevant stimulus [8-10]. While the P300 is elicited in many different ways, the most common factors influencing it are two stimulus-discrimination tasks presented to the subject in an unknown fashion. One occurs infrequently (i.e., target) and the other frequently (i.e., non-target). The P300 has been shown to be fairly stable in locked-in patients. The reappearance of P300s involves a brainstem structure [11]. Farwell and Donchin [12] first