Learning Vector Quantization for recognizing P300 evoked potential in Brain Computer Interfaces

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I. Introduction and objectives

The purpose of this work is to develop a system for recognizing mental commands using electroencephalographic (EEG) registers, allowing patients with communication deficits to transmit their needs to their caregivers. The system exhibits a sequence of images (food, drinks, medicines, family, etc.) while patients stare at the screen. The recognition capability of the system relies in the fact that an EEG evoked potential, called P300, is produced by the brain when the object that is thought unexpectedly appears in the visual field. The developed modules are: a) A system for identifying P300 evoked potential by using a Learning Vector Quantization neural network [1] b) Routines for exhibiting images within precise time intervals.

II. Methodology

EEG data was obtained from a public data base [2]. Each EEG register started when an image of 100 msec. duration appeared in a screen after a pause of 400 msec. There were 6 images presented according to the oddball paradigm. Thirty two samples were collected in each electrode during each second. P300 recognition was done using a Learning Vector Quantization (LVQ) neural network with 32 input neurons for each electrode, 2 hidden neurons and 2 output neurons. Output neurons were trained with binary values. A unitary value in the output of first neuron indicates that the EEG input is a P300 potential. If the second neuron in the output layer yields a unitary value, the EEG input is not accepted as a P300 potential. Network performance tests were done with the EEG registers of eight subjects. These tests were performed with various numbers of electrodes (1 to 4) in parietal, occipital, central and frontal scalp regions. Data was pre-processed by doing an average of EEG registers obtained as response to the same image. LVQ network was fed with 150 averages (100 for training and 50 others for testing the network).

III. Results

The MP neural network used for signal filtering does not outperform conventional signal filtering methods. When feeding the LVQ network with testing EEG averages, it succeeded in recognizing P300 wave in 90% of the cases when using a single electrode (32 input neurons) and an average of 5 registers. When using two electrodes (64 input neurons) and an average of five EEG registers, its success rate rises to 99%. With four electrodes (128 input neurons) and a three-registers average its success rate reached 99.92%.

IV. Conclusion

The LVQ neural network had a significant performance for recognizing image-triggered P300 when fed by the average of three EEG registers captured by four electrodes placed in the scalp. This result almost matches the success rate of the most successful methods mentioned in literature [2, 3]. The advantage of using an LVQ neural network over these methods is its reduced computational cost during the testing phase, in which new EEG patterns are input to the network.

References

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