PRELIMINARY RESULTS OF OCULAR ARTEFACTS IDENTIFICATION IN EEG SERIES BY NEURAL NETWORK

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Abstract

The human electroencephalogram (EEG), is record of the electrical activity of the brain and contains useful diagnostic information on a variety of neurological disorders. Normal EEG signal are usually registered from electrodes placed on the scalp, and are often very small in amplitude, of 20 µV. The EEG, like all biomedical signals, is very susceptible to a variety of large signal contamination or artefacts (signals of other than brain activity) which reduce its clinical usefulness. For example, blinking or moving eyes produces large electrical potentials around the eyes called the electrooculogram (EOG). The EOG spreads across the scalp to contaminate the EEG, when it is referred to as an ocular artefact (OA). This paper includes method of identification portion of the EEG record where ocular artefact appears and classification its type by neural network.

Keywords

electroencephalogram (EEG), electrooculogram (EOG), ocular artefact (OA), neural network, backpropagation, parametric backpropagation

1. Introduction

Ocular artefacts are a major source of difficulty in distinguishing normal activities from abnormal ones. In some cases, for example brain-damagged babies and patients with frontal tumours, it is difficult to distingish between the associated pathological slow waves in the EEG nad OAs. The similarity between the OAs and signals of clinical interest also makes it difficult to automate analysis of the EEG by computer. In general, neurological disorders often manifest themselves in the EEG as slow waves which unfortunately have appearance similar to OAs and of course share the frequency bands as OAs.

2. EEG Data

The method, which was using for identification portion of EEG signal, where the ocular artefact appears, is based on premise, that the recording EEG signal is sum of „true" EEG signal and signals corresponding artefacts. From this reason, we have contemporary recorded EEG signals with channels of vertical (VEOG) and horizontal EOG (HEOG). The placement of the electrodes for recording of VEOG and HEOG is given on Fig. 1.

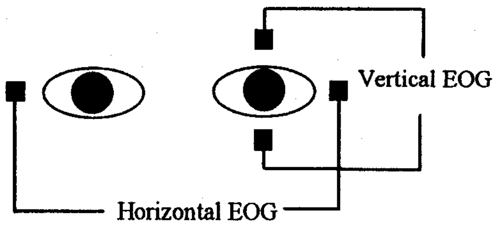

Fig. 1: The placement of the electrodes for recording of VEOG and HEOG.

We suppose that a change at the EOGs channels transfers to EEG channels with corresponding transmission coefficients. Because both groups of signals, EEGs and OAs, have stochastic character, were chosen as features statistical parameters describing measure of coupling between stochastic signals. Vector of features for each ocular artefacts type consists of correlation coefficients of EEG channel and vertical EOG, correlation coefficients of EEG channel and horizontal EOG, covariance matrix of EEG channel, covariance matrix of vertical EOG, covariance matrix of horizontal EOG, covariance matrix of EEG channel and vertical EOG, covariance matrix of EEG channel and horizontal EOG.

3. Training Set

In this work we have pre-processed several 16 - channel records of native human EEG with contemporary recording of channels of vertical and horizontal EOG from patients with headache and from patients with epilepsy (by paperless EEG equipment Brain Quick).

After conversion from Brain Quick data format to data format of MATLAB we have to execute adaptive segmentation of EEG signal for correct feature extraction and for solution the problem of nonstationarities in EEG. The EEG signal is divided into quasistationary (piece-wise stationary) segments of variable length, depending on the occurrence of nonstationarities in signal [1].

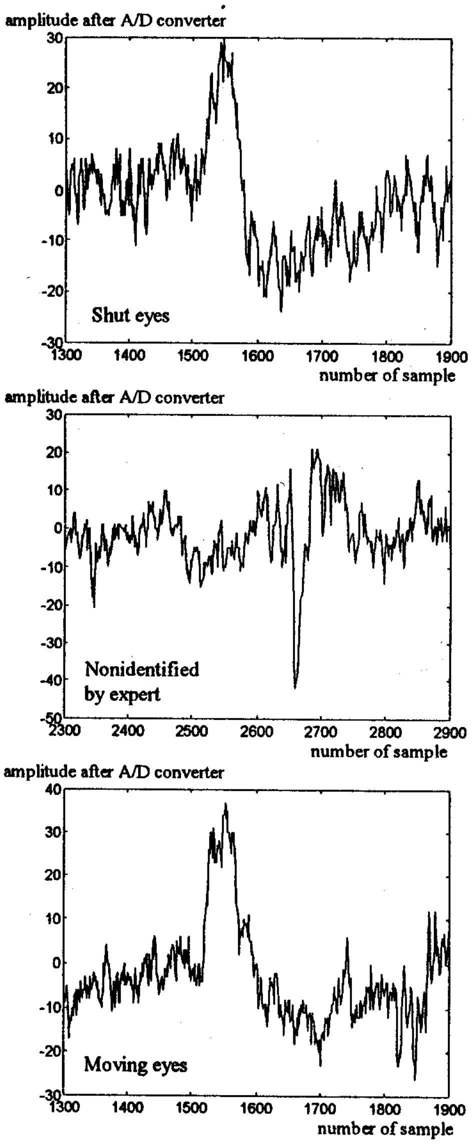

Fig. 2: Patterns of EEG signal.

From this segments of EEG signal we have to select section of define length for which we evaluate features for each segment of EEG signal for subsequent identification by neural network.. The length of each section is 600 samples in accordance with the longest length of the ocular artefacts type. Features of each sections are standardised to mean and detrended. These section of EEG signal create the training set, which consist of several types of ocular artefacts: moving eyes, blinking, shut eyes or artefact nonidentified by doctor. From this training set, which consist of 30 sections, we select limits of features, which corresponding to levels of excitation of neurons of the input respectively output layers, and patterns of each group of ocular artefacts. The patterns of EEG signal corresponded each group of ocular artefacts are given on Fig. 2.

4. Neural Net Classifier

Features correspond to input layers neurons and patterns correspond to output layers neurons. Neural network was programming in Neurex 5.0 [2] and was chosen perceptron with the backpropagation and parametric backpropagation function of adaptation. Scheme of these neural networks are 7 - 5 - 3 instead of 7 - 5 - 4, because for the group of blinking artefact we have not succeds to set limits of the features. From this reason group of blinking artefact was eliminated from training set. Scheme of neural network is given on Fig. 3.

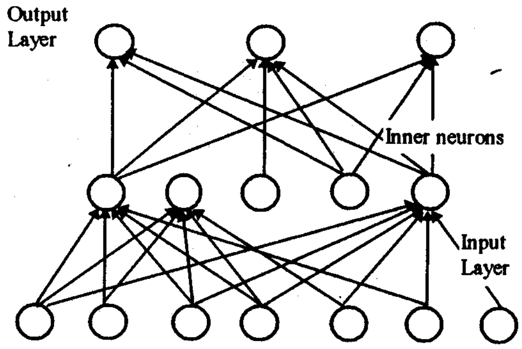

Fig. 3: Scheme of neural network.

After adaptation of neural network, when values of the synaptic weights are adjusted, remaining pattern from training set were used to test the ability to generalise above the learned material. The time of the adaptation process of the synaptic weights is 2,5 times shorter for neural network with parametric backpropagation function (heterogeneous network, where every neuron has its own activating dynamics) than for neural network with backpropagation function (homogeneous network, where every neuron has same activating dynamics) for the same values of synaptic weights and maximal error (2 %). Both neural networks are able to generalise and number of wrong identified pattern for suitable values of synaptic weights is very small and accuracy of identification of ocular artefact's type is sufficient. The problems of using these types of neural networks will be dedicated separate article in next number of Radioengineering.

5. Conclusion

Preliminary results show that both neural networks are able to identify correctly type of ocular artefact, which two independent doctors (with different length of clinical practise) identified differently. The system of identification of segment which is contaminated by ocular artefact not only leads to more accurate determination of diagnosis of neurological disorders, but can helps to young doctors learn types of ocular artefacts. Till present time, the doctors have not handbook with the survey of types of artefacts with their technical description. This work gives first preliminary results at this area and calling , to the fact that the ocular artefact „shut eyes“ is accompanying by ocular artefact with name „nonindetified by expert“. This ocular artefact is accompanying by moving of bulbus, which till present time was unnoticed. We suppose the identification of type of ocular artefact probably enhances precision of removing ocular artefact (e.g. by adaptive filtering) from EEG signal with preserving signal of clinical interest.

References

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About author...

Michaela KOFROŇOVÁ was born in Karviná in 1967. She received the Ing. degree in 1992 and at the present time is Ph.D. student. Thesis of her doctoral research is the artifact processing of the physiological origin from the human EEG. Her research interests are both analog and digital signal processing with using spectral theory, measurement and control theory, system identification, adaptive signal processing and neural networks.

RADIOELEKTRONIKA 96

The 6th national scientific conference RADIOELEKTRONIKA 96 with international participation was held at the Faculty of Electrical Engineering and Computer Science, Technical University Brno in April 23 and 24, 1996. The organizer was the Institute of Radioelectronics TU Brno in co-operation with the Radioengineering Society, Czechoslovakia IEEE Society and its MTT/AP Chapter and Czech IEE Centre. Over 150 participants from the Czech and Slovak Republics, from Poland, Hungary, Germany, France and Ucraine have been active present at the conference.

Over 150 summaries of contributions from more as 180 authors was submitted to the Conference Programme Committee. From there 71 papers were selected for presentation in the following four oral sessions:

- Theory of Electronic Circuits and Systems
- Applications of Electronic Circuits and Systems
- Signal Processing and its Applications
- EM Waves, Antennas, Microwaves and Optoelectronics

Further 61 contributions of corresponding scientific areas were presented in two poster sessions. In all oral and poster sessions many student's papers were presented by about 50 graduate and postgraduate students from Czech and Slovak universities.

In the plenary session at the openning of the conference the invited paper "Text-to-Speech Conversion History and Present State" was presented by Dr.R.Vích and P.Horák from Czech Academy of Sciences in Prague.

All presented papers are published in the Conference Proceedings, some copies of which are still available by the organisers. Since 1995 the proceedings is puted in the abstracting service of INSPEC. Best of the presented contributions will be published in the next issues of the RADIOENGINEERING journal.

The conference was traditionaly supported by an exhibition of electronic instrumentation, measuring equipment and subsystems related to the radioelectronics areas. Seven Czech and international organisations in the electronic industry and trading were presented here: DICOM Uherské Hradiště, EKSOM-Radiotelekomunikace Brno, GHV TRADING Brno, HTT-TESLA Pardubice, MIKROKOM Praha, TECH-RENTALS Brno and TRANS-TECH Electronic Praha. During the conference a sale exhibition of textbooks and other printed lectures of the Institute of Radioelectronics TU Brno and an exhibition of the RADIOENGINEERING Journal was organised in the Conference Hall.

I hope the conference and its accompanying programmes were interesting for all authors, participants and other visitors and also for many of those Technical University's students who have visited them. I am looking forward to see the radioelectronics colleagues at the next conference RADIOELEKTRONIKA.

Jiří Svačina, Technical University Brno