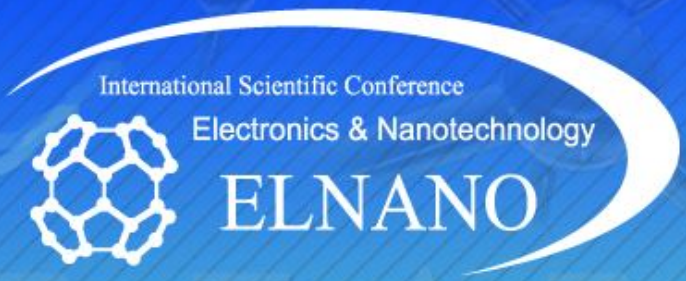
National Technical University of Ukraine "Kyiv Polytechnic Institute"

# Electronics and Nanotechnology

## Proceedings of the

## XXXI International Scientific Conference




**April 12-14, 2011**

**Kyiv, Ukraine**

National Technical University of Ukraine
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# ELECTRONICS AND NANOTECHNOLOGY

## Proceedings of the XXXI International Scientific Conference ELNANO 2011

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# ELNANO 2011

## Electronics and Nanotechnology

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National Technical University of Ukraine «Kyiv Polytechnic Institute»;
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# Electrooculography for Brain-Computer Interface

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*Abstract* – **The aim of this work is to present experimental example of brain computer interface system based on electrooculographic signal analysis. The described system consists of hardware for signal amplification, filtering part, PC interface and data processing software part. The new technique of eye rotation angle calculation through frequency-modulated signal spectral analysis is proposed.**

*Keywords* – **BCI, EOG, FM-signal analysis**

## I. INTRODUCTION

Creating an additional channel for people without possibility to speak or move body parts can significantly improve their standard of living and thus the overall psychological state. This leads to the need to develop a class of electronic systems called brain-computer interface. Brain-computer interface (BCI) is a system that is designed to obtain and analyze neural signals to organize a communication channel directly between the brain and the computer.

The aim of our work is to develop the software and hardware of the BCI system for cursor control based on eleoctrooculographic signal.

## II. MAIN PART

As sources of information on neuropsychological status can be used various signals such as electroencephalogram (EEG), electromyogram (EMG), electrooculogram (EOG) and other complex signals. Depending on the tasks of the application the best option may vary. In a constrained environment, when EEG monitoring may encounter a problem, for the task of mouse cursor moving the registration and analysis of EOG signal may be used.

EOG signals are roughly in the band of about 0 – 100 Hz and of 50–3500 uV magnitude. Measurement and processing of the EOG signal are easier than those of EEG (< 100 uV) signals, because compared with EEG signals EOG has larger amplitude. Horizontal and vertical eye movements and eye blinking generate easily distinguishable EOG signals even in time series without performing preprocessing.

There is a linear relationship between EOG and potential changes of angle, i.e. horizontally and vertically for ± 45$^{o}$ and right to left for 38.7$^{o}$ and 30.7$^{o}$. The corresponding voltage changes are ± 720 uV, and from 620 uV to 490 uV respectively. EOG signals vary with horizontal and vertical eye movements, so 1$^{o}$ horizontal motion causes the potential change of 16 uV, and vertical movement – of 14 uV. [1]. Thus it is possible to record eye movements that can be used to control an external device.

To register the EOG biopotentials the amplifier scheme is developed. The scheme has adjustable gain from 5500 to 8500. In this device low-pass and high-pass filters with cutoff frequencies at 0.5 Hz and 49 Hz are used.

For the EOG signal processing a personal computer and integrated ADC is proposed to use. Because of the frequency limitations in sound card ADC, frequency modulation at 2.5 kHz carrier frequency is used.

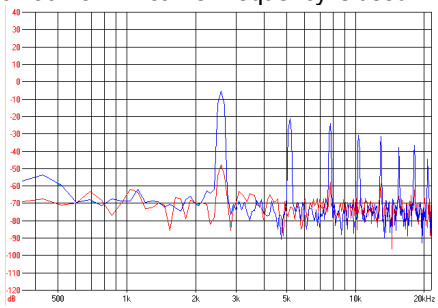

Fig.1. Short-Time spectral characteristic of modulated signal.

The new technique for analysis of spectral characteristics of frequency-modulated EOG signal (Fig. 1) is developed. The use of frequency of peak in spectral characteristic monitoring in the range from 2 kHz to 3 kHz over time is proposed to avoid demodulation. Frequency shift induced by EOG changing can be used for derivation of eye movement angle. It is used to classify the signal: when absolute value of amplitude is larger than optional threshold, the event trigger is running (Fig.2).

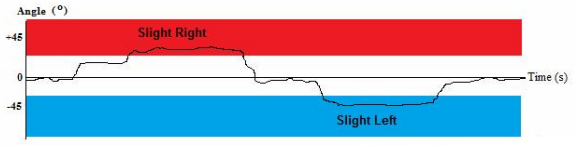


Fig.2 Signal classification

## III. CONCLUSION

EOG processing devices is a promising direction by themselves and as part of a more complicated system, including processing of EEG and EMG. The system can be used as for research purposes for EOG analysis and for experimental use for people with disabilities.

## REFERENCES

[1] M. F. Marmor and E. Zrenner, "Standard for clinical electrooculography," J. Clin. Electrophysiol. Vis., vol. 85, no. 2, pp. 115–124, Feb. 1993