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HARDWARE-SOFTWARE SYSTEM FOR EVALUATION OPERATOR'S PSYCHOPHYSIOLOGICAL STATE

The software and hardware complex, i.e. an automated expert system, allows a physician to classify operators according to their category of temperament and rigidity; to realize the analysis of received quantitative parameters of the electroencephalogram; to diagnose operator's psychophysiological state of cerebral cortex.

In today's world, there is a need of high-quality and fast evaluation of operators' psycho-physiological state (PPS) of health of different activities, such as pilots, polar explorers, athletes, drivers and others [1].

One of the effective means of evaluating of PPS of operator's cerebral cortex (OOC) is electroencephalography. However, modern researches of OCC with existing electroencephalographs have several disadvantages, which are interconnected: the effectiveness of measurement tools of OCC biosignals (the hardware of electroencephalograph) and quantitative methods of processing the data received (software part). To improve the efficiency of usage of OCC biosignals the diagnostic complex was developed – kephaloelectroencephalograph [2, 3].

The limbic system by interoceptive ways integrates information about the work at the operator's physic and psyche level and displays this information as OCC biosignals. Therefore, processing of this biosignals gives an opportunity to highlight the diagnostic informative component of operator's PPS. Researches show that the most diagnostically valuable signals are those of transient process of electroencephalogram that allow to predict the operator's PPS, that shows the perspective of this area of research [4, 5, 6].

Researches of following authors show the efficiency of transient signals for diagnostics of cerebral cortex. For example, Siver D. [7] notes that when operators are stimulated by light in the first phase of the received transient signals lowering the amplitude of the measured OCC biosignals may occur, reflecting the functional deterioration of the visual organs. Another scientist Jahno N.N. [8] noted that the first phase of the received transient signals reflects the operating status of the visual system, and further phases - the operating status of the limbic system and brain structures through which the signal of the visual stimulus passes thru.

Before measurements of OCC biosignals in the software part of the automated expert system to count the operator's individual characteristics, method of classification by category of operator's temperament and rigidity should be implemented [9]. However, each operator may be added to one of 16 or more categories, allowing to pre-group operators with same level of rigidity and characteristics of operator's PPS. This approach to the implementation of an experiment allows to create a computerized database of high-quality expert system.

Analyzing the above, it is necessary to develop a software-hardware system with an automated expert system that is able to classify the operators according to the parameters of rigidity, analyze electroencephalographic data for quantitative parameters and provide an opportunity to diagnose a health care professional psychophysiological state of operator's KGM.

To solve this problem the hardware-software system based on software package MatLab was developed, which has the following stages of work:

- determining the type of operator's temperament;
- classification of operators for rigidity parameters;
- methods implementation of measuring of the electroencephalographic data [5];
- processing of the received diagnostic data.

Realized approach allows to group operators by the 36th type of rigidity at this stage of the software development.

Implementation phase of measuring of the electroencephalographic data for operators provides a record of stationary and transient signals. The received signals are processed by the software section according the following stages:

- a stationary and transition signal is separated into pieces that can be considered as quasi-stationary;
- quasi-stationary signals for both recording modes are averaged in amplitude;
- averaged quasi-stationary signals are subjected to spectral analysis using Fourier's method and power spectral density (PSD) for a stationary recording and transient signal is received;
- the area under the graph baseband signal PSD of stationary recording and transient signals is calculated;
- using a special algorithm, with obtained PSD area, power coefficient (Q) is calculated [10] for a stationary recording and transient signals;
- the result power coefficient is compared with the energy coefficient calculated previously based on repeated measurements for the operator with the same category of temperament and rigidity parameters, which is stored in the database of the expert system. Based on the comparison the result of evaluation of psychophysiological state of operator's cerebral cortex is given.

Performance of all processing steps is presented in the program as appropriate calculations and graphs for clarity. For example of the application of signal processing the comparison graph of the PSD of a stationary recording (a) and transient (b) signals is shown in fig.1 for the operator with choleric type of temperament and depressed state of the nervous system. For this operator the resulting value of the energy coefficient is $Q_{dys} = 0.6449$.

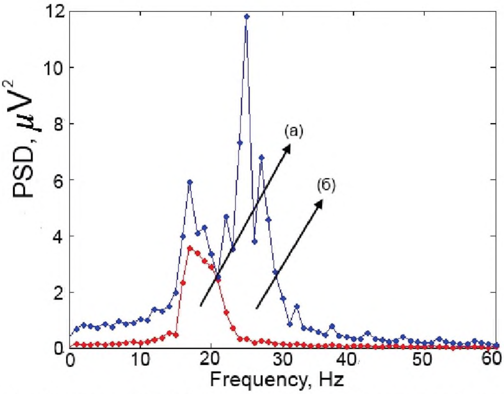

Fig. 1. Graph of power spectral density: a - for a stationary signal recording; b – for a transition signal recording.

To develop a quality expert system multiple measurements of the energy coefficient for healthy operators of various types of temperament were implemented. These data gave the possibility to calculate limits of the average power coefficient for healthy operators with a certain type of temperament. The average limits in which the operator of the choleric type of temperament has no dysfunction of cerebral cortex range Q_{hl} = (0.30 ÷ 0.60). Comparing the coefficient Q_{dys} of the operator with dysfunction of cerebral cortex with range of the coefficient Q_{hl} for healthy operators it's seen that given value of power coefficient of operator with dysfunction goes out of limits. It allows to talk about a high probability of the existence of the operator dysfunction of cerebral cortex.

Thus, there was created a hardware-software system that allows to classify operators according to the type of temperament and rigidity parameters, process the received electroencephalographic data and it includes automated expert system that is able to realize the diagnosis of operator's cerebral cortex. The present software can be used by doctors to evaluate psychophysiological state of cerebral cortex of different activities operators.

Conclusions

It was created hardware-software system that allows you to:

- classify operators by type of temperament and rigidity parameters;
- process recording EEG signals in stationary and transition modes based on quantification parameter;
- provide assessment of the psychophysiological state of the operator's cerebral cortex;
- it includes automated expert system for the diagnosis operator's psychophysiological state of the cerebral cortex.

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