BRAIN COMPUTER INTERFACE

Frolova I.V.
National Research Tomsk Polytechnic University
Scientific adviser: A.I. Soldatov

The aim is to study the effect of brain activity by the parameters of the electrical signals and how to retrieve information on activity from electrical impedance measurements for organization of the brain-computer interface.

In the course of the study it was necessary to fulfill the following objectives:

One. Conduct research into methods and techniques of organizing brain-computer interfaces in order to identify and organize the ways to get information signals from the man [1].

Two. Identify the most interesting parameters of the electrical signals in terms of determination of the brain activity state.

Three. To make the guidelines for organization of information transmission from the human to the computer by EIT.

In the course of the study the first objective was to analyze different methods of organization of the existing brain-computer interfaces [3]. According to the results of the analysis two basic ways to organize a brain-computer interaction were identified.

The first is the method that has been provisionally named "request-response" based on the measurement of parameters of signals in the brain of any external stimulation, and detection of the response to this stimulation, for example, the process of recognition of the presented stimulus. Figure 1 shows an example of implementation of this method: the person placing the letters one by one, at the time of recognition of the right letter to react and recording of EEG evoked potentials.

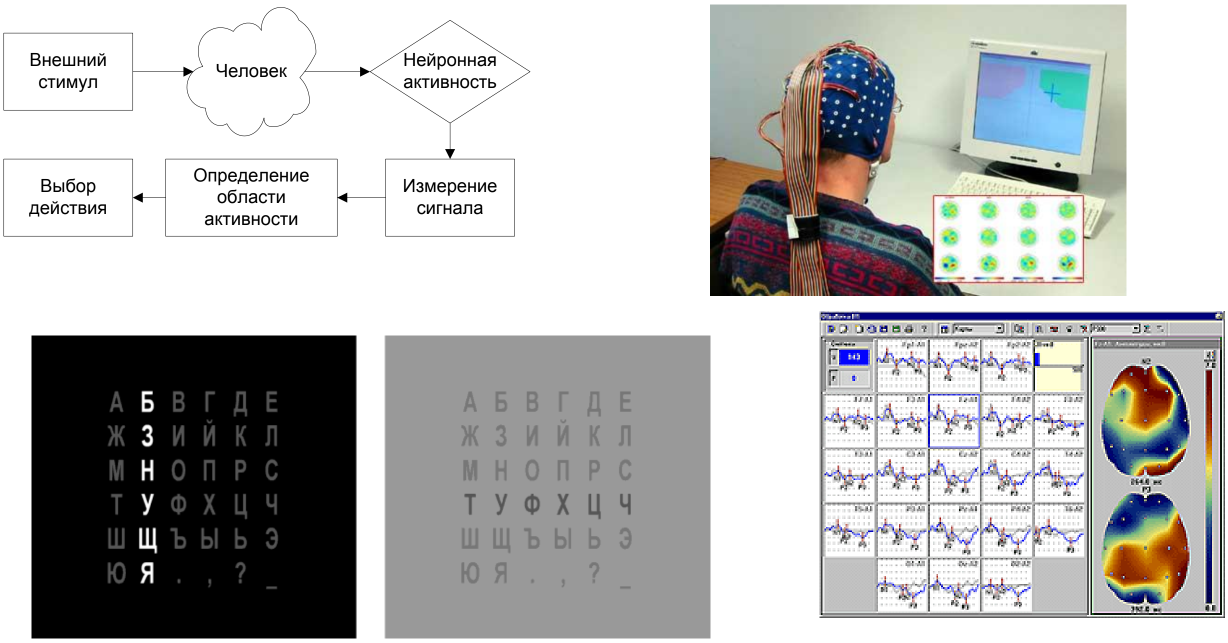

Figure 1.The method of organization of brain-computer interface called "request-response"

The second method is a method of "proactive management" in which the man himself changes some parameters of the brain signals (Figure 2). The distinction of this method is the possibility of proactive communication from a person at any time without a stimulus [2]. This method has limitations related to the number of different data signals, which people can artificially cause. For example, a person at any time may himself cause either alpha or beta rhythms, but these are only two signals. FMRI of cortex can detect a variety of areas of brain activity and the number of signals increases significantly. Depending on the accuracy of the equipment you can try to define up to a dozen of different states of brain activity.

Building systems, these methods can be combined and complement each other. In this paper, we propose to use electrical impedance measurement of the brain for the organization of the human-computer interaction.

In the study of information on the establishment of brain computer interfaces, and psychophysiology of higher functioning of the nervous system we observed the fact that when the brain activity occurs the blood flow in the "active" areas of the brain increases. The increase in blood flow should cause a decrease in the resistance part of the brain, where the flow is. In addition, changes in the blood flow will lead to changes in signal parameter rheoencephalograms. Therefore, a series of experimental studies was designed and conducted. The first part of this research concerned the study of the effect of the brain activity on the parameters rheoencephalograms.

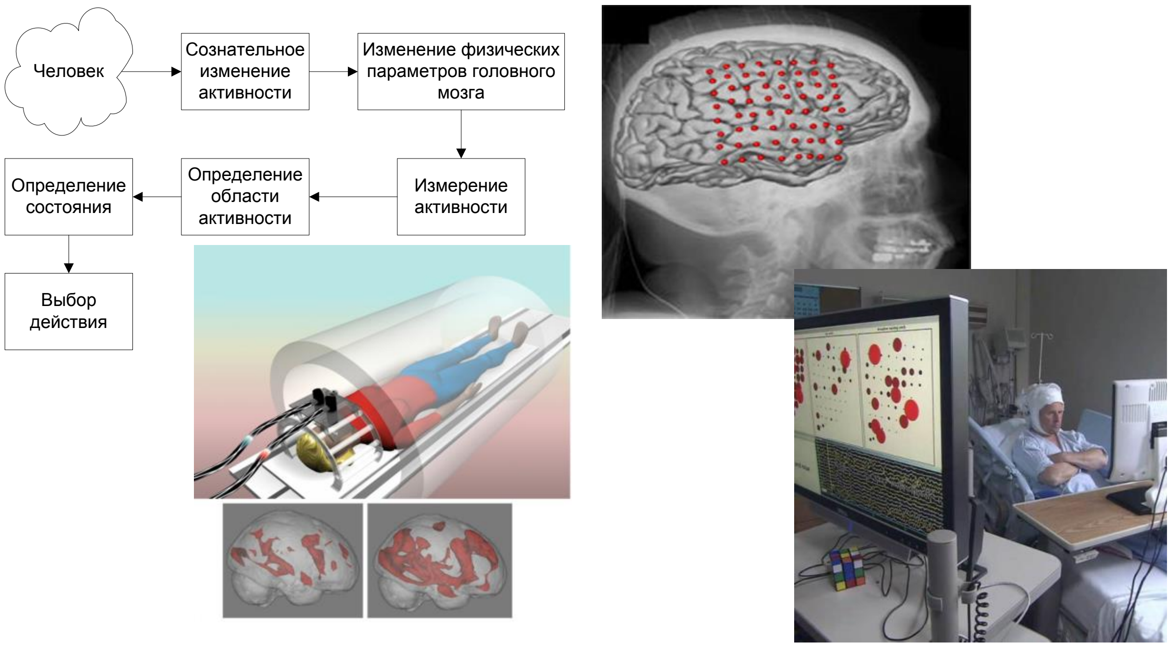

Figure 2. . The method of organization of brain-computer interface called "proactive management"

The scheme of the experiment involved the following stages: rheoencephalogram parameters were taken at rest with eyes closed, in a quiet environment within 40 – 60 seconds, then within 40 – 60 seconds is held by photo stimulation flashes at a frequency of alpha rhythm, for the appearance of activity in the occipital region of the brain associated with visual information processing. Then it was repeated within the quiescent state of 40 – 60 seconds. After that, the subject was trying to intentionally cause the active site of the visual cortex. To do this, he was asked to visualize seen the flash. In parallel, at all the stages, the rheoencephalograms were recorded in the temporal region to assess the effect of photo stimulation on the parameters of REG in other parts of the head. In total, these studies were performed with five volunteers.

When the measurement was carried out, statistical processing of the received signal was made. The amplitude and time parameters in each cardiac cycle rheoencephalograms normalized with respect to the amplitude and duration of the systolic wave of the cardiac cycle. Then averaging over the cardiac cycle was carried out for each stage of the experiment.

The results are shown in Figure 3. In the figure the average values of the ratio A/Aart at different states of the brain and spread in these parameters during measurement arepresented. From to the graph you can see that although the spread of the parameters from one cardiac cycle to another is large enough, the average values of the normalized parameter in the quiescent state are different from the stimulation of both areas of the brain. In mental stimulation the difference, can be seen as well, although to a much lesser extent. Figure 3 shows a diagram for the ratio A/Aart, the same diagrams were constructed for the other measured parameters.

References

1.Brown B.H., Barber D.C. and Seagar A.D. Applied potential tomography: possible clinical applications. -Clin. Phys. Physiol. Meas., 1985, v. 6, p. 109.

2.Cherepenin V., et al. Preliminary static EIT images of the thorax in health and disease. -Physiol. Meas., 2002, v. 23, p. 33.

3.Cherepenin V., et al. Three-dimensional EIT imaging of breast tissues: system design and clinical testing. -IEEE Trans, on Medical Imaging, 2002, v. 21, p. 662.