The brain is a nanoelectronic object

I.I. Abramov
Belarusian State University of Informatics and Radioelectronics, Minsk, Belarus, E-mail: nanodev@bsuir.edu.by

It was noted that «the brain can be interpreted as an object of organic hybrid nanoelectronics created by Nature» [1]. Therefore the nearest analogue in artificial electronics is an integrated circuit (IC) of micro-and nanoelectronics.

The aim of this work is a deeper argumentation of these statements, as well as an attempt to answer the following questions: 1) Why can the brain be interpreted as an object of organic hybrid nanoelectronics? 2) How does the brain function from the point of view of a specialist in electronics? 3) Is quantum mechanics enough for description of the brain functioning, including consciousness, thought, and its other mental functions? 4) How to investigate the brain further?

The following hypotheses are formulated: 1) the hypothesis of the dominant influence of electrical processes on the brain function; 2) the hypothesis of the adequacy of quantum mechanics as a base for the study of the brain; 3) the hypothesis that rigorous mathematical simulation of the brain functioning is refered to NP class problems. The hypotheses allow satisfactorily answering these questions as shown in the paper.

In particular, it is shown that all the basic elements of neuronal sets of the brain can be considered as elements of electrical circuits, i.e. neuronal circuit (first type) is a peculiar kind of electrical circuits. Therefore the comparison of the first type circuits with ICs of micro- and nanoelectronics (second type) was made and their basic differences were determined. Thus, the neuronal circuit is firstly growing, and then possibly modified electrical circuit. In addition, this is perhaps the most important and fundamental its difference from the IC, which leads to the most significant advantages of first type circuits over the second type ones.

In accordance with the carried out analysis the hypothesis of the dominant influence of electrical processes on the functioning of the brain is stated. Chemical processes provide a supply for the electrical circuits of the brain, as well as their possible modification. First of all this is why Nature did not follow a purely «electronic way», but followed the «hybrid way», i.e. the way of elegant interaction (transformation) of electrical and chemical processes.

Thus, according to the proposed interpretation, the human brain is a set of nonlinear electrical (neuronal) circuits of the two kinds that shouldn't be modified and which should be modified. In all cases it is memory.

Since the brain is a multifunctional device the various modes of its operation are discussed in the paper. Three types of operation modes of the brain as a set of nonlinear electrical circuits are realized, namely: 1) with external influence; 2) without external influence (internal), and 3) mixed. All the individual modes of the brain, including perception, thinking, and other mental functions, are related to one of these types. It is shown that any particular operation mode of the brain is a result of the passage of an electrical signal (or signals) across a corresponding set of electrical circuits of the first type, besides basic possible operations are following: comparison, encoding, decoding, action command, modification of neuronal circuits.

Such important modes of functioning of the brain as processing of sensory information, image recognition, thinking, dreams, etc. are discussed. In particular, thought is a decoding (internal reproduction) of electrical signal (or signals) initiated by the brain itself, passing by the brains' neuronal circuits of a corresponding spatial-temporal configuration. The more complex mental processes are considered, for example, insight. Usually, however, thinking is the internal perception of the earlier coded information in the brain.

In the paper the scheme of a multilevel simulation of the brain based on the noted key ideas is presented.

The above mentioned interpretation and its consequences allow, on the one hand, to analyze the principles of the brain functioning more deeply, and, on the other – to suggest a complex approach to brain investigation, based on a multilevel simulation combined with experimental methods.

1. I.I. Abramov, "Problems and principles of physics and simulation of micro- and nanoelectronic devices. I. Basic positions", Nano- and mikrosistemnaya tekhnika, № 8, pp.34–37, 2006 (in Russian).