Structural Model of Eidetic Memory

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Abstract: The purpose of this research is to introduce a model of an eidetic memory. The structure of the model is based on the curved tubes of memory, which are formed during the training of a multilayer and multiply connected neural network. This model has capacity to process simultaneously a large number of the input images of different objects. The eidetic memory is characterized by its plasticity, stability, and distributed structural biochemical nature. Research of the mechanisms of the eidetic memory has an enormous potential in education, health services, and other areas. The application of the developed training techniques and approaches resulted from the research will simplify the process of memorization of complicated information without any need in multiple repetitions or cramming.

Keywords: memory, imagery, neural networks, modeling, mathematics

1 Introduction

An accidentally thrown word, some smell, or taste, at times, can give rise to the whole range of feelings or bright images in a person’s mind. That person can clearly see some objects, smell them or hear sounds that vanished a while ago. This clearly indicates that the eidetic memory mechanisms started to work in the person’s mind. The study of the laws of an eidetic memory reveals enormous opportunities for its application in teaching and training because this type of memory is formed instantly and does not require multiple repetitions to consolidate the new incoming information.

Multiple world researchers were able to make a significant progress in the memory modelling based on artificial neural networks, after they established the models’ structure and functioning as close as possible to the biological neural networks of the cerebral cortex. Hence, to insure the effective work of the created models, the perception of the information must meet two basic requirements [1]:
1. Plasticity, i.e. it should be able to adapt to any new information, and
2. It should not destroy the memory of the old images.

2 Topology and work of a multilayered and multiple coherence resonant network

Based on the biological structure of the cerebral cortex, we can state that the topology of a real biological neural network may be similar to the multilayered and multiple coherence resonant network (MMRS) [2]. This network can be formed of a plurality of inhibitory and excitatory neurons, which are hierarchically interconnected both vertically and horizontally (see Fig. 1). The neurons in their turn form vertical and horizontal conditional planes.

Fig. 1. Topological structure of a multilayered and multiple coherence resonant neural network

The network function must ensure the memory plasticity on one hand and its stability on the other hand. Let us consider how this can be implemented by using the structure shown in Figure1. The network self-adjustment takes place at the recognition of the input images. Only the most excited and experienced neurons must be trained in a given area of each layer. At the input of the first training image, the chain of the interconnected and strongly excited neurons (see fig. 2A) must be formed in the network shown in Figure 1. It passes through all neuronal layers from the entry point A to the output point B (see Fig. 1). An increase in strength of excitation of the already excited neurons (see fig. 2A) must be formed in the network shown in Figure 1. It passes through all neuronal layers from the entry point A to the output point B (see Fig. 1). An increase in strength of excitation of the already excited neurons (see Fig. 2B and 2C). The structure of the type shown in Fig. 2C, that was formed after the training in the
network shown in Figure 1, can be represented as a conventional curved tube (see Fig. 3).

Fig. 2. Formation of the structures of highly excited neurons at training of a multilayered and multiple coherent resonant neural network

This tube is the entry area associated with the entry point A (the left end) and the exit area (the right end), associated with the exit point B. When a new image is introduced to a trainee, the following process can happen. If a chain of highly excited neurons passes from the entrance area to the exit area within any of the previously formed curved tubes, then the input image is identified as a related to a certain earlier presented image and therefore at this point, it is recognized as a familiar to the trainee object (the resonance effect occurs).

Fig. 3. Graphic representation of the curved tube of the memory, formed during training of a multilayered and multiple coherent resonant neural network

If the chain of strongly excited neurons, which appeared after the new image input, does not pass or passes partially through the previously formed curved tube, then in the network shown in Figure 1, the formation of a new tube begins, in accordance with the model shown in Figure 2. In the above case, the adaptation process to the new input information takes place. It is characterized as the plasticity of memory. The formation of the recognition structures (automatic recognition) is possible after the conducted training that was based on the introduction of multiple sets of different image samples. The new formed structures will look like those shown in Figure 4. The curved memory tubes (M-1) and M overlap partly (in layers IV and V) see Fig. 4. However, they will relay to different classes of images. With significantly similar combinations of the curved memory tubes, the excitation of the chain of neurons at the recognition of the input images (the appearance of resonance) will result in the excitation of the neurons in another chain. Therefore, the resonating ensemble of the interacting curved memory tubes is formed. Supposedly, a similar mechanism of information perception and recognition arises in real biological structures when an eidetic memory activates, after which some images evoke the appearance of different objects, smells, etc. in the human brain. Synesthesia is the foundation of the eidetic memory phenomenon. It is a combined, synchronized sensation. In fact, this phenomenon is described as followed: any stimulus of a certain sense organ causes aside from a person’s will, a particular feeling and, at the same time, it trigs additional sensations.

Fig. 4. Graphic representation of the recognition structures (the automatic recognition) and multilayered, multiple coherent resonant neural network

The authors of this paper have an intention to further study the phenomenon of an eidetic memory by performing diverse tests of the described above eidetic memory model, which will involve the eideits participation. Eidetics are those people who are able to recall images with unusual vividness and detailing. Either they possess a very well developed eidetic memory by birth or they obtained after the training (for example, after taking a speed-reading course). At the first phase of the experiment, it is expected to identify the areas of the white matter, which would serve as the marker of the expressed eidetic memory in the eideits. The Diffusion Tensor Imaging (DTI) will be used as an instrument. At a later stage, it is planned to establish the functional connections between the areas of the white matter, using the Functional Magnetic Resonance Imaging (fMRI).

3 Conclusions

The proposed model of an eidetic memory possesses the ability to process simultaneously a large number of the input images due to the presence of the plurality of the curved tubes in training. It is characterized by both plasticity and stability, as well as by a distributed structural biochemical character.

This model is recommended for implementation in the theory of teaching and training, development and application of learning technics and in the field of artificial intelligence systems.

4 References