PARALLEL-HIERARCHICAL TRANSFORMATION AS THE SYSTEM MODEL OF NEUROLIKE SCHEME OF DATA PROCESSING

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New approaches of optical transmission, processing and storage of information, poster

Unified methodological approach was developed for analysis of parallel processes. This approach considers influence of structural hierarchy in dynamics, in other words it tracks processes of spatial areas transformation of correlated and generation of uncorrelated in time elements of generated network, at the time of transition of the network from one stable stage to another. The main feature of the proposed method is the studying of the dynamics of spatial-correlated procedure for transformation between current and output units in neural network. This procedure gives an opportunity to present processing in neural network as the process of parallel-sequential transformation of diverse image components and consideration of temporal characteristics of transformation. In addition, physical parameters (as amplitude, frequency, phase or input image texture) of input elements, which are involved in correlation-decorrelation process, are determined by the type of used transformation depended on the class of current tasks.

The given research offers new approach to the creation of computing medium - of parallel-hierarchical (PH) networks, being investigated in the form of model of neurolike scheme of data processing. The approach has a number of advantages as compared with other methods of formation of neurolike media (for example, already known methods of formation of artificial neural networks). The main advantage of the approach is the usage of dynamics of multilevel parallel interaction of information signals at different hierarchy levels of computer networks, that enables to use such known natural features of organization of computations in cortex as: topographic nature of mapping, simultaneity (parallelism) of signals operation, inlaid cortex, structure, rough hierarchy of the cortex,

spatially correlated in time mechanism of perception and training. The formation of multi-stage PH networks assumes the process of sequential transformation of correlated and formation of decorrelated in time elements of neural networks at its transition from one stable state into another. The key feature of the offered approach is analysis of dynamics of spatially correlated mechanism of transformation of current and formation of resultant elements of neural networks. Such mechanism allows to present in a new way the processing in neural networks as the process of parallel-sequential transformation of various components of image and ac count of time responses of transformation. Physical contents of input elements of neural networks, that participate in correlation - decorrelation, such as, for example, the amplitude or frequency, phase or energy of signals, cohesion or texture of images, is determined by the type of transformation being used, the selection of which depends on the class of problems being solved. In general view the multistage concept regarding image processing can be formulated in the following way. The image analysis presents sequential transformation of concurrent and detection of discrepant in time image components at transition of neural networks elements from current energy state with certain space coordinates into states with less energy with other space coordinates. Such process of image analysis occurs at many stages, each of which includes fulfilment of above-stated procedure. The condition for transition of image components at higher level is availability of dynamics of mutual coincidence of intermediate results of processing in time in parallel channels of lower layer. The outcome of image analysis is formed from insulated in time-space area image components.

In the given research considers problems connected with the creation of efficient system analysis of parallel processes, that would allow to change structural hierarchy in dynamics, that is put forward while development of promising computing systems.

The researches shows, that the most promising and studied means intended for presentation of hierarchical structures is a tree-like structure[1]. Main examples of tree-like structures application as hierarchical description in terms of decomposition of the target in space have been examined. It is noted, that the existence of strictly tree-like order relations between levels of hierarchy structure is not obligatory[1,2]. These relations may exist within one hierarchical level. The second, not less important version of hierarchical structures are those structures that combine aim decomposition in temporal and spatial planes. They are called spatial-temporal hierarchical structures, that realize the method of spatial-multilevel data representation and temporal-network principle of their analysis. Two groups of spatial-temporal hierarchical structures are suggested: pyramidal and parallel-hierarchical, correspondingly with strong and weak links. The given groups are investigated on model, algorithmic, structural-functional, system and circuit levels[1,3,4].

The suggested work gives system notion of neurobiological process in the form of convergent-divergent structures as concept base needed for PH networks construction. For this purpose the results of modern histological and electrophysiological studies have been analyzed[1]. The analysis shows that in sensor and, particularly, in associative zones of the cortex along with vertical neuron routes there exists also numerous horizontal neural routes, which connect nerve cells situated near each other[1,2,3]. Taking into account this peculiarity it is suggested to take into consideration the horizontal routes in hierarchical structure of PH transformation, as a result we obtain the structure of 3D network. It has been noted that in case of such mixed usage of neuron rotes: horizontal route - vertical route - horizontal route etc., of each level of the networks temporal shift is formed, described in early 1970's in structures of one-dimensional N networks by Professor W.Grenander, and later, in 1980's the shift was suggested on 2D optoelectronic devices in the works of Professor V. Kozhemyako[4].

1. V.P. Kozhemyako, Yu.F. Kutaev, S.V. Svechnikov, L.I. Timchenko, A.A. Yarovyy Parallel-hierarchical transformation as the system model of effective artificial intelligence tools. *Monograph*. – Vinnytsia, Universe-Vinnytsia, 2003. – 324 pages.
2. L.I. Timchenko, Yu.F. Kutaev, V.P. Kozhemyako, A.A. Yarovyy, A.A. Gertsiy, A.T. Terenchuk, N.Shweiki, *Proc. SPIE*, **4790**, 465-479, (2002).
3. V.P. Kozhemyako, L.I. Tymchenko, Yu.F. Kutaev, A.A. Yaroviy, *Optoelectronic Information-Power Technologies*, №1, 110-124, (2001).
4. V.P. Kozhemyako, L.I. Timchenko, Yu.F. Kutaev, A.A. Gertsiy, A.A. Yarovyy, N.I. Kokryatskaya, N.P. Grebenyuk, O.A. Poplavskyy, *Proc. SPIE*, **5175**, 222-236, (2003).
5. V.P. Kozhemyako, Optoelectronic logic-temporal information-computing environments. *Monograph*. – Tbilisi, Metsniereba, 1984. – 368 pages.