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Nikolaieva Ye. O., Mahas M. Yu.
National Aviation University, Kyiv

NEURAL NETWORK RECOGNITION

Artificial neural networks are computing systems inspired by the biological neural networks constituting the brain of animals. These systems "learn" by considering the examples without task-specific programming [1].

The paper considers equivalent neural networks models and associative memory based on the corresponding vector-matrix or vector-tensor procedures using continuous logic and nonlinear processing as basic operations. These spatial-non-invariant (SNI) and spatial-invariant (SI) models have several advantages such as the ability to recognize a large-sized 2D images with better efficiency and strong mutual correlation. The second advantage is a significant neural networks capacity and neural associative memory increase.

These models can simply describe processing of the signals during the all training and recognition stages and they are suitable for bipolar and unipolar multidimensional and multilevel signals coding. The neural networks equivalent paradigm implementation based on known equivalent or traditional correlation devices (CD) is possible if they are based on proposed equivalent two-dimensional functions of image similarity and non-linear correlation functions connections. Unlike the most well-known neural networks and associative memory models which mostly operate with SNI recognition models and are often single-port, we propose to consider equivalent multi-port neural networks and associative memory model for 2D images recognition. These models allow parallel associative (auto- or hetero-associative) recognition of some images using a standard set of image array that were used in the training of such networks. The recognition efficiency in such models and their implementation depends on the discriminant properties of hidden layers' conventional neural elements. Therefore, the main models and architecture parameters and characteristics as the processed images dimension, memory capacity, and processing time depend on the applied types of non-linear processing and function used for image comparison or for adaptive-equivalent weighing of input patterns. The main attention is focused on the modeling process of nonlinear signal processing in neural networks based on the SNI equivalent functions. We can perform the comparative analysis of the results obtained in a series of experiments with different model parameters, and using these experimental data we can estimate the basic parameters of such structures.

In order to improve the recognition efficiency, it is necessary to provide adaptive-correlation weighting of the input image matrix and scalar coefficients determined by an array of reference images. The identification of these factors is also based on the equivalent measures of images similarity usage. We have presented the results of associative significant dimension (128x128, 600x300) of image recognition – modeling renewal. These models are capable to recognize images with a significant percentage (20-30%) of damaged pixels. The experimental results show that such models can be successfully used for auto- and hetero-associative pattern recognition. They can be also used to explain some mechanisms, known as "focus" and "the reinforcement-inhibition concept". We have demonstrated a real model of experiments in Mathcad, which confirm that the non-linear processing by equivalent functions, known as auto-equivalent (non-equivalent) functions and the appropriate parameters selection of non-linear transformations allow to determine the neuron-winners, processed the correlation peaks and side lobes corresponding to the spatial-dependent functions. We want to show how to use the obtained results and propose new more efficient hardware implementation of such recognition systems. We propose optoelectronic architecture for multichannel neural associative memory systems with time-pulse integration and that is based on vector-matrix and matrix-tensor multipliers. Moreover, we estimate the parameters and performance of such architectures and will focus on possible components, which can be used for their elements.

Conclusions. Artificial neural networks have become firmly established in our lives and are now widely used in solving a variety of problems and are actively used wherever conventional algorithmic solutions prove to be ineffective or completely impossible.

References:

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Scientific supervisor: Konoplianyk L. M., PhD, Associate Professor