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SYNTHESIS ALGORITHM OF CONTROL SYSTEM BASED ON NEURAL NETWORK FOR THE GAS AND OIL PROCESS

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Abstract. *Automatic control systems in the oil and gas processing are considered. After extraction of natural gas condensate, management of technological parameters plays an important role in its processing. Among the parameter of regulating algorithms, control based on neural network technology was considered. These control systems are created on the basis of algorithms of neural network technology. There are several structures of neural networks according to their structure. Differences in the process of information processing of these branching structures are considered.*
Keywords: *automatic control system, classical structure, quality indicators, neural network, hidden layer, direct spread, flexible spread, cascade spread, molecular spread.*

Annotatsiya. *Neyron tarmoq texnologiyasi algoritmlarini joriy qilish asosida gaz aralashmalarni tozalashning murakkab texnologik jarayon va ishlab chiqarishlarni takomillashtirilgan (ilg‘or) boshqarishning adaptiv tizimlarini qurish masalalari muhokama qilingan. O‘rganilayotgan tizimning tuzilishi va parametrlari to‘g‘risida ma’lumotlar aprior va joriy noaniqligi sharoitida murakkab dinamik obyektlarni identifikatsiyalash, emulyatsiyalash, bashorat etish va boshqarishning dolzarb masalalarini samarali yechishga imkon beradigan neyron tarmoqlarining ixtisoslashtirilgan arxitekturalarini va ularni mashinani o‘qitish usullarini ishlab chiqilishi maqsadga muvofiqligi asoslangan.*
Tayanch so‘zlar: *adaptiv boshqaruv tizimi, takomillashtirilgan (ilg‘or) boshqaruv, murakkab dinamik obyektlar, obyekt modelining parametrlari strukturaviy-parametrik noaniqligi, neyro-tarmoqli yondashuv.*

Аннотация. *Обсуждаются вопросы построения адаптивных систем усовершенствованного (продвинутого) управления сложными технологическими процессами и производствами очистки газовых смесей на базе привлечения алгоритмов нейросетевой технологии. Обоснована целесообразность разработки специализированных архитектур нейронных сетей и методов их машинного обучения, позволяющих эффективно решать злободневные задачи идентификации, эмуляции, прогнозирования и управления сложными динамическими объектами в условиях априорной и текущей неопределенности по структуре и параметрам исследуемой системы.*
Ключевые слова: *система адаптивного управления, усовершенствованное (продвинутого) управление, сложные динамические объекта, структурно-параметрический неопределенность параметров модели объекта, нейро-сетевой подход.*

I. Main problems in automatic control system in oil and gas processing.

Nowadays, the development of technique and technology is increasing in all fields. Automatic control systems play an important role in the process of oil and gas processing. The control program is required to be optimal together with the normal operation of the installed sensor, signal converters and controllers. We can count many regulator and control algorithms for automatic control systems. Currently, the most control algorithms installed in technologies are based on classical methods [1].

One of the main problems is the correct making of a mathematical model for the technologies of gas processing. We can observe the issue of having a constant value by measuring all the parameters and external influences presented in the mathematic model.

The problem of automatic regulator is the process of the input value of a parameter to the value of a given task. Algorithms, now known as classical tuning systems, provide the transition

characteristics shown in the figure below (Fig. 1) [1-3].

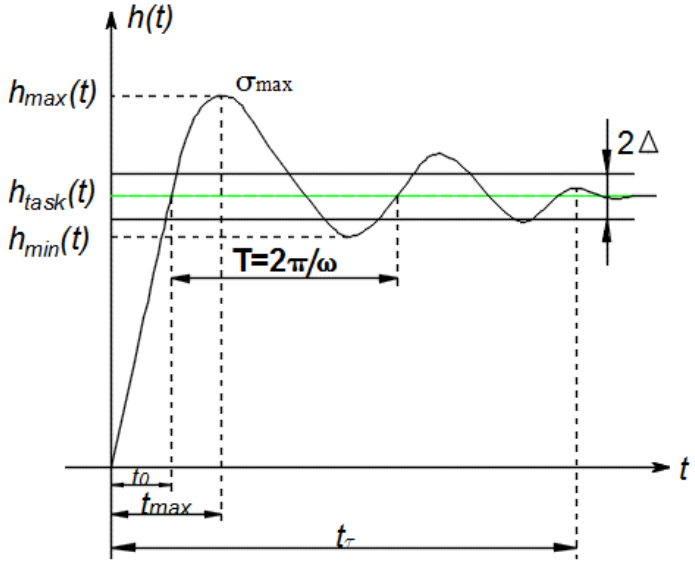

Fig. 1. ***Quality indicators presented in classical regulating method:***

h *- parameters regulated.* h_0 *- the initial value of the parameter being regulated.* k *- regulating coefficient.* A *- regulating amplitude.* Δ *- control error.* n *- the number of vibrations.* T *- period of oscillations.* τ *- delay time.* ω *- cyclic frequency.* ξ *- decay decrement.*

These parameters indicate the quality of regulator. Each of these parameters has specific requirements. As it approaches these required values, the regulator system reaches an optimal state.

There are many regulator systems, among which the adaptive regulator system is used to adjust complex processes. Adaptive regulator system is a system used to adjust the parameters of complex or continuous technological processes.

These control systems are considered intelligent or classical algorithms today. We can see many such algorithms. These regulators are now being replaced by neural network algorithms.

The use of neural network technology in automatic control systems makes it easier to solve these problems. Regulator has a positive effect on quality indicators, regulating time, amplitude, period and frequency [4].

II. Architecture of neural network model. Interconnection architecture between neurons. Teaching methods.

Description model of architectures and methods of neurons used to determine dependencies of their layers.

Neural networks, as a rule, consist of a set of several layers of relatively simple. But interconnected by a large number of connections of computational elements called neurons. Layers are usually divided into three types: input, hidden and output (Fig. 2). Each connection between two neurons is characterized by a real number called the connection weight. The set of weight coefficients of connections between neurons determines the computational properties of the neural network. The training of the neural network comes down to the corresponding regulator of the weight coefficients θ_1 [7-9].

Inside each i^{th} - neuron of the n^{th} - layer, two-stage calculations are performed (see Fig. 2). Firstly, the total input signal Net_j of the neuron is calculated by summing all given the input signals. Then using the transfer function, the output signal Out_j of this neuron is calculated.

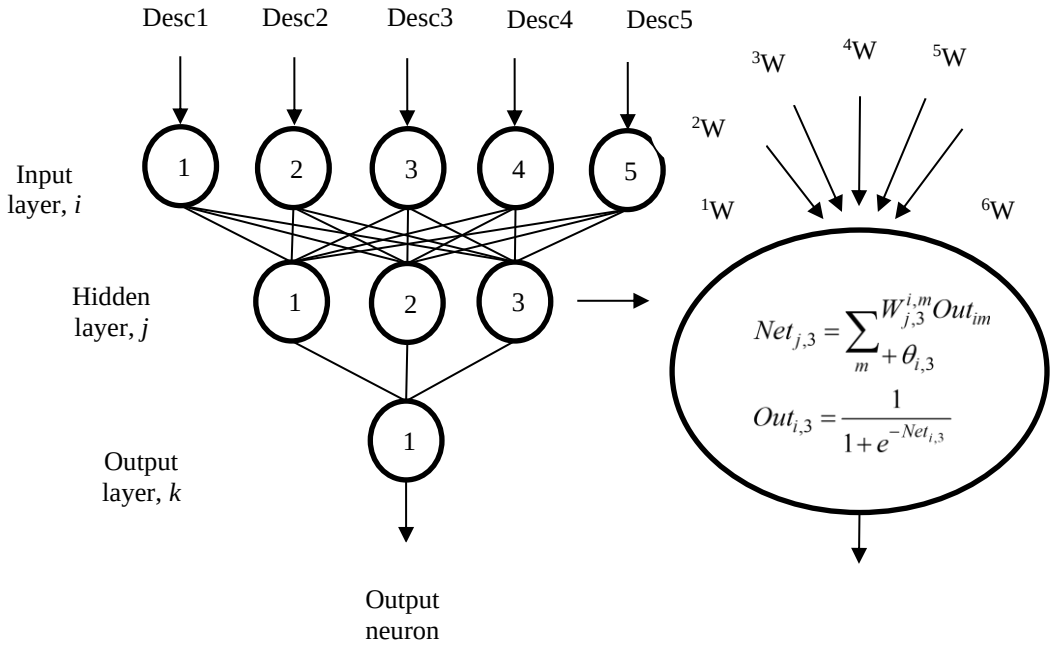

Fig. 2. ***Structure of the neural network of direct spread. The enlarged fragment shows the main computational operations performed by a neuron.***

$$Net_j = W_{ij} Out_i + \Theta_j$$

$$Out_i = f(Net_i) \quad (1)$$

where Net_j is the general input signal of neuron *j*, belonging to layer *n*; Out_i is the output signal of neuron *i*, belonging to layer *n - 1*; W_{ij} is the weight coefficient of communication between neurons *i* and *j*; Θ_j – maximal value for neuron *j*; Out_j is the output signal of neuron *j* of layer *n* [8].

$$Out_j = \frac{1}{1+e^{-Net_j}} \quad (2)$$

$$Out_i = \begin{matrix} 0, Net_j < 0 \\ 1, Net_j \geq 0 \end{matrix}$$

$$Out_j = kNet_i, (k = const) \quad (3)$$

$$Out_j = \frac{e^{Net_i} - e^{-Net_i}}{e^{Net_i} + e^{-Net_i}} \quad (4)$$

Sigmoid functions are most often used as transfer functions (1); but, in addition, boundary (2), linear (3), hyperbolic tangential (4) and a number of other functions can be used.

As a rule, instead of using boundary value Θ, so-called displacement pseudo-neurons (2) with a constant output signal are added to each layer of the neural network (except for the output layer) scrap equal to (1).

All connections are initialized with random numbers before starting training. An appropriate choice of initialization boundaries can reduce the neural network training time and improve the quality of the resulting neural network models. In certain cases, when the learning process, teaching does not converge, the training is repeated with other training parameters or with another initialization of connection weights.

III. Multilayer neural networks of direct spread.

Most publications devoted to the search for structure-property dependencies use multilayer feed-forward neural networks. The main advantages of such neurons include their ability to find multi-

parameter nonlinear dependencies. They characterize by high interpolation accuracy even in text cases when the experimental data are insufficiently representative or contain noise [7-9].

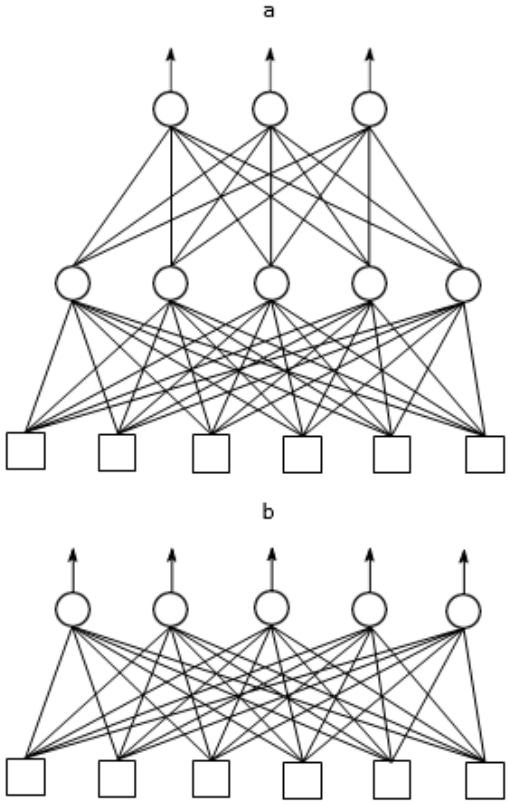

Fig. 3. ***Classical neural network with direct spread.***

Neurons of direct spread are characterized by layer-by-layer transmission of the signal from the input of the neuro-net to its output. Classical direct spread neurons may contain several hidden layers (Fig. 3, a) or consist only of input and output layers (Fig. 3, b).

When learning multilayer neurons of direct spread, the regulator of the weight coefficients of connections is carried out sequentially. The starting with the connections of the output layer, therefore. The methods used to train such neurons are called error back spread methods.

Other architectures of neurons

To model the dependencies of structures - properties, neural networks are also successfully used with other architectures. Below is a brief description of some of these architectures following.

For direct spread neurons containing at least one hidden layer, there may be additional direct connections connecting the neurons of the input and output layers. There are also recurrent connections between the output of a neuron and its input [10-12].

For tasks related to the classification of connections. Layers and co-authors proposed using a neural network in the form of a tree, and the topology of this neural network was maximally approximated to the structures of the molecules being studied. Input neurons were assigned values of 0 or 1 in such a way as to obtain subgraphs isomorphic to the structures of the molecules being studied. Later, a similar approach was used in the computer program.

An interesting neural network method for describing the compounds under study. They make it possible to obtain the dependence of their properties on the structure without calculating descriptors for molecules as a whole, and using only descriptors of atoms and bonds. To represent structures, an additional neural network is introduced. Consisting of two main blocks: a sensor field, the input of which is supplied with the original structural information. And “eyes” that transform the data received from the sensor field into a signal invariant to the reversal of atoms in the molecules of the compounds

under study. The structural information processed in this way is fed to the input of an ordinary feed-forward neural network to obtain the dependencies of the structure [11].

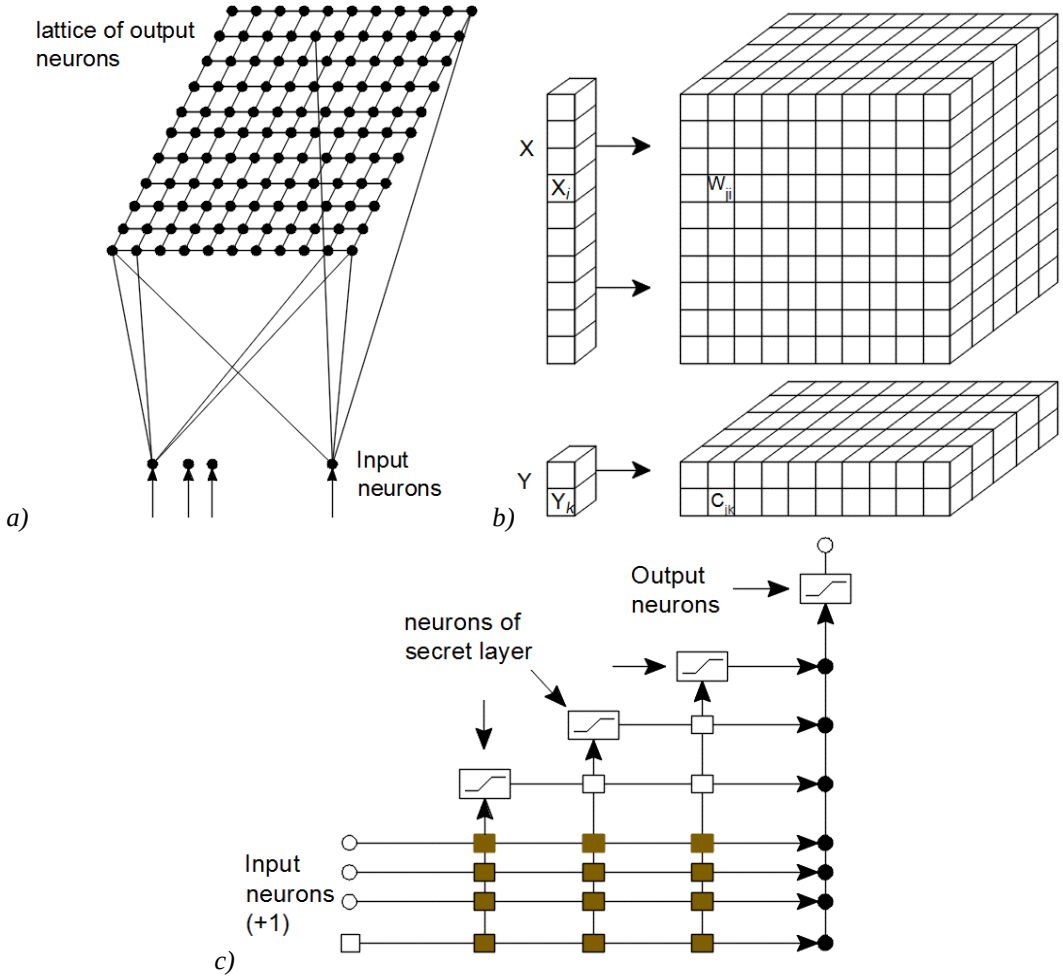

Fig. 4. ***Conventional representation of the architecture of some neural networks used to model the dependencies of structure:***
a - molecular neural network, c - counter neural network spread, c - cascade neural network.

Some cross-spread neurons use two different types of layers: the hidden layer and the output layer (Fig. 4). The significant advantages of neurons that learn by the method of back-to-back spread include a relatively small (on the order of several hundred) number of iterations. The required suitable for neural network training. Fig. 4b and also the ability to find the global minimum of the error function for any starting settings of weight coefficients. The disadvantages of such neurons include their inferior approximating ability compared to a number of other architectures.

It is possible to create an optimal automatic control system using algorithms based on these neural network technologies. It becomes easier to solve the problem of regulating the parameters in the technological process in the deep processing of oil and gas [10]. As a result, qualities of a product improve. It is also economically beneficial.

Conclusion

In this research, the quality indicators of parameter regulating in the automatic control system are considered. Classical and modern algorithms for regulating these parameters are analyzed. The effect of control systems made based on neural network technology on quality indicators was observed. Several structures of neural network technology are covered. Structure of the neural network of direct spread may be confirmed here. The enlarged fragment shows the main computational operations

performed by a neuron. Classical neural network with direct spread is also seen. To add, conventional representation of the architecture of some neural networks used to model the dependencies of structure molecular neural network, counter neural network spread and cascade neural network.

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