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An Intelligent Device With A Neural Network That Controls The Moisture Content of Bulk Materials

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Abstract

The article uses neural network technology for an intelligent measurement device that includes a database, knowledge base, and other blocks. The working principle, functional scheme and training algorithm of the intelligent measuring device have been developed based on neural networks. Temperature, density, and other uncertain parameters that affect the accuracy of the measuring device and the moisture content of the scattering materials are taken as control objects.

Keywords: Moisture, neural networks, intelligent device, functional circuit.

Introduction

Nowadays, solving technical issues such as management, control and measurement of technological processes in all sectors of industrial production is being intellectualized. The intellectualization of such technological processes requires expanding the functional capabilities of management, control and measurement technical means, improving their technical characteristics, and solving new scientific and technical issues of efficient use of energy resources. Therefore, a class of intelligent devices and sensors with the ability to change the principle of operation, input signal characteristics, technical condition and the level of external factors affecting the measurement system is emerging depending on the change of control and measurement conditions.

Intelligent devices and sensors differ from other analogues of this type in that they have functions such as automatic adjustment of the measurement range, self-calibration, data processing, and decision-making [1-5].

It is known that humidity is one of the most important technological parameters, which directly affects the price, technological structure and other properties of substances and materials. In order to organize high-quality control of moisture content of volatile materials (wheat, barley, rice, millet, beans) in technological processes, high-precision moisture meters participating in the technological process are directly used. Therefore, the issue of selecting converters for each control system, their principles of operation, constructions and other parameters is of great importance.

The following requirements can be imposed on devices used in measuring the moisture content of spreadable materials:

– that the measuring device measures moisture in the technological process and does not damage the measured substance;

– the measuring device should not be highly sensitive to the external environment and have a stable measuring system.

Materials and Methods

The analysis of currently available moisture measuring devices shows that the above

requirements set by control and management systems for measuring the moisture content of dispersed materials can be satisfied by moisture measuring devices developed using intelligent technologies. The simplified operating principle of the neural network intelligent device proposed in the article is shown in Fig. 1. Here we can include parameters control sensors, input and operation mode control blocks in the content of the control object blog. The control block of the neural network device contains the neural network and the output device.

Information about input parameters is collected in sensors. The neural network forms the resulting output signal and transmits it to the output device (display).

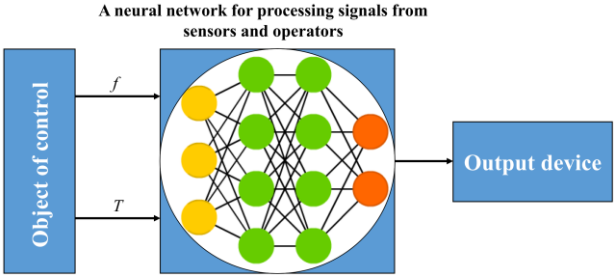

Figure 1. A simplified operating principle of a neural network intelligent device that controls the parameters of spreadable materials.

In recent years, devices with an intelligent adaptive control and measurement element, which are microcontrollers or microprocessors, form the basis of measuring techniques in all areas of production. The proposed neural network intelligent device has the appearance of a microcontroller consisting of five main blocks - database, knowledge base, neural network, learning and decision-making modules [6-11]. The functional scheme of the neural network intelligent device is presented in Fig. 2.

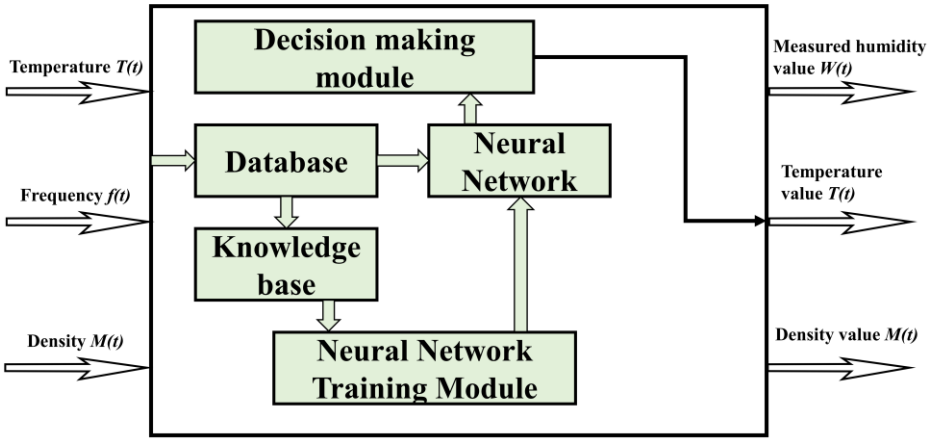

Figure 2. Functional scheme of the neural network intelligent device that controls the parameters of the spreadable materials.

The input of the microcontroller can be given as controlled parameters - frequency f(t), density M(t) and temperature T(t) in the form of a disturbance signal. Information about the parameters of the object and the effects of the disturbance comes into the knowledge and database. The knowledge base passes the parameters to the neural network training module. The database also provides input to the neural network and previous values of the controlled parameters, as well as information about the initial quality of the scattering material. The trained neural network then displays the signal processing results on the display using the decision making module. This result describes the actual values of the measured quantities. The output of the neural network can represent physical quantities such as moisture, temperature, and density of the scattering materials.

Results and Discussion

A generalized functional scheme of the device that controls the parameters of spreadable

materials is presented in Fig. 3. It consists of a control object (CO), a switch, a neural network and a display.

The measuring (control) scheme includes a converter and a neural network microcontroller. Its input is given the values of the measured parameter, as well as the previous values of the controlled parameters for one or two timer cycles, depending on the dynamics of the system.

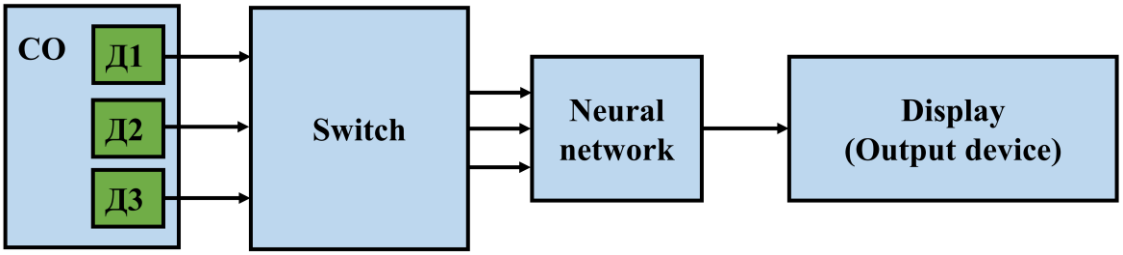

Figure 3. Generalized functional scheme of an intelligent device with a controller containing a neural network.

The neural network microcontroller forms output signals that describe the actual values of the measured parameters based on the data received and their processing. As a result, they are transferred to the output device - the display.

An algorithm of the process of building a neural network was developed to solve the task of humidity control in the measurement system (Fig. 4).

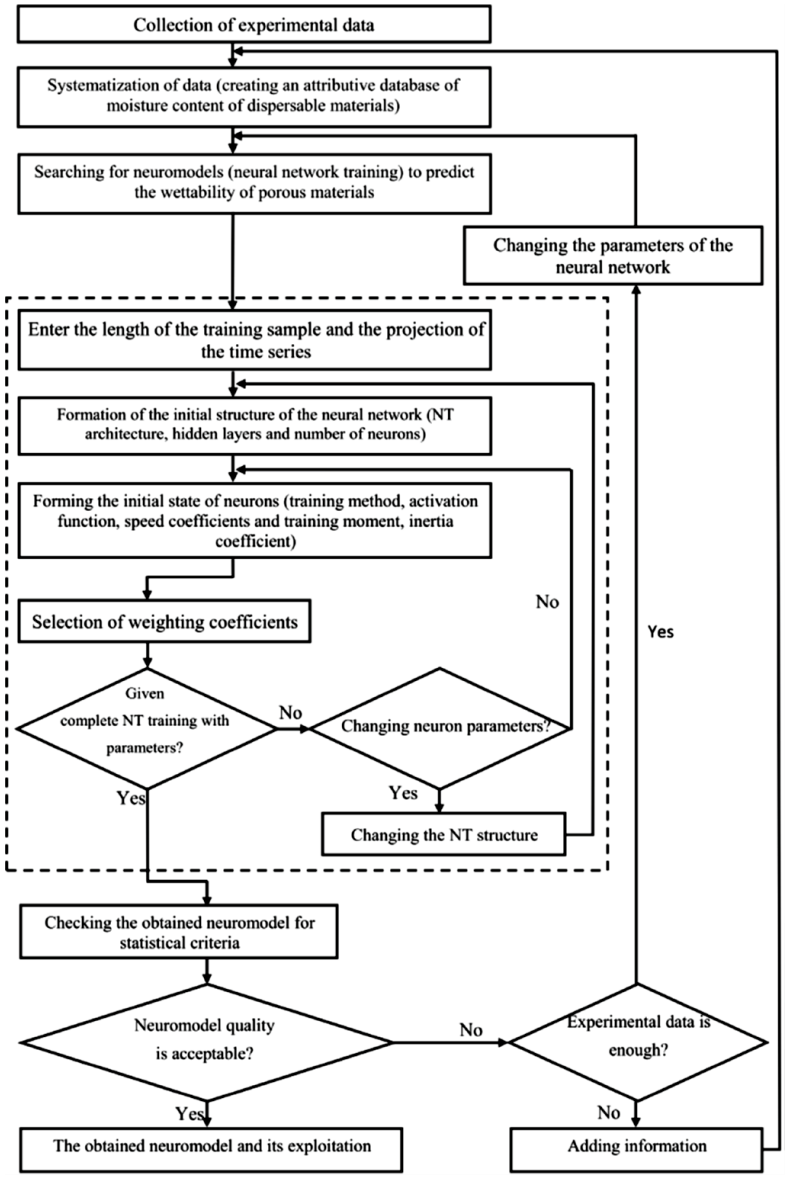

Figure 4. Algorithm for creating neural networks for an intelligent device that measures the

moisture content of spreadable materials

To develop a neural network model, first of all, it is necessary to choose the type and architecture of the neural network [12, 13].

Currently, properly distributed artificial neural networks are widely used to solve problems in intelligent systems. Therefore, we use properly distributed interconnected neural networks in an intelligent device that measures the moisture content of diffused materials [14,15]. Because the system is considered static, all neurons in the given vector of signals of neurons in the input layer generate a single value of the vector of signals in the output layer. A neural network consists of a number of inputs and outputs, is composed of a set of interconnected neurons, and performs nonlinear transformation.

The structure of the artificial neural network implementing the given problem is presented in Fig. 5.

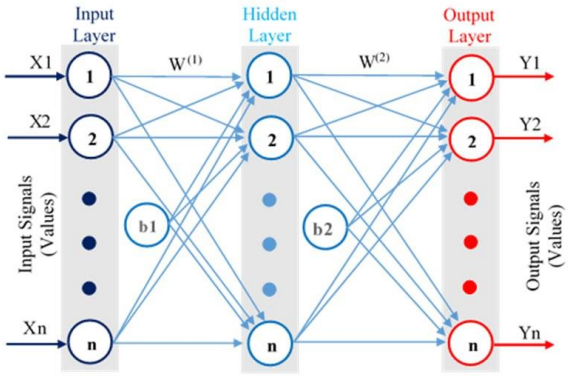

Figure 5. A multi-layer neural network consisting of one hidden layer.

The choice of neural network structure depends on the complexity of the problem. The selected structure provides the following possibilities:

- implementation of sequential training in a neural network;
- implementation of selective training in a neural network;
- add or remove information from a given familiarity without disrupting and retraining the neurons.

This is the optimal architecture of the network, and the training result does not take much time.

Conclusions

The use of a neural network intelligent device that controls the parameters of spreading materials provides the following advantages:

1) Due to the use of adaptive control technology, the flexibility of the intelligent device is high;

2) It allows to increase the quality and accuracy of measurement.

An algorithm for applying neural networks to an intelligent device has been developed to control the humidity of spreading materials. This made it possible to form a knowledge base on the type and architecture of neural networks, their training algorithms.

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