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# Application of Intellectual Systems in Measuring Instruments

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***Abstract:*** *This article focuses on improving the measurement accuracy of measuring instruments by applying artificial neural networks. Algorithms for "training" artificial neural networks, in particular, the basic properties of gradient algorithms and their application are devoted to study.*

***Keywords:*** *artificial intelligence, artificial neural network, training.*

## Introduction

In the era of globalization, in which science and information and communication technologies are rapidly developing, leading to the fourth industrial revolution, state and social management, economy, production, social protection, education, medical diagnostics, agriculture, defense and security, tourism and wide use of modern information technologies and artificial intelligence capabilities is entering many fields.

Artificial intelligence usually deals with the creation of capabilities associated with the human mind: language understanding, teaching, discussion, problem solving, translation and other capabilities. Artificial intelligence consists of algorithms and software systems designed to perform various actions and can perform many tasks that the human mind can perform.

Devices that measure temperature, humidity, pressure and other quantities are being created by experts in various fields. But in many areas of production, the measurement error differs from the specified "range". Reducing controlled and controlled parameters serves to increase the quality of manufactured products and reduce defects. As a result, it creates the need to create new basic measuring devices [1].

## Main part

Today, scientific research is being carried out on the development of intelligent measuring devices designed to control the moisture content of scattered materials based on such functions as automatic adjustment of the measuring range, calibration, linear static characteristics, high measurement accuracy and reliability, data processing, decision-making.

Extensive new opportunities for building intelligent systems for controlling technological processes are being developed through the use of artificial neural networks and are widely used in issues such as pattern recognition, prediction and diagnostics, optimization, signal processing under the influence of noise [2]. Artificial neural networks consist of a number of inputs and outputs, are composed of a set of interconnected neurons, and perform nonlinear transformation.

In artificial neural networks, the input signals coming to the hidden layer neurons are added according to their respective weights and the sum signal is calculated.

$$S = W \times X + b, \quad (1)$$

where $W$ – weight coefficients of neurons; $X$ – signal to input layer neurons; $b$ – constant bias; $S$ – the sum of the input signals.

The neurons in the hidden layer are connected to the neurons in the input layer, each with a certain weight. The weight coefficients (W) describe the interdependence of elements of the layers and determine the communication efficiency of those elements. We know that each element of the neural network operates in a discrete time and forms the resulting signal based on the received signal.

With the help of activation functions, the results in the neurons of the hidden layer can be converted into output signals. A sigmoid-shaped activation function is nonlinear and can smooth a given multidimensional function with arbitrary precision at a unit cross-section. As a result, the output layer will also have a nonlinear characteristic. It looks like this.

$$Y = \frac{1}{1+e^{-S}}, \quad (2)$$

The sum of the input signals acting on the neurons of the output layer can be calculated using a sigmoid-shaped activation function to calculate the actual values of the output signals. We know that the sigmoid activation function is non-negative and monotonically increasing. Therefore, the values of the output signals will also consist of positive results.

The most complicated process in building multilayer neural networks is "training". "Training" consists of identifying the unknown parameters of the neurons, weights and bias coefficients. In the training of multi-branch neural networks, gradient search methods are often used for the minimum of $E(w) = (Y^* - Y)^2$ criterion functions depending on the parameters of the neurons. This process is iterative, and at each iteration all coefficients of the network are found (inverse error distribution method). Other forms of minimum search can also be used, such as genetic algorithms and the method of least squares. This created intelligent measuring device is distinguished from other measuring devices of this type by the following features:

**Conclusions**

1. Lack of comparison tools and additional devices that meet the requirements of the measurement methodology;
2. The duration of the analysis is less time-consuming;
3. Availability of humidity measurement in field conditions, production de-partments, and loading and shipping areas;
4. Low energy consumption.
5. The measuring device is easy to operate and does not require additional devices during the measurement process.

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