Analysis of the current state of control problems of the flotation enrichment process using artificial intelligence approaches

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Abstract

Nowadays, the actual problem is the flotation enrichment process control based on the methods of artificial intelligence (AI). At the creation of control systems of the flotation process the developed multi-level dynamic model is an algorithm of neural network modeling that allows to choose the method and laws of regulation, nomenclature and parameters of the accuracy of monitoring tools. In fact, it looks like an inclusionof a feedback to the model that regulates one or more input parameters according to the measured values of one or more output parameters. For the neural network flotation control system the conformity of the model to a real flotation unit plays a decisive role. Existing mathematical models can not sufficiently accurately and fully describe the flotation process. A suitable solution for simulating of a complex nonlinear process with many parameters is neural networks.

Keywords: flotation, artificialintelligence, algorithm, neuralnetworkmodeling, sulphideores

1 Introduction

This work describes the problems of the flotation enrichment process control and modeling the process. The most widely used in this area is artificial intelligence, in particular, neural networks, followed by fuzzy logic, genetic algorithms, support vector machines and training decision trees [1]. The problem of flotation enrichment can be successfully solved with the help of intelligent systems. Therefore, the analysis of the current state and the use of methods of artificial intelligence make it possible to find effective algorithms for complex objects control with various types of parameters uncertainty [2].

2 Research problem statement

The problem statement is formulated as follows: the flotation process is investigated as a control object of artificial intelligence. Incomplete study of the flotation enrichment process of sulphide ores makes it difficult to create efficient automation systems.

3 Analysis of the current state of control problems of the flotation enrichmentprocess

The leading professional software systems of the neural network make it possible to obtain an effective solution of production tasks for control of the flotation enrichment process of sulphide ores. The technology of the artificial neural network has been successfully used by thousands of experts in order to solve complex tasks of data mining, image recognition and predictive modeling, for the construction of classifiers and neural network simulators and forecasting solutions. Here are some of the most well-known simulator programs for neural networks on the software market: Alyuda Neuro Intelligence - Neural network software and an Excel extension for forecasting and data analysis. Supports several algorithms. A trial version is available. Amygdala - Open source software for neural networks modeling, written on C ++. Neural Network Modelsin Excel - Software that implements neural networks for solving forecasting and classification problems in Excel. The reverse distribution is used. Can handle missing values and categorical data. Neural Network Toolbox for MATLAB is an environment for neural networks researches, for their design and modeling in MATLAB [3].

The developed analysis of the flotation enrichment process control is based on the artificial intelligence approach, which is used to create a multilayered network of direct distribution with the support of both fully connected and networks with structural connections. Neural network software can be divided into two stages:

Stage 1. Preliminary processing of data containing information on the behavior of a complex control object (for example, the values from various sensors, such as: temperature, pressure, flow, liquid level, object speed, etc.). Obtaining qualitative data on the basis of which an optimal neural network model is constructed that affects the final result, i.e. the quality of image recognition using artificial intelligence approaches.

Stage 2. Neural network modeling, in which as a mathematical model of a control object is used time series compiled of informative features describing the behavior of a real complex control object [4-5].

There is considered the neural network technology for complex objects control based on artificial intelligence.

4 Algorithm

1. A very important element of neural networks is an adaptive adder. The *adaptive adder* calculates the scalar multiplication of the input signal vector *x* by the parameter vector. In other words, it calculates a linear homogeneous function (x,), has n adjustable parameters. On the diagrams, we will designate it as shown on Fig. 1. We call it adaptive because of the presence of a vector of adjustable parameters .

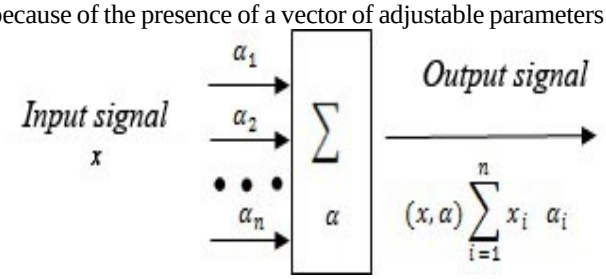

FIGURE 1 Adaptive adder

2. In order to carry out our task it is useful to have a non-homogeneous linear function of the output signals. Its calculation can also be represented by an adaptive adder having an n+1 input and receiving a constant single signal at the 0 input. The use of 1 is more often convenient, although not necessary. The adder with such an additional input is called a non-homogeneous adaptive adder (Figure 2) [6].

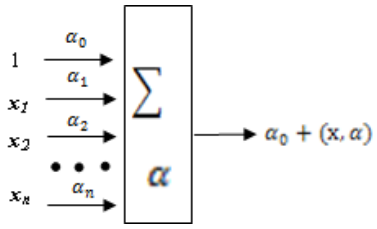

FIGURE 2 Non-homogeneous adaptive adder

The aim of network training is to adjust its weights when the applying a set of input values leads to the required set of output values [7].

In this case, the input receives the results of parameters measuring that affect the flotation process; the output results - laboratory measurements of the sulphide ores content. An important feature of neural networks of a direct transmission is the possibility of prior training, which will allow to continuously adjust the model for maximum correspondence to the real process [8-9].

5 Conclusion

There was composed an analysis of the current state of control problems of the flotation process using artificial intelligence approaches, where a neural network technology for complex objects control based on artificial intelligence. Therefore, the development of intelligent flotation control systems remains a promising direction in improving the efficiency of sulphide ore enrichment.

References

[1] Jovanovic I, Miljanovic I, Jovanovi T 2015 Soft computing-based modeling of flotation processes *A review, Minerals Engineering* **84** 34-63
[2] Jovanovic I, Miljanovic I 2015 Modelling of flotation processes by classical mathematical methods *Arch. Min. Sci.* **60**(4) 905–19
[3] *Artificial intelligence - reality and prospects* http://ai-es.blogspot.com/p/blog-page.html/1st of March, 2018
[4] Samigulina G A 2012 *Development of the decision support systems on the basis of the intellectual technology of the artificial immune systems* Automatic and remould control Springer. **74**(2) 397-403
[5] Zhukov L A, Reshetnikova N V 2007 *A manual on the discipline "Applications of neural networks"* Krasnoyarsk 20-2
[6] Bumazhenko T M *Application of neural networks for the flotation process regulation* BSUIR, Minsk, Republic of Belarus
[7] Gorban A N 1990 *Training of neural networks* Moscow: SP ParaGraph
[8] Suleimenov B A, Sugurova L A, Suleimenov A B 2016 *Intelligent systems of optimal control and operational diagnostics (methods of synthesis and application)* Almaty "Shikula" 78-80
[9] Koshimbayev Sh K, Suleimenov B A 2016 *Automation of standard technological processes: Textbook* Almaty 226 p