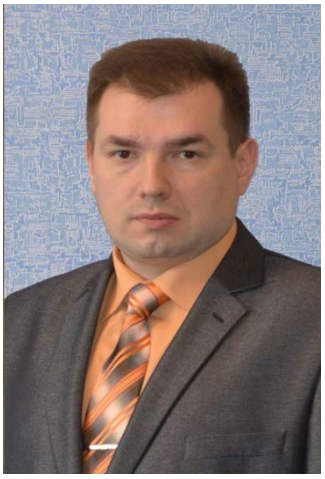
Reason for application of intelligent systems for disintegrating complex control



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Abstract
Rational application of intelligent systems of control based on the neuro-fuzzy operation technologies and artificial brain is given.
Key words: ADAPTIVE SYSTEM, ARTIFICIAL BRAIN, NEURAL NETWORKS, FUZZY LOGIC, COORDINATED CONTROL, DESINTEGRATING COMPLEX.

Problem and its connection with scientific and practical tasks.

One of the main problems of mining enterprises of Ukraine is that the reorientation on the world market outlets requires constant competitive growth of output product, reduction of its power capacity.

Global experience shows that under such conditions the most effective way for quality improve and cutting of production costs is complex automation of principal processes based on the application of modern integrated systems of intelligent, optimal and adaptive management [1].

The main problem, which arises during implementation of such systems, is the absence of reliable control means with the required accuracy or rather high cost of separate sensors. At the present time alternative construction methods of automated control system (ACS) on the base of usage of artificial intelligence technology (neural networks, fuzzy logic, genetic algorithms, etc) are actively developing. Along with this the experience shows that for development and implementation of intelligent control systems there expended far less funds due to decrease of the

necessity to use expensive equipment (sensors, utility systems).

Research and publication analysis. Analysis of works shows that large majority of ACS is realized on the base of application of classical approaches of control theory, adaptive and optimal systems. 1-2 channel linear systems, as a rule, are applied as mathematical models. Most of such systems are simple to carry out with the help of classical pid-regulators. Relative simplicity of implementation and comparatively high reliability of such systems conditions their application among 80-90% of industrial automation systems [1]. Along with this it is known that such systems cannot always provide the necessary quality of control, especially under the conditions of nonstationarity, persistence, retard, random disturbances, fuzzy or incomplete data. Besides, pid-regulators require permanent reconfiguration of own coefficients in the case of changing of technological situation (e.g. range in burden composition, productivity, quality etc).

The aim of research. The aim of research is the reason for application of intelligent systems of desintegrating complex control.

Presentation of material and results. Aiming for reduction of power consumption for ore benefication in common leads to the new up-to-date decisions, to the usage of adaptive systems of automated coordinated control of technological stages of ore size reduction by desintegrating complex.

Herein it should be marked that the economically important fact is here not only the index of optimum performance of crusher during ore processing with as low as practicable energy usage, but also the index of steady operation with the smallest size of final crushed material. As energy costs on the following stages of benefication – cycles based on the bead mills of central discharge ball mill (MCDBM) significantly exceed the costs for crushing and running efficiency of the mill depends on the homogeneity of the output product. This is the reason why homogeneous constitution of input ore is of priority meaning.

Energy saving policy implementation is especially important for Ukrainian economy, as in conditions of acute shortage of financial, energy and material resources it allows on effective capacities of mining companies to increase extraction of valuable element into concentrate, increase its quality, reduce maintenance charges and so to cut production costs of finished products, increase its competition capacity in the world market.

Solution of this task is possible by means of implementation of energy-efficient technical means, technological and technical and organizational solutions, continuous quality control of production process, and also energy-saving control methods and automatic control systems [2, 3].

As it was mentioned above, the most energy-intensive process at mining and processing works is ore crushing. In the works [2, 5] there suggested two ways for cost reduction of electric energy for this process. The first one is improvement of equipment and ore crushing technology for reduction of product size, which goes then for crushing. There paid great attention to this direction abroad. It is calculated that increase in expenses of energy for crushing on 1 kW·h in order to reduce the size of crushed ore effects a saving during crushing 3÷4 kW·h. This is achieved both by using of closed crushing cycle and new generation of crushers. For example, application of “Svedal” crushers provides production of crushed ore with the size -16, -10 and -5 mm. During usage of such crushers at the Central mining and processing work (Kryvyi Rih city) one may save 20 mln hryvnas per year.

The other way for cost saving consists in modernization of the grinding operations themselves and creation of new aggregates. For example, the usage of vertical bead mills for crushing with rotating rotor provides energy cost saving up to 50%. At the same time in spite of a very low efficiency of bead mills, they are not worked out. It is enough to say that in USA there used 18kW·h of energy to produce 1 t of ready class during crushing, whereas on the native mining and processing works there required 43 kW·h. Investigation of operation of mill of the third stage shows that for crushing after classification in hydraulic cyclones there comes material, which contain up to 75 % of released ore grains, which do not require crushing. In this case the mills work idle, overgrinding the material, forming tailing, wearing out the lining and grinding balls, making noise and generating heat into environment.

At the present time fuzzy-set theory is widely used for formation of automatic flow control [3]. The major premises for this are: lack of precise formalized knowledge, nonlinear mode of behavior, high scale of uncertainty, complexity of formalized model (e.g. implicit dependence input-

output) etc. Fuzzy sets serve as straight interface between qualitative parameters included into the rules and numerical data of model input and output [3].

Over the last few years, there happened rapid growth of fuzzy-logic controller usage to manipulate complex processes, which are characterized by large degree of uncertainty. Most of fuzzy controllers, developed until now, are based on the conception [6], when the rules in controller simulate operator response for the current situation in process operation. Alternative approach uses fuzzy or back fuzzy model during control [7], because often it is much more easier to get the information as to how the process reacts to the applied impact, with the help of what it should be fixed, how and why operator reacts to the specific situation.

In the works [6-7] there considered learning systems based on the usage of neural networks and fuzzy models in the return circuit of control.

In the work [8] for identification of benefication process in conditions of ore-dressing plants there used neural network approach with further controller with algorithm based on the fuzzy logic building. Different models of realization of neurocontrol were investigated (particularly, sequential and parallel control, schemes with emulators and self-tuning).

The usage of artificial neuro-fuzzy networks (ANFN) for modeling and identification of control object – is the approach, which is usually considered as the alternative for methods, based on the physical or technological principals. Disadvantage of this method (basically the black box) is the danger of formation of unrealistic model because of insufficient information content of identification data and extra parametrisation of models. The other disadvantage in such simulation – is non- scalability of black box models, i.e. the necessity to collect the data if the object changes. Promising direction is the combination of mentioned approaches in composition of hybrid models, allowing to eliminate above mentioned disadvantages.

From the mentioned above one may conclude that the main task during synthesis of energy-efficient control of production processes of beneficiating manufacturing is the grounding and development of creation method of automatic control system in conditions of incomplete and fuzzy data about the object of control, providing the necessary quality of its benefication in accordance with current characteristics of charge stock, at maximum yield of processing line and time minimization, during which process units work out of their optimal characteristics. For mathematical description of control object in these conditions it is efficiently to use the strategy of hybrid simulation, which allows to use advantages of both analytical description of knows interrelations and the mean of “black box” for presentation of difficult-to-formalize components.

Conclusions. Considering all the mentioned factors, one may say that the problem of application of artificial intelligence technology in mining practice is relatively new now and currently important. This concerns the possibility to use neural networks and fuzzy logic for controlling of technological processes of crushing and grinding and benefication of mineral products. Exactly intelligent systems due to application of certain mathematical models of human’s thoughts, generalized properties, fixed nonlinearity and adaptability during securing of certain conditions allows to solve set tasks.

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