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НАУЧНО-ТЕХНИЧЕСКИЙ ЖУРНАЛ
«МАШИНОСТРОЕНИЕ»

SCIENTIFIC AND TECHNICAL JOURNAL
«MACHINE BUILDING».

№5 (Махсус сон)
I том 2022 й.

ОЛИЙ ВА ЎРТА МАХСУС ТАЪЛИМ ВАЗИРЛИГИ
АНДИЖОН МАШИНАСОЗЛИК ИНСТИТУТИ

МАШИНАСОЗЛИК
ИЛМИЙ-ТЕХНИКА ЖУРНАЛИ

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МИНИСТЕРСТВО ВЫСШЕГО И СРЕДНЕГО СПЕЦИАЛЬНОГО ОБРАЗОВАНИЯ РЕСПУБЛИКИ УЗБЕКИСТАН
АНДИЖАНСКИЙ МАШИНОСТРОИТЕЛЬНЫЙ ИНСТИТУТ

НАУЧНО-ТЕХНИЧЕСКИЙ ЖУРНАЛ
МАШИНОСТРОЕНИЕ

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MINISTRY OF HIGER AND SECONDARY SPECIALIZED EDUCATION OF THE REPUBLIC OF UZBEKISTAN
ANDIJAN MACHINE-BUILDING INSTITUTE

SCIENTIFIC AND TECHNICAL JOURNAL
MACHINE BUILDING

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№5 (Махсус сон) I том,
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ISSN 2181-1539

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METHODS AND MODELS FOR DIAGNOSING TECHNOLOGICAL OBJECTS

МЕТОДЫ И МОДЕЛИ ДИАГНОСТИРОВАНИЯ ТЕХНОЛОГИЧЕСКИХ ОБЪЕКТОВ

TEXNOLOGIK OB'YEKTLARNI TASHXISLASH USULLARI VA MODELLARI

Abstract

The modern business world is becoming more and more technological. Many areas quickly realized their potential. Artificial intelligence (AI) and machine learning in the refining of gas-oriented sectors have evolved more slowly. This is largely due to the fact that the industry is very slowly realizing its potential. However, this situation is gradually changing. Machine learning used for the diagnosis of extraction columns using a neuro-fuzzy method can be used to expand the capabilities and mechanisms of work to increase the

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2022 йил
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competitiveness of this sector in complex industrial plants, oil refining, petrochemical, gas and other industries. Not only can this help streamline the workforce. The technology can also be used to optimize the extraction and delivery of accurate models. These benefits are just some of the reasons why machine learning in the oil and gas industry is becoming increasingly important.

Аннотация

Современный деловой мир становится все более и более технологичным. Многие направления быстро реализовали свой потенциал. Искусственный интеллект (ИИ) и машинное обучение в нефтеперерабатывающих отраслях, ориентированных на газ, развивались медленнее. Во многом это связано с тем, что отрасль очень медленно реализует свой потенциал. Однако эта ситуация постепенно меняется. Машинное обучение, применяемое для диагностики экстракционных колонн нейро-нечетким методом, может быть использовано для расширения возможностей и механизмов работы по повышению конкурентоспособности данного сектора на сложных промышленных предприятиях, нефтеперерабатывающей, нефтехимической, газовой и других отраслях промышленности. Это не только может помочь оптимизировать рабочую силу. Эту технологию также можно использовать для оптимизации извлечения и доставки точных моделей. Эти преимущества — лишь некоторые из причин, по которым машинное обучение в нефтегазовой отрасли становится все более важным.

Annotatsiya

Hozirgi vaqtda texnologik jarayonlar tobora ko'proq rivojlanib bormoqda. Ko'pgina mamlakatlar o'z imkoniyatlarini tezda ro'yobga chiqarmoqda. Neftni qayta ishlash sanoatida sun'iy intellekt (AI) va mashinali o'qitish sekinroq rivojlandi. Bu ko'p jihatdan sanoatning o'z imkoniyatlarini juda sekin amalga oshirayotgani bilan bog'liq. Biroq, bu holat asta-sekin o'zgarib bormoqda. Neyro-noqatiy usullar yordamida ekstraksiya kolonnalarini tashhislash uchun ishlatiladigan mashinali o'qitish kompleks sanoat korxonalari, neftni qayta ishlash, neft-kimyo, neft-gaz va boshqa sohalarda ushbu sektorning raqobatbardoshligini oshirish ishlarini imkoniyatlarini va mexanizmlarini kengaytirish uchun ishlatilishi mumkin. Bu nafaqat ishchi kuchini optimallashtirishga yordam beradi, balki ushbu texnologiya aniq modellarni chiqarish va etkazib berishni optimallashtirish uchun ham ishlatilishi mumkin. Ushbu imtiyozlar neft va gaz sanoatida mashinani o'qitish tobora muhim ahamiyat kasb etayotganining sabablaridan, hamda neyro - noqat'iy modellarning parametrlarini aniqlashga imkon beradigan usulni yaratishdan iborat.

Key words: *neuro-fuzzy model, neural network, machine control, methods and algorithms, diagnostic methods.*

Ключевые слова: *нейро-нечеткая модель, нейронная сеть, машинное управление, методы и алгоритмы, методы диагностики.*

Kalit so'zlar: neyro-noqat'iy model, neyron tarmoq, mashinali boshqarish usullari va algoritmlari, tashhislash metodlari.

INTRODUCTION

The theory of fuzzy sets is a direction of artificial intelligence and allows you to build fuzzy models of objects using linguistic variables and a fuzzy inference mechanism. At present, fuzzy logic methods developed by fuzzy expert systems (ES) are widely applicable for the management, diagnostics, coordination, support of management decisions during the operation of extraction columns.

Models and diagnostic algorithms for extraction columns allow computers to quickly and accurately analyze huge volumes of data. This includes the ability to accurately sift signals and noise in seismic data. After this information has been collected and analyzed, modern software applications can build accurate fuzzy logic models. This allows field investigators to accurately predict what is below the surface before launching the extraction plants.

MODERN APPLICATION IN MODELING

An example of the application of diagnostics of the operation of extraction plants can be seen in the Dutch Northern City. The use of software systems allows engineers to automatically monitor mechanical, temperature, chemical influences, the possibility of leakage during the operation of extraction plants. At the same time, the latest generations of algorithms give more detailed and accurate results than any previous modeling. These algorithms also do not lose their accuracy when they are asked to analyze difficult terrain and conduct diagnostics. Faults or stratigraphic complex areas can be accurately mapped in detail. There is always a need to test models. This technique of diagnostics of work proves itself as a quick and high-quality study of the desired situation and the development of the necessary model.

Such software developments will allow improving the control process for the main operating parameters, avoiding clogging of pipe nozzles and plate openings with coke, preventing the ingress of flammable liquid from the column into the steam vents, preventing column vibrations, reducing erosive wear during oil distillation, and ensuring the performance of robust QC data management algorithms. Despite these achievements, it takes time to fully understand the advantages of machine learning in the process of introducing neuro-fuzzy methods for diagnosing the processes of extraction columns, which will show visible advantages. A detailed, accurate and reliable model and the information obtained through machine learning is invaluable. This allows you to know for sure, calculate the full phase equilibrium on the plates of the ratification column, the main indicators of heat transfer, liquid separation, the presence of impurities, hydraulic resistance, mechanical strength of all running processes of the extraction plant. This allows you to solve problems almost before they occur. Using these models, companies can save money and increase productivity. It is clear that this will be an invaluable application for oil and gas operations [1-3].

METHODS

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SCIENTIFIC AND TECHNICAL JOURNAL MACHINE BUILDING

№5 (Махсус сон) I том,
2022 йил
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In the process of operation and operation of extraction plants, the methods of mathematical modeling, fuzzy logic, artificial neural networks, applied statistics, data visualization, and object-oriented programming are used to solve the main problems.

The system of neuro-fuzzy rules is applicable for diagnosing problem solving in the oil industry, which is highly effective when using mathematical and software. The structure of the necessary software and its compliance with the tasks and methods of work are presented in Figure 1 [2, 4].
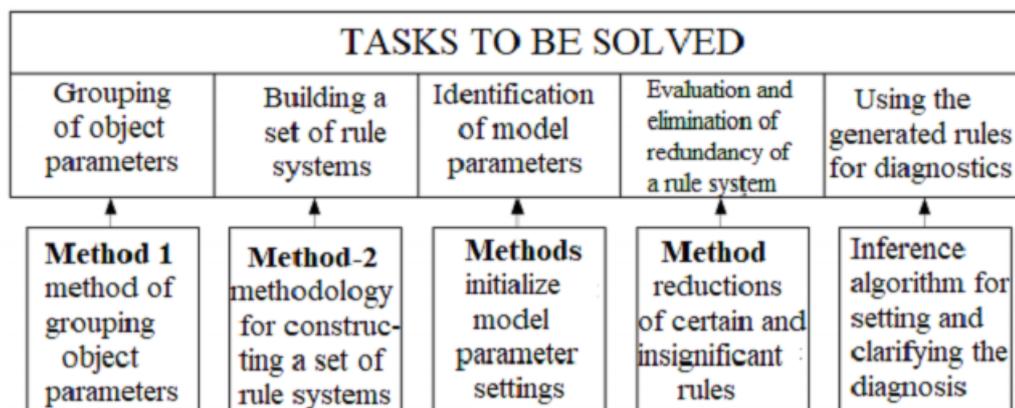

Fig.1. Composition of the support system in accordance with the tasks to be solved.

The system for diagnosing situations during the implementation of the mechanisms of operation of extraction columns is an automated system for:

- triggering alarm protection in the event of a need for an emergency stop of the local network and automatic control over the main parameters, taking into account the work of automatic control systems in case of fire during the operation of the extraction column;

- Prevention and presence of emergency gas contamination;

- triggering of the safety valve system in case of accumulation of excessive amounts of vapors and gases as a result of increased pressure in the presence of malfunctioning auxiliary systems;

- to control the level of minimum and maximum pressure at the inlet and outlet of the pump; tracking temperature indicators at the pump inlet and pump outlet;

- to account for the maximum pressure and temperature of the oil;

- to diagnose indicators of system damage;

- to control the integrity of cables and voltage.

Depending on the response parameters of the protective system, all elements of the reactor installation system may be simultaneously or alternately switched off. Reliability and safety of oil and gas facilities security systems depends on the state of electronic and programmable electronic emergency protection systems -EPS. Such systems should remain operational even in the event of failure of other extraction functions.

The main tasks assigned to such systems:

- prevention of accidents and minimizing the consequences of accidents;

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- blocking of any interference with the technology of the facility, which leads to the development of a dangerous situation and the triggering of emergency protection.

STATEMENT OF TASKS

The main tasks of diagnosing neuro-fuzzy models for oil refining facilities are as follows:

1. The selection of the desired model for determining the state of the object, taking into account neuro-fuzzy rules and grouping of the main parameters of the object,

2. Identification of the main parameters of the fuzzy-production model for determining the state of an object based on the development of effective computational methods using computer technologies.

3. Solving problems for the formation of fuzzy rules in the diagnosis of systems used in oil refining.
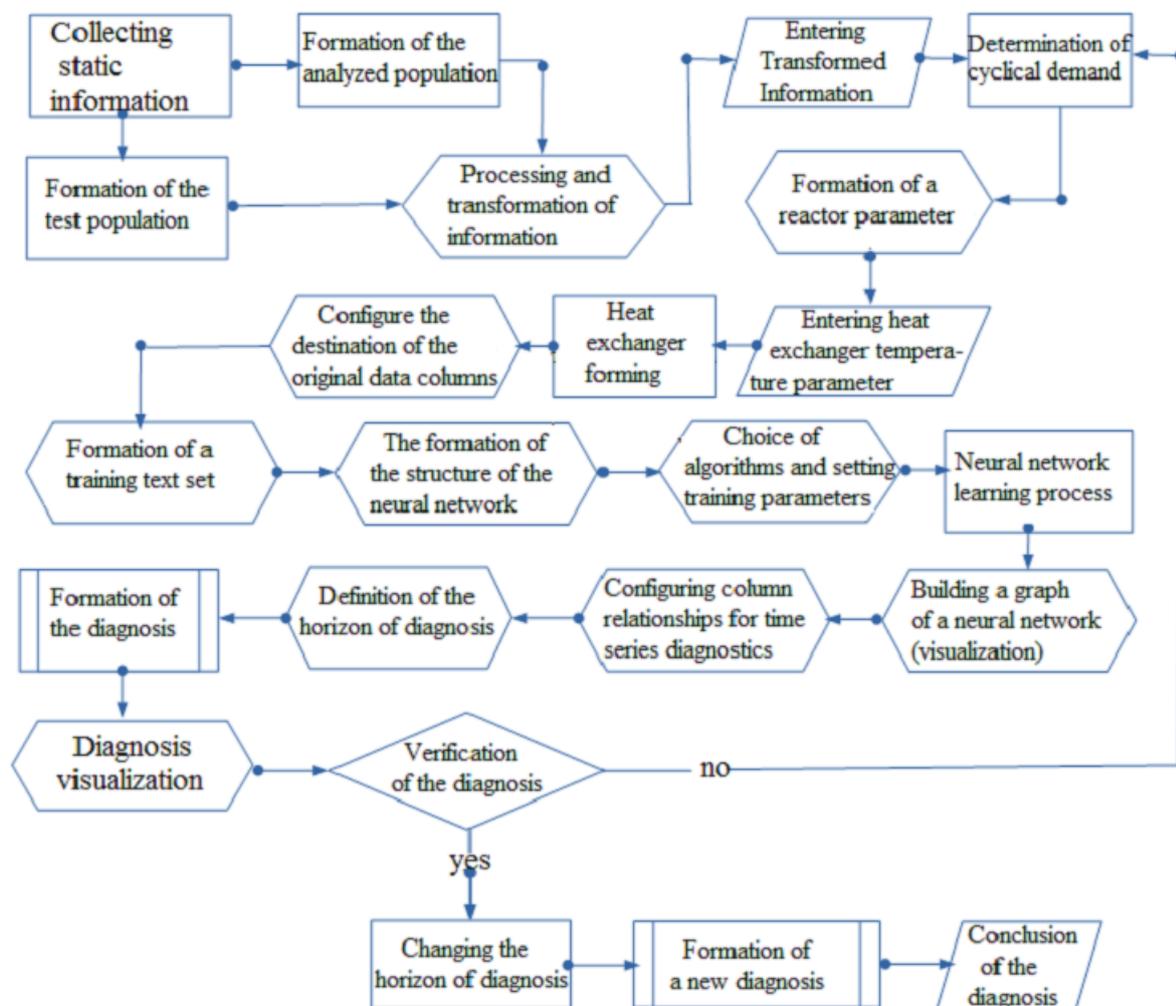
The neural network system is shown in Figure 2.

Fig. 2. Diagram of a neural network for diagnosing situations.

Today, development and research in the field of neurobionics are constantly expanding and functionally growing [5]. The basis of the neurocomputer is the neural network model, which are the basic components of neuroparadigms that allow you to read and recognize complex printed characters and handwritten characters, recognize images and fragments, use the technique of algorithmic methods taking into account the main features, and use associative memory [6-8].

MATHEMATICAL MODEL

Neuro-fuzzy models can be implemented in several ways and grouped into classes of networks of direct distribution and feedback. The types of networks can be found in Figure 3.
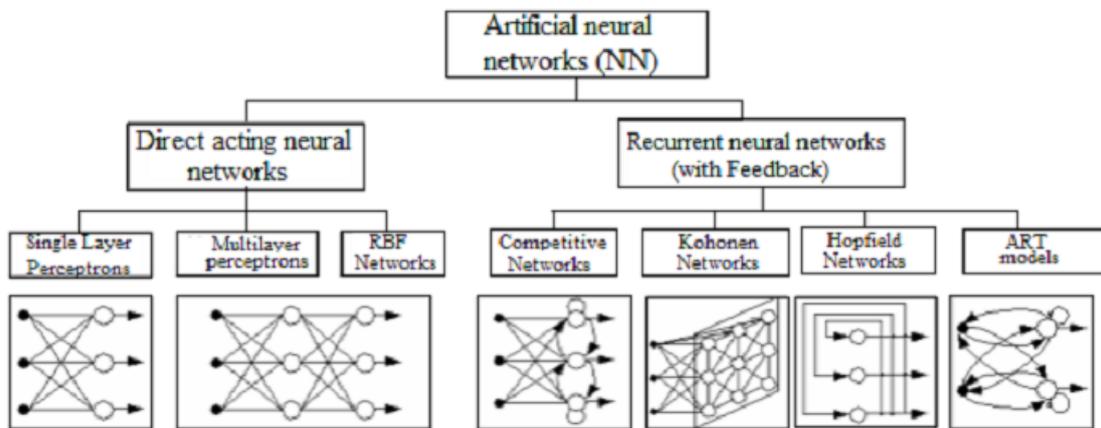

Fig. 3. The structure of the network of neural connections-direct and reverse propagation.

As can be seen in Figure 3, the neural networks of the first class — in the multilayer perceptron, have the arrangement of neurons in layers and the connections between the layers have the same direction. Direct impact networks produce one set at the input and output, are independent of the previous state of the network, and are static. The sets of feedback links modify the inputs of neurons and result in a change in the state of the network [2,7,10].

The neurons themselves and its structure consists of several inputs (synapses, adder, non-linear converter to output), see Figure 4.
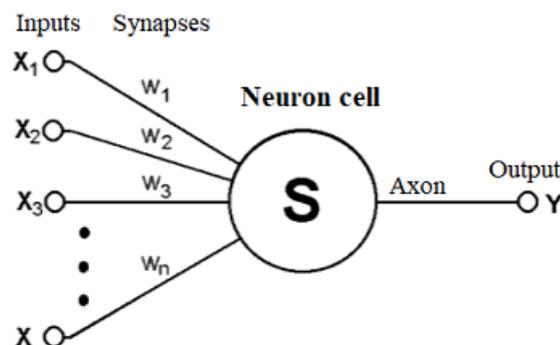

Fig. 4. The structure of the neuron

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$$S = \sum_{i=1}^{n} x_i * w_i \; ; \; Y = F(S)$$

Signals to the output of the neuron output the previous layer. In this case, the signals are multiplied and fed into the adder. The signals from the adder are transmitted to the input of the transducer, which activates the neuron. In order for a neural network to perform certain specified functions, it must be trained. At the same time, in the learning process, the necessary values are selected that provide a minimum of erroneous functions to obtain the desired output signal vector for a given input vector.

PROBLEM SOLVING

In connection with the widespread use of installations for extraction columns, much attention is paid to solving problems to ensure effective control of the existing extraction fund, equipped with them and assessment of the technical condition of the equipment during its operation at the oil and gas enterprise [10].

6.1. Proposed approach. In the framework of research, in order to increase the reliability of equipment, it is necessary to develop a monitoring system and test it on the example of the installation. The structure of this system includes the formation of a database; updating and processing the database; calculation and analysis of reliability indicators; forecasting reliability indicators; making decisions to improve the reliability of the facility.

We give a brief description of the main stages of the diagnostic system. The formation of the database. A database is formed on the basis of actual and regulatory parameters that characterize and show the degree of reliability of the facility from the start of operation to the present moment. For the most correct forecasting, certification is carried out. The database is constantly updated in real time twice: before and according to the results of analysis and forecasting.

Database processing is carried out in accordance with the results of processing of each object at different levels, taking into account the creation of a set of reliability indicators that characterize the ability of the object to maintain operational parameters within specified limits.

Calculation and analysis of reliability indicators. At this stage, single and complex indicators of equipment reliability are calculated. Since the measured indicators have their own weight and strength, an expert assessment method is needed. Each indicator, both single and complex, has its own weight coefficient. N_{ext}, the analysis is performed on the integral indicator N_{sist} by comparing with the normative N_{norm} and critical values $N_{cr(n)}$. The purpose of the analysis is to identify the "weak link" and decide on the need for technical intervention.

Diagnostics of reliability indicators. To diagnose the reliability indicator under consideration, a method based on artificial neural networks will be used.

RESULT

Based on the results of the diagnosis, it is supposed to determine the times when the values of the reliability indicators are critical, and technical intervention will be required.

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Making decisions to improve the reliability of the facility. In accordance with the obtained values, the duration of the interdiagnostic and overhaul periods is adjusted (Fig. 5). Decision making can be done by experts or an electronic expert system.
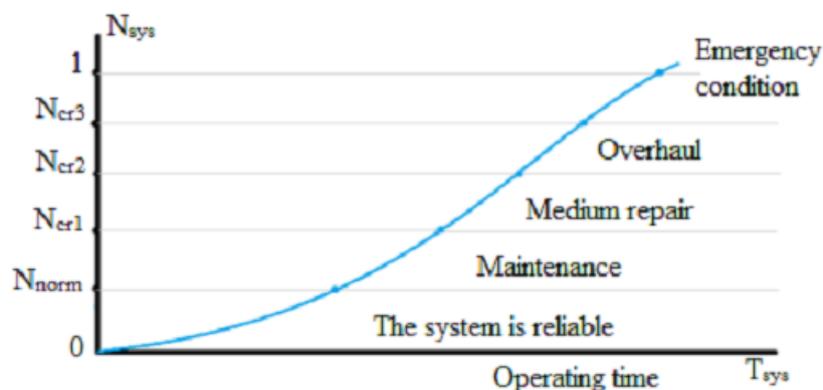

Fig. 5. Diagram of system reliability indicators

When $N_{syst} = (0; N_{norm}]$ - is not required;

When $N_{syst} = (N_{norm}; N_{cr1}]$ - maintenance;

When $N_{sist} = (N_{cr1}; N_{cr2}]$ - average repair;

When $N_{syst} = (N_{cr2}; N_{cr3}]$ - overhaul, the object can go into emergency condition at any time.

The prediction will be carried out due to the work of a program based on the mathematical apparatus of artificial neural networks, such as: a multilayer perceptron; radial basis functions (RBF); exponential smoothing; ANFIS.

To organize training of a neural network, it is necessary to have a set of training data. Such data can be recorded technological parameters of the operation of the extraction column (EC) in the format (txt). The priority tasks of the system are to create the possibility of conducting an operational assessment and predicting the state of EC in the operation mode.

CONCLUSION

Analysis of existing neuro-fuzzy models shows that the choice of model type depends on many factors. As a main focus, neuro-fuzzy models are used to increase "intelligence", learning speed, adaptability online, achieve a global level of errors and low-cost computing. Many neuro-fuzzy models use controlled and uncontrolled methods to recognize various parameters of the output system. In addition, neuro-fuzzy models allow you to constantly monitor and control the system of oil and gas equipment, as well as diagnose all systems at the input and output of the industrial process.

In other words, today the use of neuro-fuzzy models for the synthesis of automatic control systems has several advantages, but at the same time, this area needs to be constantly improved, new algorithms for solving problems should be introduced, the necessary directions should be tested, synthesis should be carried out constantly and the results obtained should be analyzed to obtain the best results in all the process of oil extraction, as well as

minimize the emergency situations that occur as a result of equipment failure or software overload more voltage. This direction of the development of diagnostics is especially in demand and is relevant in today's time when artificial intelligence and machine learning technologies are especially valuable.

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