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PROSPECTS FOR THE DEVELOPMENT OF ARTIFICIAL INTELLIGENCE IN THE ENERGY SECTOR

Abstract— Currently, there is an increase in the popularity of artificial intelligence, which is actively being implemented not only in the work of scientists, but also entrepreneurs. The rapid development of computer science and electronics has a positive effect on the prosperity of this area. People need intelligent machines for creative activity and solving complex problems, and therefore artificial intelligence is widely penetrating into such scientific fields as energy, economics, management and medicine. AI is one of the incredible areas of computer science, combining the enthusiasm of humanity and the latest developments in the field of computing technologies. In this article, special attention is paid to the use of AI in energy systems and processes, as well as potential directions for the development of neural networks in the future.

Keywords— artificial neural, neural networks, power systems, artificial intelligence, electric power, AI algorithms, human brain, artificial neural network, electric power industry, neural network model.

INTRODUCTION

Artificial intelligence (AI) is a concept that is difficult to define unambiguously. There are many different interpretations of this term, but they all converge to the general fact that artificial intelligence tends to model aspects of people's thinking using computer technology or solve tasks that would take a person much longer to complete. Moreover, the cognitive capabilities of the human brain are limited in the field of visualization and analysis of hyperspace systems, due to which AI-based algorithms have an advantage in forecasting, modeling, as well as in optimizing analytical tasks [1].

The concept of "artificial intelligence" contains the term artificial neural networks (ANNS) or simulated neural networks (SNNS). They are a significant part of machine learning and underlie deep machine learning algorithms [2,3]. The structure and name of neural networks are based on the biological neurons of the human brain, which mimic the way biological neurons interact.

Everything around us, including images, sounds, smells, tastes and sensations of pain, we perceive precisely thanks to neurons. Neurons are the smallest elements of the nervous system capable of detecting external influences and redirecting them to other neurons until this effect reaches the brain. Millions of neural cells are involved in this process.

Artificial neurons are equivalent to biological ones and collectively form an artificial neural network (ANNS) consisting of many layers that are divided into input, hidden and output layers connected to each other through neurons.

ANNS are trained on data, which in turn is necessarily divided into data for training (training, in order to increase the accuracy of making forecasts) and data for testing (checking the correct operation of the neural network). When the neural network reaches a high speed of forecasting, a tool appears, the use of which is possible in any field, whether it is image recognition [4] or speech [5].

AI in the electric power industry has been used to solve such problems as planning and forecasting [6], modeling [7,8], and management of various technological processes [9].

The purpose of this work is to consider the possibilities of a neural network in the electric power industry, as well as the prospect of their application in energy systems and processes. Due to the limited potential of the human brain, AI algorithms have superiority in the energy field, which can be applied in forecasting, as well as in optimizing certain energy processes.

APPLICATION OF ARTIFICAL INTELLIGENCE IN THE ELECTRIC POWER INDUSTRY

In our world, where knowledge and time are becoming more valuable every day, computer modeling is becoming key to obtaining information about complex power systems and devices in the shortest possible time. This technique is of particular importance in process optimization when it is necessary to perform several hundred calculations for a single case. It is important to note that such models are used in all areas of energy, starting with the modeling of specific devices and ending with the analysis of power systems at the national or regional level.

However, modeling of power systems is a time-consuming and time-consuming process due to the need to describe their behavior with the help of giant systems of equalization. Artificial neural networks are used as an alternative to the replacement model. At the same time, it is possible to create an innovative hybrid system by combining a genetic optimization algorithm with a neural network [10]. This allows you to create a high-precision replacement model that can give effective results in optimization, since its training is carried out on a large amount of data from the relevant areas.

In most cases of practical application of AI in the energy industry, the focus is on optimization and forecasting. Attempts to predict the demand for electric energy are becoming particularly popular, since data about it is available, and consumption itself depends on factors such as the day of the week, time of day, season and weather. These data represent a time series that can be successfully analyzed using various methods, including Kohonen networks [11] and neural networks [12]. Effective demand forecasting is critically important, given that electricity is difficult to store, and it is necessary to balance its consumption and production, because its shortage can lead to serious problems. In addition, it is impossible to instantly change the production capacity of power plants, so it is necessary to have a small surplus of electricity. Forecasting electricity demand has a huge role for large consumers, because their costs associated with it depend on it, the higher the forecast, the lower the costs.

AI is actively used in renewable energy systems [13,14,15,16]. Here artificial intelligence is used to predict weather conditions, in particular wind strength and insolation. Another example of the use of a neural network in the energy industry is the prediction of energy consumption of buildings [17].

In addition, the neural network can be used in the planning of power systems, determining the location of elements of the power transmission network, and the use of various types of RES [18]. Fuzzy logic methods can be used in such projects [19]. When designing power systems, this innovative approach contributes to the development of algorithms that help in the selection of various parameters for these projects [20]. It is important to note that expert systems can also be used in these projects to help in decision-making.

PROSPECTS ARTIFICAL INTELLIGENCE

A promising direction for the development of AI methods in the energy industry are intelligent power systems - Smart Grid [21,22]. The concept of Smart Grid is to improve standard electrical networks. An intelligent network will create a connection between all elements of the energy system, integrating small energy sources and smoothing the demand curve for electric energy. This approach will improve the efficiency of energy supply and reduce costs. However, its implementation requires a comprehensive plan and management, as well as changes in all components of the electrical network.

Many AI methods can be applied to design a modern intelligent network. It is also possible to use artificial intelligence to manage energy consumption on the part of consumers. To control the operation of chargers in the office or at home, it is necessary to build a system that will be controlled by artificial intelligence. This would allow charging devices during periods of low demand for electricity. However, it is necessary to take into account the demand for services of a different nature – these patterns can be taken into account with the help of properly configured neural networks.

Another equally important direction in the study of the field of optimization of power systems is the definition of an AI algorithm that would correspond not only to the qualitative, but also to the quantitative characteristics of the problem. Ashraf and colleagues [23] proposed classifying the operation of the power system into the following levels: strategic, system and component. Performance indicators that are associated with the system and component levels have highly nonlinear characteristics. The function obtained from these two levels is created in the hyperspace input space. That is why the functional space of input and output variables is very extensive, and building an effective functional map among variables is a difficult task. Artificial neural networks are an excellent algorithm for approximating functions and are able to create an effective predictive model, but only if hyperparameters are optimized and reasonable complexity is introduced into the architecture of the model itself. The studies described in the literature and related to the tasks of the system and component level of the power system are able to determine the competitive advantages of the artificial neural network model over other AI algorithms to create a generalized model [24].

On the other hand, at the strategic level, the operational problem has qualitative features, as opposed to quantitative, related to the system and component levels. At the strategic level, the problem can be modeled based on the available operating parameters of the system level, the number of which is not so small in comparison with the performance at the component level, such as shaft alignment, pressure, level and temperature of the bearing lubricating oil, vibration of the pump impeller and others. Therefore, AI algorithms originally designed for classification tasks, such as the support vector Machine (SVM), and their variations, such as the support vector regressor (SVR), may be preferable and demonstrate more efficient operation compared to artificial neural networks. Studies published in the literature comparing the performance of ANNS and SVR for strategic-level tasks (modeling the thermal efficiency of power plants) show the best results in generalizing and modeling SVR [23]. Nevertheless, future studies may consider different power systems and conduct a comparative analysis of the performance of AI models depending on the qualitative and quantitative characteristics of the problem.

ANNS has shown outstanding results in various areas of energy growth, starting with optimization and forecasting, and ending with diagnostics and troubleshooting. Below are examples of how artificial neural networks are used in power systems:

1. Load forecasting: artificial neural networks are successfully used to predict the demand for electric power. energy. This is critical for system operators to ensure a stable and efficient power supply. An artificial neural network is able to take into account various factors, such as time of day, weather and previous consumption indicators, for a more accurate forecast of future demand [25,26].

2. Renewable energy forecasting: Artificial neural networks are used to predict the production of electrical energy from renewable sources, for example, such as wind and solar energy, which can vary significantly. Accurate forecasts make it possible to integrate these sources into the energy network more efficiently [27,28].

3. Optimization of electricity consumption: artificial neural networks are used to optimize the operation of power systems, including the distribution of energy resources, determining the optimal schedule of power plants, as well as the creation of energy management systems. Artificial neural networks study historical data in order to identify trends and patterns that contribute to increasing efficiency in energy consumption management [29,30,31].

4. Diagnostics and troubleshooting: Artificial neural networks can be used to diagnose and identify malfunctions in power systems, including identifying the source of power failures and detecting equipment malfunctions. Timely detection and diagnostics help prevent interruptions in the supply of electrical energy and significantly increase the reliability of the power system [32,33].

5. Electricity trading and pricing: an artificial neural network is used to build models and predict prices for energy carriers, which helps traders make more informed and informed decisions about the sale or purchase of electricity. Artificial neural networks analyze various factors affecting prices, such as supply, demand, weather conditions and geopolitical events [34,35].

6. The role of artificial intelligence in zero outliers: The algorithm of artificial neural networks is an effective method of approximation of functions and is able to create an effective model for systems with fuzzy parameters. During the analysis of this system, this algorithm has demonstrated its effectiveness in predictive modeling. Nevertheless, the real potential of the artificial neural network in particular, as well as other AI algorithms in general, requires further study. The main barrier preventing the implementation of an artificial neural network model in large-scale industrial programs and applications for management, modeling and decision support is associated with

the so-called "black box" of this algorithm. Nevertheless, studies published in the scientific literature show the successful use of the results obtained with the help of artificial neural networks in the context of the operation of power plants [36]. Using the developed model of an artificial neural network, an analysis based on expert knowledge in the relevant field is performed, and the results obtained, analyzed by engineers, are then integrated into the operational activities of power systems. Improvements in enterprise productivity, such as increasing energy efficiency, reducing emissions and reducing operating costs, can be achieved through real-time optimization using an artificial neural network model. Thus, contributing to the cleanliness of the environment becomes more accessible [23].

CONCLUSIONS

Eight decades is quite a long period, but in the context of the development of science, it is not enough to conclude that artificial intelligence is an established field with rigidly fixed methods. We are still striving to create a computing machine with an intelligence comparable to that of a human. Although we already recognize the human brain as a kind of computer, many of its functions still require in-depth study:

1. In the period from 1960 to 1980, clear goals with expectations of achievement were formulated in the field of AI. The main task was to program computer technology to perform intelligent tasks. However, this approach has not always been successful, but each failure has contributed to the emergence of new ideas and directions for development. In today's AI and ANNS research, there are no rigidly set goals; most scientists consider ANNS as a tool, expanding the scope of AI, without the need to create new algorithms.
2. In the field of AI research, it is important to consider the following aspects: whether there is an interest in developing products that include AI methods; determining the circle of people interested in such research; what opportunities these studies provide and what are their prospects.
3. The use of ANNS is growing due to a significant reduction in computing time, which makes them more efficient compared to expert methods that require several hours of work. Over the past few years, AI has begun to surpass humans in some areas, which implies the emergence of more and more advanced algorithms. Advancement in AI demonstrates how creative and productive the human mind is.

AI offers a huge range of solutions waiting to be applied in real-world tasks. In a rapidly developing scientific field, such as energy, the use of AI seems extremely promising.

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