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Prevention and Protection of Urban Water Pollution Based on Neural Network

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Abstract: The water pollution control system is a complex multi-level system, which must be analyzed from the perspective of network and development. Only through quantitative analysis can the best choice to control pollution and achieve the best social impact be found. The latest development of modern science-system engineering technology and computer technology are used to solve the planning problem of water pollution control system. System engineering technology provides an ideal tool for this research, and computer is an indispensable tool for this research. The research and development in the field of machine intelligence has attracted more and more attention, and the ability and performance of computers continue to develop rapidly. Based on this, this paper first analyzed the elements of water pollution control planning, focused on the basic characteristics of water pollution control planning, and put forward the principles of water pollution control planning and the contents and means of water pollution control planning. Then, this paper designed the application of neural network technology in the field of urban wastewater treatment, and discussed the effect of neural network in the simulation and control of urban wastewater treatment process. The soft sensor of neural network for urban wastewater treatment was proposed, and the effect of neural network combined with other intelligent technologies for urban wastewater treatment was discussed. Neural network was used to strengthen the prevention and protection of water pollution. Through comparison, it can be seen that the perfection of treatment facilities after the new urban water pollution prevention and protection system was 33.2% higher than that before the prevention and control, and the pollution source prevention and control was 25% higher than that before the prevention and control. After using the new urban water pollution prevention and protection system, the real-time sewage purification rate was 0.33 higher than that before the traditional monitoring system, and the water resource protection degree was 0.25 higher than that of the traditional system.

1. Introduction

Due to the rapid development of industry and cities, a large amount of waste flows into rivers, lakes and oceans, causing serious water pollution. In order to control pollution and protect the environment, various wastewater treatment technologies have been studied, and a large amount of financial resources have been invested in the construction of wastewater treatment plants. However, with the development of water pollution technology in depth and breadth, the development and improvement of wastewater treatment technology has become a problem. Water treatment has not brought obvious economic benefits, and the cost of wastewater treatment has increased year by year. The use of neural network technology to design water pollution system can save a lot of money. Therefore, water pollution system planning is the basis of modern water quality management.

Neural network is widely used in water pollution prevention and control. Wang, Yubao believed that it was necessary to establish an environmental complaint reporting system to monitor and manage industrial water pollution in a timely manner [1]. Jenny Jean-Philippe reviewed the current and emerging threats of the world's large lakes, including the landmark examples of lake management failure and success, from which he identified the priorities and methods of future protection work. His review highlighted the degree of degradation of lake resources, which was the result of long-term cumulative disturbance combined with long-term human impact and other emerging pressure factors [2]. Sadler J M proposed a data-driven method. He used crowdsourcing data and environmental observation data to estimate the flood severity in the urban coastal environment [3]. Alnahit Ali O compared two machine learning methods to predict the water quality parameters of the watershed located in the southeastern Atlantic region of the United States [4]. Feng Xiaofang aimed to design typical and cost-effective heterojunction and Schottky liquid complex and its progress, mechanism and trend in the degradation of environmental organic pollutants [5]. Ji Mengzhi believed that wastewater was the breeding ground of many pathogens, which might pose a threat to human health through various water transmission routes [6]. The above studies have described the application of water pollution prevention and control. However, there are still some deficiencies in the research of neural networks.

Many scholars have analyzed and studied the prevention and control of urban water pollution. Tang Yankui proposed an escape method as a unit conversion to obtain a common basis for comparing concentrations. He successfully used this method to evaluate the probability risk of benthos by applying different matrices compared with the standard chronic toxicity baseline [7]. Feng Xiaofang aimed to design typical and cost-effective heterojunction and Schottky liquid complex and its progress, mechanism and trend in the degradation of environmental organic pollutants. In his paper, the heterogeneous catalytic mechanism of the degradation of organic pollutants by base photocatalysts was reviewed [8]. Dogo Eustace M reviewed the progress of detecting water quality data anomalies using deep learning methods, which could be further studied and used to detect anomalies in water quality data [9]. Guo Gaimei aimed to evaluate the impact of water pollution accidents on human body and ecosystem, and adopted a new average absolute deviation calculation method to measure the model error. He used the environmental damage model of water pollution accident to simulate the water pollution accident caused by phenol leakage [10]. Parameswari M believed that the Internet of Things had become the leading starting process of information and communication technology progress. In order to observe the level of water quality, he implemented various technologies in the field of water everywhere, such as drinking water quality monitoring, water quality management and irrigation water, lakes, treatment and ponds [11]. Thai-Nghe Nguyen introduced a framework with predictive models for the Internet of Things system to monitor water quality in aquaculture and fisheries [12]. The above studies have described the prevention and control of urban water pollution. However, there are still some deficiencies in

the research of neural networks.

In order to understand the specific development of urban water pollution prevention and protection, this paper analyzed the risks existing in urban water pollution prevention and protection, and studied the constituent elements of water pollution control planning, so as to better deepen the reform of urban water pollution prevention and protection. Compared with current urban water pollution prevention and protection, it is more accurate to use neural network algorithm to strengthen urban water pollution prevention and protection, and can build a more complete urban water pollution prevention and protection system.

2. Elements of Water Pollution Control Planning

2.1. Basic Characteristics of Water Pollution Control Planning

Water is the source of life. Without water, human society cannot develop. However, in the development history of human society, the understanding of water environmental problems has gone through twists and turns and paid a high price. The water pollution control system is an important part of the pollution control system. The essence of modeling and planning is the nature, economy and society related to water quality. Considering technology and other aspects, the ideas and methods of system engineering are used to analyze and adjust the relationship between the components of the water pollution control system to effectively affect the water quality at low cost [13]. Water pollution planning is a complex, multi-purpose and multi-level system optimization process, including environmental, economic and social coordination. Therefore, a reasonable water pollution planning scheme can not only significantly reduce investment and bring greater economic benefits, but also set regional limits on pollutant discharge, establish realistic environmental objectives and water quality standards, so as to evaluate the current relationship between water quality and environmental discharge. It plays an important role in selecting systems and wastewater treatment plants, optimizing wastewater treatment processes, and predicting the environmental impact of large construction projects, as shown in Figure 1.

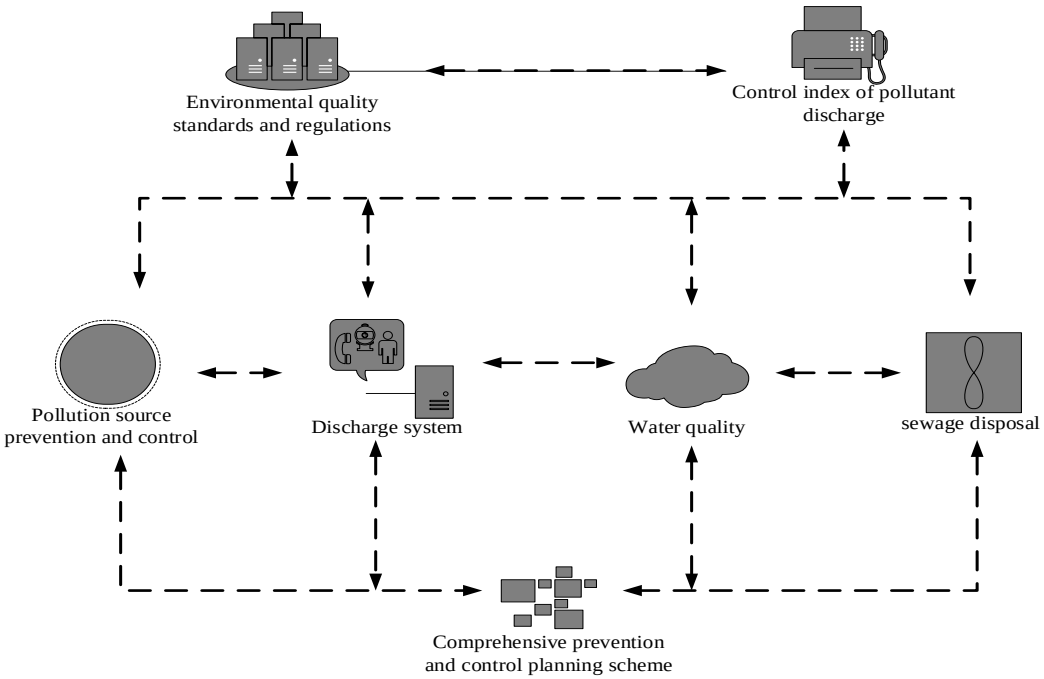


Figure 1. Basic characteristics of water pollution control planning

2.2. Principles of Water Pollution Control Planning

Under the guidance of environmental science and technology and socio-economic law, the dialectics of regional development, urban and rural agriculture and environmental protection are properly managed to optimize the ecological, economic and social comprehensive benefits. According to the environmental quality standards and regulations of the relevant countries, the nature, function and ecological characteristics of the "region" are defined. According to the needs of the people and the technical and economic level, environmental water quality indicators and a series of pollutant emission control indicators are considered to be formulated. Considering the quantitative relationship between wastewater treatment and water quality, the comprehensive water pollution management plan has been formulated. Through optimization solution analysis, the comprehensive efficiency of the regional water pollution control system is optimized. Advanced water pollution control technology is used to research and develop comprehensive engineering planning and water pollution environmental management planning to achieve system optimization efficiency.

The most effective and feasible planning option is to unify and coordinate the current situation and prospects, economy and water quality, overall demand and capacity, and subjective and objective components [14]. The basic concept of water pollution planning is to ensure the best environmental quality at the lowest economic cost. In water pollution planning, the economic benefits of wastewater treatment efficiency and the environmental benefits of material based treatment capacity can interact and adjust. These relationships are adjusted to meet water quality requirements and minimize the cost of the entire system.

2.3. Contents and Means of Water Pollution Control Planning

The specific aspects and research methods of water pollution control planning are closely related to their respective scopes. Water pollution control planning can generally be divided into three levels. Regional planning refers to water quality planning in complex catchment areas with urban and industrial pollution sources and non-point agricultural pollution sources. It can be divided into several stages: target planning, modeling, optimization, evaluation and decision-making.

In the planning process, the procedures are usually carried out alternately as needed. Then feasible options are obtained, and finally the best scenario is optimized through re-demonstration and coordination. In order to achieve the goal of optimizing the water treatment system planning, first of all, the water quality must be assessed by investigating the pollution sources and collecting water quality data. An appropriate water quality model is established. Compared with the calculation of the maximum allowable discharge of pollutants in water, the pollutant load trend is predicted to determine the water quality standard required to reduce the pollutant load in the planned year, and the best plan to reduce pollution under the conditions of economic development in the planned year, that is, to find the best plan to control pollution, as shown in Figure 2. Finally, on the basis of optimization by using mathematical model method, different aspects of the actual situation are combined to unify and coordinate the objectives, and a satisfactory experiment or actual protocol is selected.

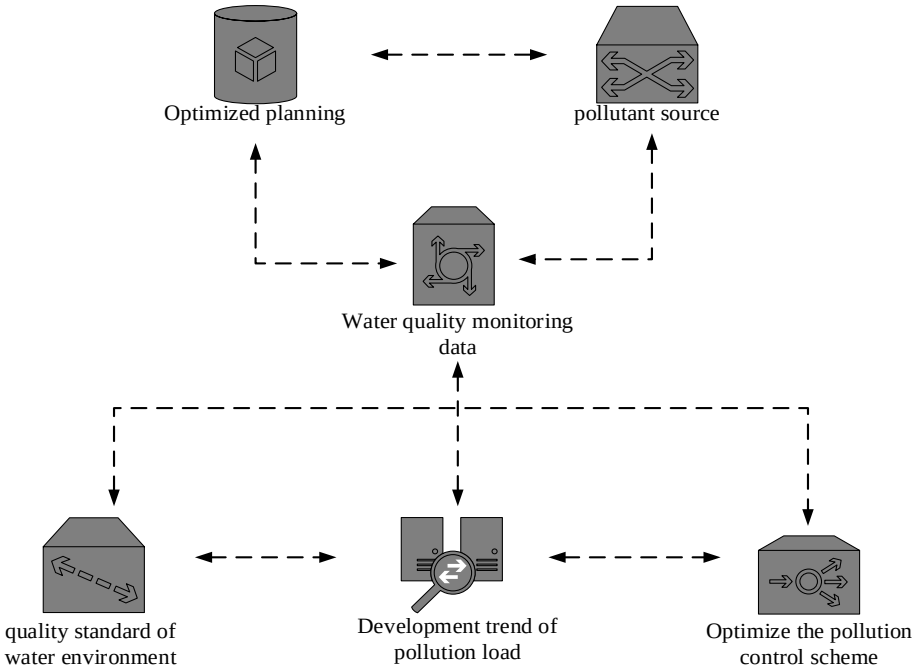


Figure 2. Contents and means of water pollution control planning

3. Application of Neural Network Technology in the Field of Urban Wastewater Treatment

3.1. Simulation and Control of Urban Sewage Treatment Process Using Neural Network

The municipal wastewater treatment system cannot obtain accurate mathematical model through mechanical analysis and mathematical conclusion, so it cannot provide a good control scheme. Neural network provides a new method to identify the model of urban wastewater treatment system. For ideal nonlinear system modeling, the real-time recognition process requires high algorithm recognition speed. Due to the complexity of the algorithm and the large computational load, many recognition methods are difficult to apply in practice. The neural network is composed of many parallel processing units. The use of fast parallel algorithms significantly improves the recognition speed. The neural network method used for system modeling is very simple. It does not need any prior knowledge. It only needs system input and output to identify the sequence structure of objects, which is a general recognition method. The prediction of specific parameter phenomena in urban wastewater treatment usually depends on many factors. The use of neural network to predict the parameters and phenomena in urban wastewater treatment can timely reflect and eliminate the abnormal phenomena in the process of urban wastewater treatment.

3.2. Soft Sensor of Neural Network for Urban Wastewater Treatment

Because the traditional method for measuring some water quality parameters takes a long time, the existing biosensors are expensive, short service life, narrow measurement range, poor stability, and do not meet the requirements of real-time monitoring. The existing stable and cheap online sensors can measure the current easy-to-measure parameters. The neural network model can predict the parameters that are difficult to measure in real time, which is the soft-sensing technology of neural network. At present, it is very active in the research of soft sensors for urban wastewater treatment. The soft sensor technology of neural network can measure many water quality indexes

online. For example, the concentration of nitrogen and phosphorus that cannot be detected online. In order to solve the problem of urban wastewater treatment quality index, neural network is developed and simulated. The results show that the method can accurately and real-time evaluate the quality of urban wastewater treatment and realize real-time control of the quality of urban wastewater treatment.

3.3. Combination of Neural Network and Other Intelligent Technologies for Urban Sewage Treatment

Based on the advantages and disadvantages of different intelligent control methods, when two or more intelligent control methods can accurately combine and absorb their advantages, an integrated intelligent control system with better performance than a single control system can be formed. Therefore, the combination of neural network, fuzzy control, expert system, genetic algorithm and other intelligent technologies to realize intelligent control of urban wastewater treatment process has attracted much attention. Based on the neuro-fuzzy model, the neuro-fuzzy fast prediction model of sewage treatment system is established to predict the response of high-speed anaerobic system to interference. The original data is used to generate the feature vector of fuzzy logic, and then the artificial neural network is used to classify the process state, identify the error or risk state, and solve the problem of pipeline blockage in real time, as shown in Figure 3.

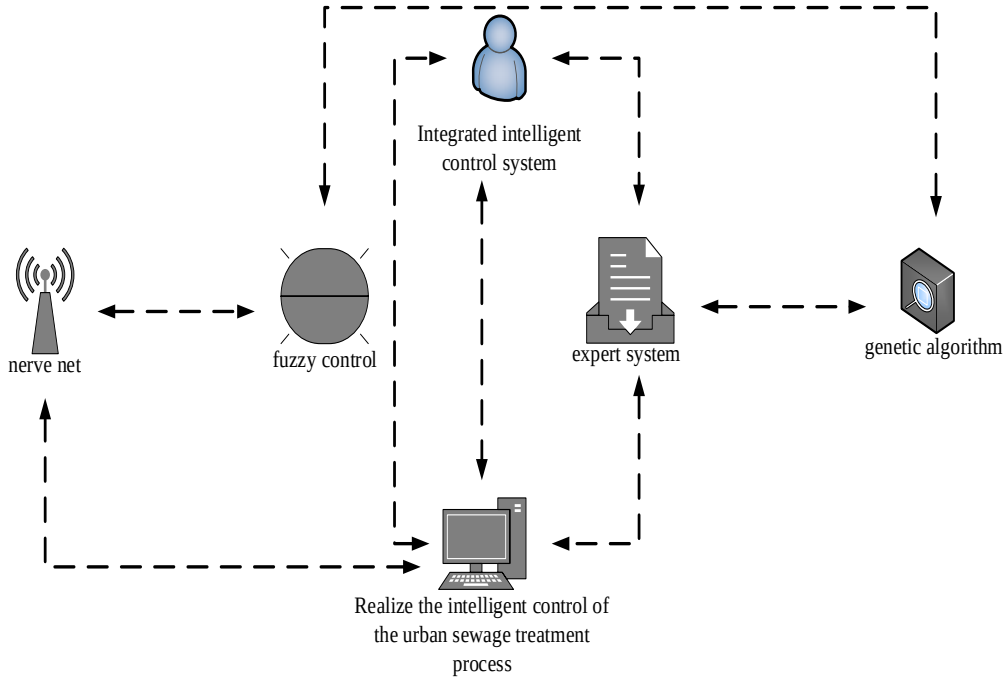


Figure 3. Integration of neural networks with other intelligent technologies

4. Use of Neural Network to Strengthen Water Pollution Prevention and Protection

The neural network is the input layer, and the multi-layer neural network includes the hidden layer and the output layer. Each layer of neurons has no connection. When the learning mode reaches the neural network, the neuron activation value is sent to each layer. The weight connected to the network continues to be adjusted according to the error between the actual value and the expected value to improve the accuracy of the model prediction.

Let the input and output values of the k-th neuron be:

$$net_k = \sum_i m_{ik} p_i \tag{1}$$

$$o_k = g(net_k) \tag{2}$$

The input and output of the j-th neuron of output are:

$$net_j = \sum_i m_{ij} p_i \tag{3}$$

The system average error of the neural network is:

$$T = \frac{1}{2p} \sum_p \sum_j (t_{pj} - o_{pj}) \tag{4}$$

Each weight adjustment amount of neural network is:

$$\Delta m_{jk} = \delta(t_j - o_j) o_j (1 - o_j) O_k \tag{5}$$

5. Experimental Investigation Based on Neural Network Algorithm

In order to study the specific effect of urban water pollution prevention and protection system in practical application, this paper analyzed the perfection of treatment facilities and pollution source prevention in urban water pollution prevention and protection system. Neural network technology was used to build a new urban water pollution prevention and protection system. Then, the perfection of the treatment facilities of the new urban water pollution prevention and protection system and the prevention and control of pollution sources were analyzed. First of all, this paper investigated the perfection of treatment facilities and pollution source control in the urban water pollution prevention and protection system in three regions, and compared them with the indicators of the traditional urban water pollution prevention and protection system. The specific investigation is shown in Table 1.

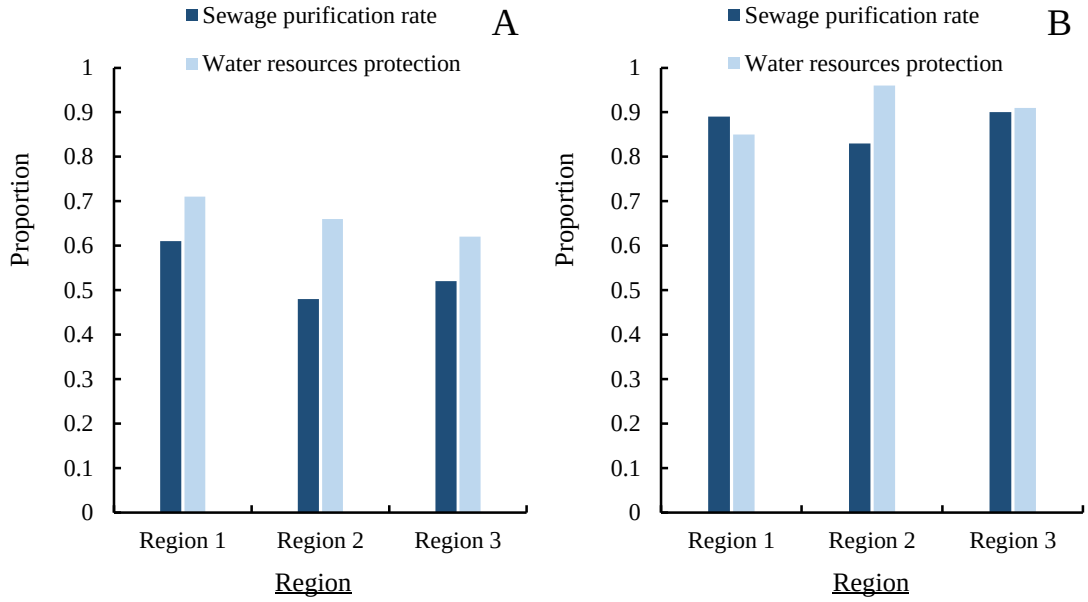
Table 1. Traditional and new urban water pollution prevention and protection system in the treatment facilities perfect, pollution source prevention and control effect

	Perfection of governance facilities		Pollution source prevention and control	
	Traditional system	New system	Traditional system	New system
Region 1	56.1%	87.6%	62.3%	85.5%
Region 2	49.6%	81.4%	68.4%	91.3%
Region 3	53.9%	90.2%	58.8%	87.8%

According to the data in Table 1, under the traditional urban water pollution prevention and protection system, the perfection of treatment facilities in Region 1 was 56.1%, and the prevention and control of pollution sources was 62.3%. The perfection of treatment facilities in Region 2 was 49.6%, and the prevention and control of pollution sources was 68.4%. The perfection degree of treatment facilities in Region 3 was 53.9%, and the prevention and control of pollution sources was 58.8%. After the use of the new urban water pollution prevention and protection system, the perfection of the treatment facilities in Region 1 was 87.6%, and the prevention and control of pollution sources was 85.5%. The improvement degree of treatment facilities in Region 2 was 81.4%, and the prevention and control of pollution sources was 91.3%. The perfection degree of treatment facilities in Region 3 was 90.2%, and the pollution source prevention and control was 87.8%. Under the traditional urban water pollution prevention and protection system, the average

degree of improvement of treatment facilities was 53.2%, and the average degree of pollution source prevention was 63.2%. After using the new urban water pollution prevention and protection system, the average degree of improvement of treatment facilities was 86.4%, and the average degree of pollution source prevention was 88.2%. Through comparison, it can be seen that the perfection of treatment facilities after the new urban water pollution prevention and protection system was 33.2% higher than that before the prevention and control, and the pollution source prevention and control was 25% higher than that before the prevention and control.

The neural network algorithm was used to analyze the real-time sewage purification rate and water resource protection degree of three regions after using traditional and new urban water pollution prevention and protection systems. The specific investigation results are shown in Figure 4.



A. Traditional urban water pollution prevention and protection system

B. New urban water pollution prevention and protection system

Figure 4. The efficiency of the traditional and new urban water pollution control and protection system

Figure 4a shows the traditional urban water pollution prevention and protection system, and Figure 4b shows the new urban water pollution prevention and protection system. It can be seen from Figure 4a that after using the traditional urban water pollution prevention and protection system, the real-time sewage purification rate of Region 1 was 0.61, and the water resource protection degree was 0.71. The real-time sewage purification rate of Region 2 was 0.48, and the water resource protection degree was 0.66. The real-time sewage purification rate of Region 3 was 0.52, and the water resource protection degree was 0.62. It can be seen from Figure 4b that after using the new urban water pollution prevention and protection system, the real-time sewage purification rate of Region 1 was 0.89, and the water resource protection degree was 0.85. The real-time sewage purification rate of Region 2 was 0.83, and the water resource protection degree was 0.96. The real-time sewage purification rate of Region 3 was 0.90, and the water resource protection degree was 0.91. Through comparison, it can be seen that the real-time sewage purification rate after using the new urban water pollution prevention and protection system was

0.33 higher than that before the traditional monitoring system, and the water resource protection degree was 0.25 higher than that of the traditional system.

6. Conclusion

The control system based on neural network has strong learning ability, but it also has disadvantages. Integration with other management methods is an important direction of future research. Although neural network has powerful functions, it cannot replace the role of mathematical model of wastewater treatment mechanism. At present, neural networks and mechanisms can be perfectly combined. Few mathematical model studies need to develop standardization and application methods to measure model parameters. Through theoretical and application studies, control methods applicable to different wastewater treatment process control parameters are determined. Finally, the combination of neural network management and model management is found. It is necessary to strengthen the research of wastewater treatment and actively carry out the application research of molecular biotechnology and biochemical analysis. On this basis, reliable and high-quality biosensors have been developed for practical wastewater treatment processes. Therefore, neural network technology has been widely used in practical engineering.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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