Fuzzy Neural Network Algorithm in Improving Electrical Engineering Control System

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Abstract. In the current era of rapid development of big data technology and artificial intelligence technology, China's comprehensive national strength has also been significantly enhanced, the rapid progress of science and technology makes the electrical engineering control system whether in terms of efficiency and quality of the application, its electrical engineering control system development is gradually improved with the support of high-tech. Based on artificial intelligence technology, neural network algorithms and improved neural network algorithms are proposed to improve the original electrical engineering control system. In this paper, the S electrical engineering control system is the main research object, and its addition of fuzzy neural network algorithm to improve the study. Firstly, on the basis of a simple description of S electrical control system, the research status of the main partition control blocks of S electrical control system is analyzed. Secondly, an improved intelligent control system, including intelligent service interruption system and central electrical control system, is proposed to design an improved electrical engineering control system based on neural network algorithm through the operation principle of sensors and the study of network communication technology. Based on the above research basis, the effectiveness and practicality of the proposed intelligent electrical engineering control system are verified by analyzing the effects of the proposed intelligent electrical engineering control system in real life. The experimental results show that although there are still many problems in the intelligent control system of three-phase electrical engineering at this stage, innovation and technological progress will continuously improve the comprehensiveness and intelligence level of the system.

Keywords: Fuzzy Neural Networks, Electrical Engineering, Control Systems, Ncs Control Models

1. Introduction

With the continuous development of big data technology and artificial intelligence technology, the accuracy and automation degree of electrical control system is higher and higher. Therefore, in order to promote the automation control system, we must correctly understand and solve the problems existing in the control system [1]. Under the background of information technology, the integration of information technology and electrical system has become the general trend. Through strengthening
cooperation, real-time monitoring and data sharing of production and operation of electrical equipment manufacturers can be realized, and the industry competitiveness and comprehensive level of electrical equipment enterprises can be improved to a certain extent [2]. In addition, it can also promote the coordination among various departments of power equipment enterprises, save operating costs and improve management efficiency to a certain extent [3].

Electrical engineering control system has broad development prospects, and the development of China's electrical engineering has also put forward a long-term development strategy [4]. In the future, the development trend of electrical engineering control system is unified management, that is to implement comprehensive management in product design, testing, operation, debugging and maintenance, and finally meet the various needs of different customers [5]. The continuous innovation and use of electrical engineering control system can guide the rapid development of intelligent electrical equipment, making the construction of electrical automation control system has a longer future [6]. At the same time, in the process of electrical control system design, we should vigorously promote the purpose and innovation of the system, in order to achieve its great leap forward development [7].

Electrical engineering control technology benefits from the continuous development of computer technology, which provides good theoretical and technical advantages for intelligent technology [8]. Through the analysis of computer intelligent technology, the purpose of automation technology is to replace manual operation, so as to operate more conveniently and accurately. There are data analysis, language recognition and image processing. Intelligent technology mainly analyzes the collected technology through computer network. After analysis, computer intelligence operates or displays the data, which is convenient for manual operation and accurate operation, greatly reducing the allocation of human resources [9]. Electrical control system, often with complex management and use, many also have certain risks. For the intelligent electrical control system, the main goal is to facilitate the adjustment and control of the system, that is to realize the remote control of adjustment and control [10].

2. The establishment and improvement of the fuzzy neural network algorithm

2.1. Clustering algorithm analysis of fuzzy averages

The algorithm uses a fuzzy algorithm to plan the matrix division of membership, and then the optimal clustering is carried out according to each different sample and different degree of attribution. The objective function of the algorithm is to weight the product of the distance to measure the membership of the expected formation.

Therefore, this article for which object's dataset X is classified when fuzzy clustering, remember as the center of the cluster, and the matrix of membership is a fuzzy matrix, each element of this matrix is valued between 0 and 1, so according to the basic principles of the above analysis can be listed as the formula (1) as the target function:

$$J(U,V) = \sum_{i=1}^{n} \sum_{j=1}^{c} u_{ij}^m d^2(x_i, v_j)$$

subject to $0 \leq u_{ij} \leq 1, j = 1,2, ..., c$

$$\sum_{j=1}^{c} u_{ij} = 1, i = 1,2, ..., n$$

Where the fuzzy knowledge m value is generally taken 3, where the smaller the distance of the formula means that the greater the similarity, in addition, if the target function can reach the value of the smaller, it means that the algorithm clustered out of the results are better.

Therefore, if the objective function is 0 for the partial guide of the two values, the minimum value of the above formula (1) is necessary as shown in formula (2):

$$v_j = \frac{\sum_{i=1}^{n} u_{ij}^m x_i}{\sum_{k=1}^{c} u_{kj}^m}$$
\[ u_{ji} = \frac{1}{\sum_{k=1}^{c} \left( \frac{d(x_i, v_j)}{d(x_i, v_k)} \right)^{m-1}} \]  

(5)

Therefore, we will U and V each element iteratively near formula (2), and finally find the best to make the target function to the smallest, so as to determine the optimal class of sample data.

2.2. The establishment of the fuzzy algorithm similarity measurement-distance function

(1) European distance: The distance function is widely expressed in many forms with its direct view. The European distance (ED) is expressed as follows:

\[ d(x_i, x_j) = \sqrt{\sum_{k=1}^{m} (x_{ik} - x_{jk})^2} \]  

(6)

At the same time, the improved weighted European distance representation is:

\[ d_{ED} = d(x_i, x_j) = \sqrt{\sum_{k=1}^{m} \omega_k (x_{ik} - x_{jk})^2} \]  

(7)

The formula for its performance is as follows:

\[ \omega_k = \frac{v_k}{\sum_{k=1}^{n} v_k} \]  

(8)

\[ v_k = \frac{s_k}{\bar{s}} \]  

(9)

2.3. Two-order fuzzy neural network clustering algorithm analysis

In order to quantify the good and bad in the clustering method, the accuracy of this paper is considered to be a nuclear evaluation criterion, and the calculation formula of precision can be determined to be:

\[ P = \sum_{k=1}^{c} \frac{|H_i|}{n} \times \max_{q=1,2,...,c} p(K_q, H_i) \]  

(10)

\[ p(K_q, H_i) = \frac{|K_q \cap H_i|}{|H_i|} \]  

(11)

where c is the number of clusters and k is the number value of the tag class.

Following the above formula, the updated cluster center matrix is calculated iteratively, where the membership can be expressed as follows:

\[ U' = \begin{bmatrix} u'_{11} & \cdots & u'_{1n} \\ \vdots & \ddots & \vdots \\ u'_{r1} & \cdots & u'_{rn} \end{bmatrix} \]  

(12)

Among them:

\[ u'_{ji} = \frac{1}{\sum_{k=1}^{r} \frac{\left| u_i - u_k \right|}{\left| u_i - u_{ij} \right|}}, i = 1, 2, ..., n; j = 1, 2, ..., r \]  

(13)

Finally, the original label in the dataset is marked as B, where the category to which the nth data sample sequence of a given label species belongs is marked as K, and the final represents as follows:

\[ K_q = \{ x_i | b_i = q, i = 1, 2, ..., n \}, q = 1, 2, ..., c \]  

(14)

Comparing this with the set obtained above, the accuracy rate of the improved electrical engineering control system proposed in this paper is calculated by formula (14), i.e. the correct rate of clustering P.

3. The electrical control system model is established

3.1. A continuous model of the electrical control system
First of all, this paper considers the electrical control system as a continuous control system analysis and design, and the controlled objects and controllers are described and analyzed using continuous state equations, and the accused linear objects are as follows:

$$\begin{align*}
    \dot{x}(t) &= Ax(t) + Bu(t) \\
y(t) &= Cx(t)
\end{align*}$$

(15)

In the above formula, $x(t)$ is the object state, $u(t)$ is the control input, $y(t)$ is the output, and $A, B, C$ is the real dimensional matrix, and the formula is either state feedback or output feedback, and the controller is using a continuous state equation to describe the analysis.

3.2. Discrete control system model

The electrical engineering control system as a discrete control system analysis and design, will be controlled by the object and its controller are to use a discrete state for return contempt, then the accused of the first object as follows:

$$\begin{align*}
    x(k + 1) &= Ax(k) + Bu(k) \\
y(k) &= Cx(k)
\end{align*}$$

(16)

In the above formula, $x(k)$ is the system state, $u(k)$ is the control input, $y(k)$ is the measurement output, and $A, B, C$ is the dimensional matrix, and the formula is either state feedback or output feedback, and the controller is using a continuous state equation to describe the analysis.

3.3. A mixed system model

The hybrid system contains continuous dynamic and discrete events, and the stability of NCS with network-induced delay can also be analyzed by means of hybrid system stability analysis.

$$\begin{align*}
    \begin{cases}
        x(t) = Ax(t) + Bu(t) + f(x(t), u(t), t), t \in I \\
u(t^+) = Cx(t) + Du(t) + \emptyset(x(t), u(t), t), t \in \emptyset
    \end{cases}
    \\
    H = \begin{bmatrix}
        e^{Ah} & B \\
e^{Ak} & CB + D
    \end{bmatrix}
\end{align*}$$

(17)

$$B = \int_0^h e^{A(h-s)}Bds$$

(18)

$$x(t) = Ax(t) + A_d x(t - \sum_{i-1}^c d_i(t))$$

(19)

$$0 \leq d_i(t) \leq d_i, d_i(t) \leq \tau_i$$

(20)

The linear object equation for loop $j$ is:

$$x^j_p(t) = A^j_p x^j_p(t) + B^j_p u^j_p(t)$$

(21)

3.4. We will strengthen the information construction of the electrical engineering control system and improve the efficiency of the decentralized control system

Distribution control system is a new type of computer control system, which is based on microprocessor and microcomputer distribution control, and integrates advanced CRT technology, computer technology and communication technology. During production, it uses multiple computers to control each cycle. The advantage of this control system is that it can obtain data in a centralized manner while managing and monitoring it in a centralized manner. At present, computers and information technology are developing rapidly.

4. Evaluation results

4.1. Experimental numerical analysis

Table 1. Fuzzy neural network algorithm data set constitutes an analysis table
The dataset | The number of samples | Dimension | The number of categories
--- | --- | --- | ---
Brea | 550 | 15 | 3
Cam | 120 | 7 | 3
Head | 120 | 86 | 2
Ionosp | 156 | 37 | 1

In order to be able to verify the proposed fuzzy neural network algorithm in the improved electrical engineering control system, this paper selects 4 different data sets for experiments, and analyzes the model of the fuzzy neural network algorithm in this paper by comparing it with other algorithms. In addition, the feasibility and accuracy of the fuzzy neural network algorithm in the actual electrical engineering control system are derived from the data collection in the experimental process. The results of this experiment are based on 4 sets of different quantities and the length of different sequences and the number of categories for data analysis and testing as shown in Table 1.

4.2. Analysis of the advantages of electrical engineering control systems

![Figure 1. 2015-2020 China's social electricity consumption (100 million kW)](image)

Since the Industrial Revolution, China's electricity application range is more and more extensive, Figure 1 for China's nearly five years of the whole society at all levels of the power consumption statistics.

With the widespread use of electric power in society, the corresponding electrical engineering and automation control systems are also developing rapidly, new control units, more innovative integrated systems are emerging, all towards a more comprehensive, more stable and more efficient direction. Learn to use tools to make humans stand out among thousands of species, and then develop civilizations and explore the mysteries of the universe. If mechanical systems make up the torso of a machine, then electrical engineering and automated control systems are the soul.

![Figure 2. Analysis of the error curve of the electrical engineering control system](image)

It is obvious from Figure 9 that the entire fuzzy neural network clustering algorithm has a relatively
high error of 0.8 in the first place, and its error will be greatly reduced after 1. Therefore, as the iteration steps increase the error value is decreasing continuously until iteration 1.6, its error value will reach the required accuracy. This process is relatively guided operation, the number of iterations is also significantly reduced, of course, can speed up convergence. This chapter gives a specific optimization algorithm and verifies that it can improve computational efficiency and convergence speed. In fact, the isolation layer is mainly in the output layer and the implicit layer design optimization algorithm, the algorithm finally used a common method according to the general inverse minimum number of paradigms and generalized inverse least squares to solve the linear equation system, but with the increasing number of adjustment parameters will also make the calculation cumbersome or delay time.

4.3. Combine electrical control systems with artificial intelligence technology

The electrical engineering control system is developed on the basis of modern scientific and technological information and is the product of the Internet age. Therefore, in the process of updating and upgrading electrical automation technology, attention should be paid to the combination of advanced artificial intelligence technology. Electrical automation can make the most of the advantages and advantages of the Internet and artificial intelligence technology. Ensure that the entire electrical system is up and running, effectively controlling the safety of the entire electrical system, so that even replacing one of the electrical equipment will not affect the normal operation of the other processes, and the entire system is still in a relatively complete state. Field bus control is undoubtedly an effective way to monitor.

5. Conclusion

In summary, this paper briefly analyzes the electrical control system, which should be innovated to meet the needs of the development of electrical engineering. Through the research and further innovation of high-tech, automation technology can reach a higher level. Therefore, the task is to add neural network algorithms to the electrical control system to solve the problem of the electrical automation engineering control system and develop it to a higher level.

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