Application of Smart Technology in the Design of Electric Automation Control System

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Abstract. Electrical automatic control (EAC) technology is currently widely used in factories. The EAC technology in the industrial production process is a technology that realizes the automation of the production process by integrating various electrical automation instruments, automatic control technologies, equipment and production processes. The application of EAC technology in factories can effectively increase labor productivity, reduce labor intensity, improve safety, and reduce the occurrence of production accidents, making an important contribution to the modernization of my country's manufacturing industry. In order to improve the control ability and automation level of the EAC system, it can meet the actual needs of current industrial production. This article has extensively reviewed relevant domestic and foreign literature, and summarized the current research status of smart technology (ST) applications in EAC systems. First, by analyzing and discussing the development of the EAC system and the application of manual ST in the field of electrical automation, the current research status of the application of electrical automation technology outside the factory summarizes the characteristics of electrical automation technology, including its simple, distributed and information development direction, and the diversity, flexibility, continuity, real-time and complexity of controls. And through case investigation, build case templates, use comprehensive quantitative and qualitative analysis methods, comprehensively compare the advantages of ST in the application of the EAC system, and use reliable data to support the scientific conclusions. The data results show that the use of ST will increase the control efficiency and automation level of the EAC system by as much as 50%. This shows that ST can improve the automation level of the EAC system and can meet the actual needs of current industrial production.

Keywords: Smart Technology, Electrical Automation, Control System, Industrial Level

1. Introduction
The rapid development of our country's market economy is inseparable from the support of industrial enterprises. The stable development of industrial enterprises and the improvement of production
efficiency depend on technological innovation, progress and technological application. The EAC system provides services for the daily production activities of the factory. It is the most effective means for industrial enterprises to improve production efficiency, ensure production and operation safety, and obtain good economic benefits. With the progress of technology and the continuous improvement of people's production requirements, the current EAC system is relatively backward in terms of control capability and automation level, and cannot meet the actual needs of current industrial production. Incorporating smart technology into the management of the EAC system can significantly improve the management level of the EAC system, which plays an important role in reducing costs, increasing profits and improving competition. Therefore, we should continue to innovate and develop in the EAC field to improve the level of my country's manufacturing industry.

At present, the use of ST in the EAC system has huge advantages, which can improve the control efficiency, performance and intelligence level of the system [1]. In recent years, many teams at home and abroad have conducted a lot of research, such as distributed control system (DCS). The distributed control system uses computer network technology to monitor, decentralize and manage the control process, and has good stability [2]. The use of centralized computer management and decentralized management and control methods can effectively solve the risk of a single computer's highly centralized control. Monitoring level, decentralized process control level, monitoring and production management level constitute the three main components of a distributed control system [3]. The basis of the system is the distributed process control layer. In the production process, distributed process control-level workstations complete data collection and distributed control functions respectively, avoiding the defects of control-level faults in the centralized control-level system that affect the entire production process. The purpose of the monitoring layer is: the data monitoring and operation in the production process can fully reflect the situation of each workstation and provide complete data for employees to intervene in the operating environment of the system; the management layer is the center of the entire system, which will be based on the monitoring layer, the information provided by the management is used to release production tasks and production requirements, and then summarize the entire system of reports that can fully reflect the working conditions, and specify the audit control plan and optimal control strategy for the next similar work [4]. Although the distributed control system has many advantages in dynamic control, the traditional distributed control system still has some problems. For example, due to the particularity and non-openness of human-machine interface software and hardware, the control software developed by various distributed control systems cannot interoperate, nor can it communicate with third parties. Finally, the system has not been better promoted. Another example is the team that applies artificial intelligence technology to the EAC system. EAC equipment will inevitably fail. ST uses its powerful analysis and diagnosis functions, and uses computer systems to accurately predict and predict system failures. In order to effectively improve the fault early warning and troubleshooting capabilities of the EAC system [5]. Therefore, the application of ST in electrified automatic control systems is the next major trend [6].

This article discusses the application of ST in EAC system in depth, proposes solutions to practical problems, and proposes that ST should be simplified, distributed and informatized in the application of EAC system. The characteristics of direction, control diversity, flexibility, continuity, real-time and complexity are expected to better promote smart technology to play a greater role in EAC systems.

2. Method

2.1 Characteristics of Electrical Automation Control Technology

EAC technology can help people obtain information through various tools and systems, process and determine various information for the daily production activities of the factory, so as to improve the production efficiency and EAC level of the factory through applications. Production level, labor productivity and operational reliability free people from programmable heavy labor and engage in more meaningful creative activities. The data acquisition mechanism of electrical automatic control technology is flow sensor, liquid level sensor, temperature sensor, pressure sensor and other sensors,
which convert various analog signals in production into electrical signals and input them into the automatic control system [7]. The mechanism of data processing and program execution is a logic circuit or programmable logic controller, which is used to calculate, control and process the collected information. The main actuators of EAC technology are electric motors, solenoid valves and limit switches. Through different functional actuators, electrical control of various functions is completed to realize the automation of factory production. Whether it is electrical systems, motor drive technology or electronic automation technology, this is an important condition to promote the sustainable development of modern, technological and automated factories [8]. The application principle of EAC technology in factories is to promote EAC technology to play its due role and provide guarantee for the sustainable development and smooth production of factories. EAC technology can only be effectively applied in the application process. Only factories can have greater application depth and breadth, and become an important technical link in industrial production [9]. In EAC, several formulas are very important, as shown below:

EAC constraint model formula:

\[ G_1(s) = \frac{1}{1+0.5sT_{sw}} \]  

Among them, \( G_1(s) \) is the value of the constraint model, \( s \) is the modal signal; "Tsw" is the delay time constant.

Control model expression:

\[ G_{eq}(s) = \frac{K_{eq}G(s)}{1+T_{eq}s} \]

Among them, \( G_{eq}(s) \) represents the value of the control model, \( s \) is the modal signal, \( K_{eq} \) magnetic density output gain, and \( T_{eq} \) is the time constant.

SPIDNN learning network formula:

\[ n_{eqt_j} = \sum_{i=1}^{n} w_{ijx_i(t)} \]  

Among them, \( n_{eqt_j} \) represents the proportion of each branch of the jth model in the total input of this neural unit, \( w_{1j} \) to \( w_{nj} \) represent the jth branch, \( x_1 \) to \( x_n \) represent Is the output constant.

2.2 Deep Learning Technology

Deep learning is a machine learning method using neural networks [10]. Depth refers to the neural network used contains multiple hidden layers, and learning refers to the process of determining the neural network model. Shallow neural networks (including a single hidden layer) have great limitations in practical applications, so most current researches use deep neural networks. The BP learning algorithm mentioned above is a commonly used training algorithm in neural networks and has good performance in training deep neural networks. The first-generation neural network is a single-layer, but a single-layer neural network can only solve linearly separable problems, and has great limitations in solving practical problems [11]. Since then, the development of neural networks has been stagnant because researchers have not yet found a learning rule suitable for multilayer neural networks. Before studying the BP learning algorithm, the BP learning algorithm adjusts the weighting coefficients iteratively to make the output gradually approach the known output target. The Convolutional Neural Network (CNN) proposed by LeCun is a widely used feedforward neural network. The basic model can be divided into two parts: one is responsible for feature extraction, which consists of one or more pairs of convolution and sub-sampling/maximum merge layers. The second is the classic fully connected multilayer perceptron, which takes the extracted features as input. The hidden layer composed of convolutional layer, pooling layer, fully connected layer and normalized layer can achieve better performance in some fields. CNN can also be trained using the BP algorithm, and it can achieve better performance than other deep neural network (DNN) models in some areas [12].
3. Experiment

3.1 Experimental Purpose
This article is based on the theoretical results of ST and electrical automatic control system, draws lessons from domestic and foreign theoretical research results, and uses methods such as theoretical analysis, literature research, and experimental methods. By analyzing and exploring the application scenarios, control performance and automation level of ST in electrical automation control systems, summarize the advantages and future development trends of ST in electrical automation control systems.

3.2 Experimental Design
This article uses the ST EAC system and the traditional EAC system as the experimental objects through the form of comparative experiment, and compares the current control and voltage control performance of these two systems. Each experiment is divided into three groups, and the average of the three groups is used for statistical data comparison, so as to obtain the advantage of ST in the electrical automation control system.

4. Result

4.1 Current Control Performance Comparison
Through the control performance simulation analysis, the traditional electrical automation control system and the electrical automation control system using ST are tested for current control experiments. The specific data is shown in Table 1.

**Table 1.** Current control performance test table

| Time (s) | 0.02 | 0.04 | 0.06 | 0.08 | 0.1 |
|---------|------|------|------|------|-----|
| Traditional system | 1    | 1.3  | 1.7  | 2.4  | 3   |
| smart system | 1.5  | 2.1  | 2.7  | 3.4  | 3.9 |

**Figure 1.** Current control performance test chart

It can be seen from Table 1 and Figure 1 that when the time is 0.02s, the current of the traditional EAC system is 1A, and the current of the smart EAC system is 1.5A. When the time is 0.04s, the current of the traditional EAC system is 1.3A, and the current of the smart EAC system is 2.1A; when the time is 0.06s, the current of the traditional EAC system is 1.7A, and the current of the smart EAC system is 2.7A.
system is 2.7A. When the time is 0.08s, the current of the traditional EAC system is 2.4A, and the current of the smart EAC system is 3.4A; when the time is 0.1s, the current of the traditional EAC system is 3A, and the current of the smart EAC system is 3.9A. It can be proved that the intelligent EAC system has better current control performance and higher efficiency than the traditional EAC system.

4.2 Voltage Control Performance Comparison

Table 2. Voltage control performance test table

| Time (s) | Traditional system | Smart system |
|---------|-------------------|--------------|
| 0.02    | 500               | 580          |
| 0.04    | 540               | 620          |
| 0.06    | 600               | 700          |
| 0.08    | 650               | 810          |
| 0.1     | 690               | 920          |

Figure 2. Voltage control performance test chat

It can be seen from Table 2 and Figure 2 that when the time is 0.02s, the voltage of the traditional EAC system is 500V, and the voltage of the smart EAC system is 580V; when the time is 0.04s, the voltage of the smart EAC system of the traditional EAC system is 540V. The voltage of the intelligent EAC system is 620V. When the time is 0.06s, the voltage of the traditional EAC system is 600V, and the voltage of the smart EAC system is 700V; when the time is 0.08s, the voltage of the traditional EAC system is 650V, and the voltage of the smart EAC system is 810V; when the time is 0.1s, The voltage of the traditional EAC system is 690V, and the voltage of the smart EAC system is 920V. It can be proved that in voltage control, the intelligent EAC system also has the characteristics of high efficiency.

5. Conclusion

With the continuous expansion of ST's application in the EAC system, the control performance and automation level of the EAC system is getting stronger, especially the introduction of advanced computer technology and artificial intelligence technology. The EAC system will also be favored by the industry and be favored by manufacturers. After the EAC system uses ST, the system can work more intelligently, and employees can get rid of repetitive control tasks and devote their energy to other more meaningful tasks. The EAC system field should also keep pace with the times, and continue to follow the high and new technology in the ST field to make the EAC system develop in a higher direction.
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