Application of Artificial Intelligence Technology in Mechanical Electrical Control System

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Abstract. Artificial intelligence technology (A I T) has also been widely used in society. Combining A I T with mechanical and electrical control systems will bring huge profits to the corporate sector and greatly improve work efficiency. It can save a lot of money in the electrical control operations of all walks of life in the country, and fill the gap in this technology in the country. The purpose of this article is to study the application of A I T in mechanical electrical control systems (M E C S). This article first introduces the basic theories and concepts of A I T, extends the core technology of A I T, and combines the current status of the electrical control system of modern enterprises in our country to discuss its existing problems, and finally studies and analyzes A I T and machinery. Combination of electrical control systems, and discuss the application of A I T in mechanical electrical orifice subsystems. Experiments show that, compared with the existing M E C S, the M E C S using A I T can better complete the work and improve work efficiency.

Keywords: Artificial Intelligence Technology, Mechanical Electrical Control Systems, Application Combination, Control Theory

1. Introduction
With the development of science and technology, how to use existing funds to effectively carry out the technological transformation of enterprises is a subject of universal significance [1-2]. At present, my country's capital construction investment is inclined to the clothing industry, water conservancy, transportation, communications, energy conservation, environmental protection and other fields. However, electric power, petroleum, chemical metallurgy, and building materials basic industries will not have plans to build large-scale enterprises in the near future. The task of the enterprise is still very heavy [3-4]. In the process of enterprise transformation, the art process and equipment are the main ones, but the intelligent supporting transformation must be carried out accordingly [5-6].

As early as the 1960s, research on the application of A I T in mechanical and electrical control systems has been launched abroad. For example, Japan applied A I T to the mechanical cleaning industry in the 1990s. Researchers at Osaka Prefectural University were inspired by the phenomenon of electric fans when they were working, and developed a pneumatic suction type wall cleaning robot [7-8]. Subsequently, improvements were proposed in the way of robot movement and adsorption. Their principle is to realize the movement on the glass curtain wall through the alternate adsorption of
drive joints and passive joints. Even for buildings where the glass curtain wall is not completely flat, it has a strong adaptation [9-10]. Our country began to conduct research in some high-tech fields in the 1970s, and began to keep up with the international progress. The most representative one is the patent "Link Electromechanical Brake (EMB) Device" invented by Tsinghua University, which uses torque the motor + crank slider mechanism uses the large force increase feature near the dead center of the crank connecting rod mechanism to achieve braking. The structure is characterized by a large force increase coefficient and good braking effect, but its disadvantage is that the machining and assembly accuracy requirements of the mechanism are required. High, the mechanism is prone to jamming and the energy demand is large when the brake is released. In addition, it is difficult to realize the automatic adjustment of the brake gap [11-12].

In this paper, the application of A I T in the M E C S is carried out through the literature method and questionnaire survey method, combined with the current status of my country’s modern M E C S, to compare the M E C S under A I T and The advantages and disadvantages of traditional mechanical and electrical control systems. The final analysis discusses the application method of A I T in the M E C S.

2. Application Research of Artificial Intelligence Technology in Mechanical Electrical Control Systems

2.1 Related Technologies

(1) Programmable logic controller (PLC)

Programmable logic controller is Programmable Logic Controller, PLC for short. It has become a core part of the industrial automation field. Programmable logic controllers can be widely used mainly because of their strong stability, powerful functions, simple development, rich interfaces, good compatibility and extensible modes.

(2) Modbus field bus technology

The characteristic of the Modbus protocol is that it supports a variety of electrical interfaces, including RS-232, RS485, etc., and can also be transmitted on various media, such as twisted pair, optical fiber, and wireless. This ensures good scalability and can support up to more than 200 devices connected to the same network to communicate. This agreement belongs to the agreement of the master/slave architecture. In the entire communication network, there is only one master node, all other nodes are slave nodes, and each slave node has a unique address. In the communication process, the master node performs query operation, that is, accesses the designated slave station according to the format, and the slave station device generates response information to complete a complete query response cycle.

(3) Failure prediction and health management (PHM)

The English full name of failure prediction and health management is Prognostics and Health Management, or PHM for short. It was first used in the military field to predict faults through the collection and analysis of system status information to reduce equipment use and maintenance costs. It is a product that integrates sensor technology, fault diagnosis technology and embedded technology. The transition from status monitoring to health management. PHM technology is mainly composed of two parts: prediction and health management. The health status is the difference between the current actual working status and the normal working status of the system, and the fault prediction is to use the current and historical working status data of the system to predict the current health status and possible faults of the system, and diagnose and deal with it in time.

2.2 Electrical Control System

(1) Pneumatic system

The system is composed of driving device, control element and executive element. The compressed air from the air compressor (including the air storage tank) is filtered and decompressed, and then
enters the cylinder through the two-position five-way electromagnetic reversing valve to drive the piston rod to expand and contract.

(2) Control system

As a distributed data processing system, the control system is divided into three equipment layers, namely, the station control layer, the communication management layer, and the bay layer. Each layer performs different functions, and each layer is composed of different devices or different subsystems. There is also a process layer, although it is not a control system, it is also a service for it.

2.3 Analysis of Existing Problems in Electrical Control Problems

(1) Poor equipment data validity, safety, and reliability

Due to the backward technology of communication equipment, the data transmission and the process takes a long time, and the communication data is prone to interference, resulting in poor data real-time and correctness.

(2) The monitoring point does not form a monitoring network

Due to equipment modification, the electrical quantities of some newly added equipment have not been added to the electrical control system, resulting in a lack of monitoring.

(3) Computer performance limitations

The TOSMAP-DS system has been put into production since the Cathay Pacific generator set. Computer technology has been an important part of the control system. With the development of science and technology, the backwardness of computer performance restricts the precision of the control system. Its computing speed, CPU load rate, and reliability have all been improved.

(4) The operator station has the situation that the operation command fails

The "program cannot respond" phenomenon occurred during the operation, and the solution can only be to restart the operator station. In the case of frequent operations during the start-up and shutdown of the unit, this phenomenon occurs more frequently, threatening the normal and safe operation of the unit.

(5) The logic configuration modification procedure is complicated

The system is very cumbersome to modify function block parameters and logic configuration procedures on the engineering station. A large number of operation steps make maintenance personnel prone to misoperation and leave safety hazards. Moreover, due to program function limitations, online logic configuration cannot be performed when the system is running, so that defects cannot be eliminated in time, which is not conducive to timely processing of the system defects.

(6) Components are aging and reliability is reduced

Since the original system has been in service for nearly ten years, it has reached the end of the service life of electronic components. Channel damage, communication module damage, and DC power module failure occurred many times during operation. According to statistics, in recent years, there have been many cases of electrical control system refusal or malfunction due to module failures, and due to various reasons, the number of spare parts cannot be effectively supplemented.

(7) Higher system energy consumption

UPS power supply puts forward higher requirements. The battery pack has been aging and its performance has declined. Moreover, due to the high energy consumption of the electrical control system, the DC and UPS systems cannot satisfy reliable power supply.

(8) Historical database archiving time is short

Due to the performance limitations of computers and software at that time, the archiving time of various historical databases was short, only about one month, which could not meet the needs of accident analysis, data statistics, and time recall.

2.4 Design of Application of Artificial Intelligence Technology in M E C S

Aiming at the problems existing in the current mechanical and electrical control system, the use of A I T can improve the functions:

1) Realize automatic fault alarm
The general installation can repeat the action and can delay the automatic release of the accident signal and warning signal device of the accident sound. When the circuit breaker accidentally trips, it can instantly send out the accident sound signal. At the same time, the corresponding position indicator flashes, and other protections signal is generally connected to the pre-announcement signal system as required to promptly notify the operating personnel to find abnormal conditions of the equipment.

2) Realize remote operation of electrical equipment

For 6kV and above electrical equipment and some important 380V electrical equipment, in addition to local operation, remote operation and adjustment functions can be realized.

3) Has certain self-diagnosis and repair functions

Through the self-checking function of the monitoring software, faults in the electrical control system can be found in time, and effective repair suggestions are provided according to the type of fault, which is convenient for daily system maintenance and guarantees the normal operation of the entire system.

4) Realize the online configuration function of logic

The logic can be configured online when the system is running, and the logic will not have any adverse effects on the operation of the controller when the configuration is downloaded, which is convenient for eliminating system defects in time.

2.5 Establishment of Mathematical Model of Asynchronous Motor

When the three-phase asynchronous motor is running normally, the slip rate \( s \) is very small, so it can be considered as:

\[
T_n \approx \frac{3pU_1^2}{2\pi f' R_2} (1 - \frac{n_p}{n_1})
\]  

(1)

According to the mechanical motion equation of the motor:

\[
T_n - T_L = \frac{GD^2 d_n}{375} = j_G \frac{d_n}{d_1}
\]  

(2)

3. Experimental Research of Artificial Intelligence Technology in Mechanical Electrical Control Systems

3.1 Subjects

(1) In order to make the results of this research more scientific and effective, this experiment investigates the problems existing in the traditional electrical control system and compares it with the M E C S combined with A I T. The data results are sorted and analyzed, and the final conclusion is drawn. All the people invited this time have worked for more than three years to ensure the reliability of the experimental data. A total of 50 persons were invited to conduct a survey, of which the ratio of men to women was equal. This experiment will adopt a semi-closed questionnaire survey method, the purpose of which is to promote the correct filling of relevant personnel.

(2) In order to better integrate A I T with mechanical and electrical control systems, this article went deep into the enterprise and conducted face-to-face interviews with relevant experts and scholars on the in-depth application research of artificial intelligence in the field of mechanical and electrical control. The second will investigate his views on the application of artificial intelligence and mechanical and electrical performance. This time, a ten-point scoring method will be used, where 1 means disapproval and 10 means approval, and the data obtained will be obtained by using the analytic hierarchy process to obtain a more accurate result.
3.2 Research Methods

(1) Document method
This article collects a lot of related materials by reading a large number of predecessors’ literature and the research results of related experts and scholars. These materials not only provide data support for the topic selection of this article, but also provide references for the research results predicted by this article.

(2) Questionnaire survey method
This article draws up a targeted questionnaire by asking relevant experts, and uses a semi-closed method to allow respondents to fill in the questionnaire.

(3) Field research method
This paper investigates the existing M E C S and collects first-line data by going deep into the machinery factory. These real and reliable data provide a firm reference for the research results of this paper.

(4) Mathematical Statistics
Use relevant software to sort and analyze the final data.

4. Experimental Analysis of Artificial Intelligence Technology in Mechanical Electrical Control Systems

4.1 Comparative Analysis of A I T and Traditional Methods
Traditional mechanical and electrical control systems have begun to decline in this fast-developing society, and cannot keep up with the needs of the development of the times. The application of A I T and mechanical and electrical control systems are necessary for the development of the times. This experiment compares the M E C S under A I T with the existing control system, and the data obtained is shown in Table 1.

|                     | Environmental protection | Safety | Reliability | Effectiveness |
|---------------------|--------------------------|--------|-------------|---------------|
| Artificial intelligence | 12                       | 12     | 9           | 7             |
| Traditional         | 3                        | 4      | 2           | 1             |

Table 1. Comparative analysis of artificial intelligence and traditional methods

![Figure 1. Comparative analysis of artificial intelligence and traditional methods](image)
It can be seen from Figure 1 that, compared to the traditional M E C S, the M E C S using A I T is more comprehensive and has better performance. Especially in terms of power loss and safety, there has been a great development, which also proves the necessity of A I T application and M E C S from the side.

4.2 Feasibility Analysis of Artificial Intelligence Technology Applied to M E C S

In order to investigate the specific situation of the application of A I T to the M E C S, this article conducts visits and in-depth interviews with relevant experts and scholars to discuss its application. The experimental results obtained are shown in Table 2.

| Table 2. Functional analysis of A I T applications |
|-----------------------------------------------|
| Man  | 8  | 6  | 8  | 3  |
| Woman| 9  | 7  | 5  | 4  |

Figure 2. Functional analysis of A I T applications

It can be seen from Figure 2 that the functions of A I T in the application of mechanical and electrical control systems are unanimously optimistic, especially in terms of safety performance and self-repair performance, which have a high degree of recognition. This fully shows that A I T can complement and perfect the deficiencies of M E C Ss.

5. Conclusion

The 21st century is the era of A I T. Everywhere in life is immersed in A I T. If you want to increase work efficiency and win huge profits, you must require companies to be able to assess the situation. Traditional methods and technologies can no longer adapt to this. The era of rapid development of science and technology. The electrical control system has better real-time performance, stronger communication performance and higher calculation speed, which can realize the unified automatic management of high and low voltage electrical equipment of the generator set. The use of A I T to apply mechanical and electrical control systems will bring qualitative improvements to enterprises.

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