Development and Intelligent Design of Electrical Automation Control Technology

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Abstract

Due to the rapid social and economic development, the industrial level in China gradually increased and transformed towards the low-power, low-pollution and high-efficiency production pattern. As one of the new specialized industrial technologies, electrical automation control technology will bring new changes and influences to industrial technology. Electrical automation mainly includes computer network technology, electronic technology and computer control technology, which have such advantages as low cost, high efficiency and high security and can effectively promote the development of science and technology and economic progress. At the same time, according to relevant data, electrical automation control technology can not only adapt to the different needs of enterprises, but also enhance their overall strength. According to the characteristics and development of electronic control technology, this paper carries out intelligent design and research, with a view to promoting further development of electronic control technology.

Keywords: Electrical Automation, Control Technology, Development, Intelligent Design.

1. RESEARCH BACKGROUND

1.1 Literature review

The continuous improvement of science and technology is greatly promoting industrial changes, and electronic automation technology has also been going through innovation and improvement. Electrical automation control technology has been widely used due to its significant advantages – it can stream manual operation and labor output, and promote economic efficiency and development of enterprises. (Li, 2014). Electronic automation technology is a major change from traditional electrical technology, which significantly strengthens the control of electrical systems and thus effectively enhances the efficiency of electrical systems (Liu, 2014). However, the emergence and popularization of electrical automation control technology is mainly affected by modern information technology and physics science. Modern information technology provides the necessary tools for electrical automation development. In addition, the physical sciences also play a catalytic role. For example, the development of technologies like transistors and large-scale integrated circuits has greatly promoted the progress in electrical automation (Wang, 2012). With the gap between the industrial level in China and the world leading level narrowing, electrical automation control technology is being more and more applied in industrial applications. At present, in most of the manufacturing enterprises in China, especially those hi-tech ones, electrical automation technology is applied in various production lines to improve the production efficiency and greatly reduce the number of operational posts. In essence, this greatly improves the industrial production conditions and reduces the accidents caused by manual operations, bringing great production benefits to enterprises (Yu, 2014). For example, power companies use electrical automation control technology to effectively expand their power generation capacity and power transmission range, which meets the actual needs of power companies and further promotes their construction and expansion (Zhang, 2014).

1.2 Research purpose

In recent years, the economy and technology in China are both developing rapidly and the application of electrical automation is also becoming more widespread - no longer limited to the power industry but also introduced to other related industries. In the coal industry, electrical automation of coal mines also accelerates its own pace of development. The work efficiency of the coal mine power system and the production efficiency of coal mines are directly linked with its economic benefit. The introduction of single chip microcomputer into the electrical automation system significantly improves the programming and operation efficiency of the system.
(Liu, 2013). The electrical energy industry, which is closely connected with daily life and social development, is the origin of the electrical automation technology, so it is more popularized in this industry. Electrical automation greatly improves the efficiency of power system operation and at the same time broadens the applicable scope of power system. The correct and efficient use of electrical automation not only properly deals with common problems in power systems, but also provides a fundamental guarantee for the safe operation of power systems. It is also the fundamental thrust for the continuous progress and development of power systems (He, 2017). In the traditional industry like cement production industry, with the continuous improvement of the industry’s own technology, the technical content, quality and production equipment of cement products have experienced greater development. However, in the cement production process, the energy consumption and pollution level of the cement industry are still relatively high. Reinforcing the application of the electrical automation control technology can further increase the cement production and boost the continuous development of cement producers (Zhang, 2014). In modern construction, electrical automation applications are also gradually increasing, which ensure the efficient and safe operation of various systems within the buildings (Long, 2016). However, at this stage, the electrical industry is facing not only tremendous opportunities but also increasingly fierce competition. Therefore, in order to develop the electrical industry, it is necessary to increase the use of intelligent technologies (Wang, 2016). Application of intelligent technology in gas engineering automation and control not only can improve the economic efficiency of the electrical industry, but also enhance the competitive strength. Based on this, this paper analyzes the characteristics of electrical automation technology, and discusses the application of electrical automation technology based on the intelligent design concept, with a view to promoting further development of the electrical industry.

2. BASIC THEORIES OF ELECTRICAL AUTOMATION CONTROL TECHNOLOGY

2.1 Characteristics of electrical automation control technology

The electrical automation control technology mainly has the following characteristics: first, rapidity: the application of the electrical automation control technology effectively reduces the actual control processes. Due to the small amount of information transferred, it takes less time to complete all operations and it can deliver signals and respond quickly. Second, remote control: by monitoring the speed of the bus communication equipment, the electrical automation control technology can achieve remote controls and operations. Third, accuracy: the electrical automation control technology can collect information data from multiple aspects and periods, which can guarantee the normal operation of the system on the data level.

2.2 Main design concept

When the electrical automation control technology is integrated in intelligent design, basically there are three technical solutions, namely, remote monitoring, centralized monitoring and bus monitoring. In the three design processes, according to the characteristics of electrical automation control technology, the design concept focuses on three aspects, which are specifically described below: first, electrical automation control technology can use a processor to implement centralized control of the overall inspection and processing, which greatly improves the operation and maintenance processes, and thus improves efficiency. Second, electrical automation control technology achieves remote monitoring through stable collection and transmission of signals and can adjust and correct control signals according to real-time feedbacks of the field. Third, electrical automation control technology uses the centralized method to achieve the control function in bus monitoring and thereby achieve efficient monitoring.

3. DEVELOPMENT OF ELECTRICAL AUTOMATION CONTROL TECHNOLOGY

With the further development of the market economy in China, the market competition that the electrical automation control technology faces is also becoming more fierce. Therefore, electrical automation control technology must exert its own advantages closely in line with the actual situation of the industry and social needs, so as to better promote the progress in social production. The use of electrical automation control technology can greatly weaken the intensity of manual labor, and at the same time improves the accuracy and responsiveness of monitoring to promote efficient and safe production activities. The electric distributed control system, established in China in early 1990, is an emerging control system compared with the centralized system, thus it is also called the DCS system. However, when the electrical automation control technology system was first widely applied, it also exposed many shortcomings. For example, limited by the analog mixed system, the initial DCS system used traditional instruments, resulting in lower reliability of the system and greater difficulty in maintenance; and the distributed control system has no uniform production standards, further increasing the
difficulty in maintenance. However, with the continuous improvement of the electrical automation control technology, the electrical automation monitoring function has been added, which has become the central pillar of the power plant control technology. And as windows nt and ie are used as the standard languages, it has high flexibility and convenience, attracting more and more users.

3.1 Centralized processing

In the whole process of power system operation, the electrical automation control technology can only rely on computer data processing technology to complete the collection and collation of real-time data without having the running equipment do the processing, which greatly improves data processing efficiency. At the same time, it can make reasonable settings in accordance with the data detected by the power system under different responses. Here it mainly involves the conversion of weak electric signals and conversion of strong electric signals, which, through adjustment, optimize the overall functions of technical systems. At the DC signal and dead contact under hard-wired cables, analog processing is carried out to the switching value and electric quantity. Finally, the output and input devices in the electrical distributed control system are connected.

3.2 Hierarchical technology

Hierarchical technology is mainly divided into three technical levels, namely communication layer, station monitoring layer and interval layer. Among them, the station monitoring layer is the core part of the communication technology system, playing a supportive role in the data management and information exchange in the interval layer. The electrical automation control technology is developing towards the hierarchical technology, which uses the terminals installed in the interval layer to greatly enhance the comprehensive management of power plants. At the same time, the occupancy of the hierarchical technology is small. This advantage has strengthened the performance of power system devices to a certain extent, improved the sensitivity, independence and reliability and imposed effective control over operating costs. In addition, management with the hierarchical technology also has good anti-interference, thereby optimizing the accuracy of computer data collection and processing.

4. INTELLIGENT DESIGN OF ELECTRICAL AUTOMATION CONTROL TECHNOLOGY

In order to verify the practicality and superiority of the electrical automation control technology, the elevator monitoring system and the lighting system in the office building X are renovated. Modern communication technology, control technology and sensor technology are used to control the construction equipment centrally so as to realize the energy saving and intelligent design of the building. In order to save money and facilitate engineering application and the openness, maintenance and management of the products, the HW - BA5000 system is selected to manage the centralized work station of the building. The HW-BA5000 system is a two-way and multi-station all-digital communication system. The system operation and control are simpler while the safety performance is greatly improved. In this renovation, the host of the HW-BA5000 system is installed in the weak current room, where there are also a PC host and a printer. These devices are powered by UPS through the bus in the dedicated weak electric wire slot in a radial manner, and at the same time, the power is also sent to the two weak electrical wells, where the wire slots are vertically arranged.

4.1 Elevator monitoring system

The basic structure of the elevator is a lift car placed in the vertical ladder shaft, which can be moved up and down by the traction wheels driven by the motor. When dragging the load, the traction machine of the elevator adjusts itself according to the weight of the car, and needs to rely on the counterweight to make the elevator car reach the equilibrium running state. However, in order to reduce the weight difference between the car and the counterweight, the motor will generate more mechanical potential energy to make the elevator system consume more energy. In order to effectively reduce the overall energy consumption of the elevator system, the elevator system undergoes energy saving transformation. Specifically, it involves measuring and analyzing the characteristic efficiency data of the elevator motor to reduce the difference between the elevator car weight and the counterweight. The main value to be calculated is the ratio between the input value and output value of the current power of the motor in active cases. The calculation formula is as follows:

\[ \eta = \frac{P_2}{P_1} = 1 - \sum \frac{P}{P_1} \]  

\(1\)
where: $\eta$ stands for the efficiency of the motor; $P_1$ stands for the power input value of the motor in the active state; $P_2$ stands for the power output value of the motor in the active state; $\sum P$ stands for the total loss of the motor. During the operation of the elevator, the load condition will always change, and the total power of the motor will continue to increase, and at this moment, the motor current will also rise. If the variable loss of the motor during operation is equal to the fixed loss value, the motor will operate optimally and generate the greatest utility.

Taking the elevator 1# of the office building X as an example. According to the running status of elevator 1#, when the per unit current value $Y$ exceeds 0.62, the operation state of the motor is good; when the per unit current value $Y$ is less than 0.62, the operation efficiency of the motor is on the decline, and the lower the per unit current value $Y$ is, the faster the operational efficiency will decline; and when the per unit current value $Y$ is in the range of 0.81-0.91, the motor is in the optimal operating state. Therefore, it is possible to achieve the best energy-saving effect in controlling the braking of the elevator when the per unit current value is in the range of 0.81-0.91. In the elevator control box, through setting of the parameters that are consistent with the above analysis in the HW-BA5203 module, the elevator operation can achieve the optimal efficiency.

### 4.2 Lighting system

To achieve efficient monitoring and management of equipment in buildings, the key part is to conduct monitoring and management on the lighting system. Therefore, in the energy-saving renovation, the advantages of electrical automation control technology should be fully exerted to impose the dedicated control over each system of the lighting equipment to achieve energy saving and at the same time ensure the basic functions of the lighting system. Specifically, self-adjusting light-sensitive lighting control devices can be used, which, through the inherent sensors, achieve effective control of lighting whenever there is a need for lighting in an area, and can also simply the operation process through remote control. The use of electrical automation control technology for integrated design can effectively reduce the power consumption of building lighting and also maintain the softness of light. In addition, the light data collected and fed back by the monitoring system are used to control the light intensity and lighting time.

In the original design of the office building X, the light source equipment was the energy-efficient fluorescent lamps, with product certifications, whose energy-saving performance met relevant standards. The light color rendering index Ra>83 and the color temperature was between 3500K and 5500K. At the same time, electronic ballasts were provided, with COS%>0.9, and other indicators of the ballasts are all in line with the safety standards. In the renovation of the lighting systems, light sources in the corridors, office areas and other regions are replaced with LED lights, which have the advantages like high light efficiency, high color rendering index, low power and long service life. The lighting electricity consumption ($L$) is calculated as follows:

$$L = WT \times \frac{E_A}{F/U M} = \frac{EAT}{\eta}$$  \hspace{1cm} (2)

where, $W$ is the rated power of each lamp, KW/each; $T$ is the duration of lighting, hr; $E$ is the average design illuminance, lx; $A$ is the floor area, m$^2$; $U$ is the coefficient of utilization; $M$ is the holding system; $F$ refers to the beam length of the light, lm; $\eta$ represents the comprehensive efficiency of the light, F/W.

According to the monitoring results of the lighting system after the above renovation scheme is implemented, the lighting time in the corridor area after renovation is reduced by 25 minutes and the lighting time in the office area is reduced by 50 minutes. When the intelligent design scheme is implemented, the office building X can reduce the annual electricity consumption by 70, 421kwh. Taking into account seasonal differences, the overall energy saving is 30%, indicating that using electrical automation control technology to retrofit the lighting system not only achieves intelligent control but also effectively reduces energy saving.

### 5. CONCLUSION

The contemporary society is featured with network, digitization, intelligence and centralization. In this society, technology and hi-tech products are continuously emerging. As one of the most popular technologies, electrical automation control technology will also become more and more important in the industrial field in China. At the same time, it will continue to proactively promote the modernization of enterprises. In this paper, the electrical automation control technology is introduced in the intelligent design and renovation of the elevator system and lighting system of an office building, which achieves good energy-saving effect. So it can be concluded that the
electrical automation control technology can promote energy conservation and economic development. At the same time, it is also believed that the promising electronic automation control technology will constantly innovate and change towards modernization and intelligence to maintain fast, healthy and sustainable development.

REFERENCES

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