Research on the Application Status and Development Trend of Automatic Control Technology in Industrial Field

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Abstract. With the growing maturity of automatic control theory, various automatic control systems have found wide applications in the industrial field. Starting with an overview of the current development of automatic control technology, this paper introduces the application of automatic control technology and analyzes its development trend by presenting four typical industrial automation application scenarios, including industrial boiler control, control of thermal power plants, electronic automatic assembly and intelligent control of temperature.

1. Introduction
The wide application of industrial automation has benefited from the rapid development of modern cutting-edge technology, such as machining, power electronics, information technology, network communication. Fully automatic industrial production can be realized through controllers and meters with pre-set process. As the core of the automatic control system, the controller is also at the center of the development of the entire industrial automation. At present, there are four main controllers on the market, namely programmable logic controller (PLC), industrial PC, distributed control system (DCS) and embedded computer. The introduction of these controllers is a revolutionary advancement in the field of industrial automation, which has greatly liberated manpower, and improved industrial production efficiency and product quality. This paper introduces automatic control technology from the perspective of its current development, typical industrial application, and the development trend, providing a new perspective to understand this technology.

2. Current Development of Automatic Control Technology
Automatic control is not a new idea, and there have been simple automatic control systems in ancient times at home and abroad. However, in the long-term human exploration, it was not until the industrial age that automatic control technology was officially applied to production. Compared with developed Western countries, China started late in developing industrial automation control technology. According to recorded documents, automatic control systems were not applied in industrial production until the 1940s in China. Our exploration of industrial automation began with the single-machine production mode. And the emergence of assembly line production in the 1970s marked China’s formal entry into the age of industrial automation [1]. Up to now, while China has fully learned from foreign advanced technology due to economic globalization, it has also carried out many independent innovations, basically reaching the middle-to-high level across the world. However, introductions of automatic control technology can hardly be comprehensive because it involves many disciplines. Therefore, this paper, centering on the development of the controller—the core of the automatic control system, briefly analyzes the application status of automatic control technology.
2.1 Programmable Logic Controller (PLC)
First produced in the United States in the late 1960s, the programmable logic controller (PLC) is one of the widely applied controllers in the industrial field. The advantage of PLC lies in that it allows users to program their internal memory and relies entirely on digital signal processing to achieve system control, thus becoming an important branch of computer technology. Though many domestic manufacturers are also working hard to develop PLC products with independent intellectual property rights, there is still a long way to go before reaching the level of foreign first-line brands. Therefore a large number of core technologies still need to be imported, which is one of the bottlenecks facing China’s strategy of being powerful through manufacturing.

2.2 Industrial PC
Industrial PC, also known as industrial computer, is actually an ordinary computer which is adjusted according to industrial applications in terms of structural design and functional configuration. At present, there are two main types of industrial PCs, namely IPC and Compact PCI. The former is a virtualization technology, while the latter is an optimized version of PCI technology. The emergence of industrial PCs enables computers to be applied in a variety of complex and difficult industrial environments so as to meet the diverse needs of industrial production. Industrial PCs offer advanced functions that other controllers cannot provide, thus finding a place in the industrial arena.

2.3 Distributed Control System (DCS)
The distributed control system (DCS) is a new type of control scheme developed from the traditional centralized control system. Emerged in the 1970s, DCS was introduced in China even later. At present, it is widely applied in many large industrial control fields. With the development of related technologies and the promotion of market demand, DCS has developed rapidly in China with the application status gradually moving closer to the world-class level. Constant emergence of various research achievements and the improvement of industrial production environment guarantee better distributed control of industrial equipment.

3. Industrial Application of Automatic Control Technology
With the advancement made in the fields of computer, communication, power electronics, and mathematics, the development of automatic control technology has also embarked on a new stage in which a relatively mature system of modern automatic control theories has been formed and different technological systems are separated according to the application needs of different technical systems. At present, although automatic control systems are widely applied in the field of industrial control and serve different functions in different applications, their basic ideas are similar. This paper selects four typical industrial automatic application scenarios including industrial boiler control, control of thermal power plants, electronic automatic assembly, and intelligent control of temperature to analyze the application of automatic control technology in the industrial field.

3.1 Industrial Boiler Control
Industrial boilers are important production equipment in the industrial field, whose stability and efficiency during operation must be highly valued in industrial production. At present, electric boilers are widely applied in the industrial field. However, there are many parameters of electric boilers need to be carefully controlled, which are all closely related to the overall performance of the boiler. Therefore the precise control of multiple parameters has become one of the core technologies of the electric boiler control system. In practice, however, it is generally difficult to control well because many controlled variables have inertia and hysteretic nature. Meanwhile, its dynamic characteristics are usually complex nonlinear rather than simple linear, which poses great challenge to the control of industrial boilers. At a time when the automatic control technology keeps advancing, the control of industrial boilers has realized certain application achievements. For example, the fuzzy PID temperature control scheme of intelligent electric boiler based on traditional PID control algorithm is
popular in current control of industrial boilers [2]. With a relatively complete theoretical system, fuzzy control technology performs better in terms of robustness and stability compared with other traditional technologies. With the development of industrial informationization in China, the control systems of various boilers will also achieve unprecedented advancement and the theory of automatic control will be increasingly mature. There is no doubt that the intelligent boiler system will achieve obvious improvement in function and performance in the future, becoming an important technology for China’s industrial modernization.

3.2 Control of Thermal Power plants
As for modern thermal power plants, thermal automation largely reflects the overall technical capability of power generation enterprises. Although the thermal automation has been promoted and applied in Chinese power plants, it still has long way to go before truly realizing digitalization, automation and intelligence. In recent years, with the gradual automation transformation of power plants, DCS has become popular in the field of automatic control of power plants, whose characteristics of decentralized control and centralized management make it have an edge over traditional control systems. In general, thermal power plants involve a large amount of process control and data processing during power generation. Therefore, information sharing and information isolation between devices must be ensured so that it can control, monitor, manage, and make decisions in a coordinate way. The thermal control system of the power plant is usually divided into four layers, including the management layer, monitoring layer, control layer and field layer. By transmitting information through the four-layer network, not only the function of decentralized control can be realized, but also the aim of centralized management can be achieved [3]. This structure can correspond well to the current computer network topology level and thus becomes the mainstream technology in thermal control of power plants. The advanced terminal equipment and control principle of the thermal control system greatly improves its reliability on the whole and make its future maintenance more convenient, thus significantly improving the centralized control operation capability of thermal power plants.

3.3 Electronic Automatic Assembly
As the world’s largest electronics manufacturing base, China is now at the critical period of transforming from a manufacture of quantity to a manufacturer of quality, which calls for improvement in electronic processing and production. With the miniaturization and integration of electronic products, the welding of components has become increasingly difficult and the requirements for workers and equipment have been more demanding. The electronic automatic assembly includes two aspects, namely the automatic welding of electronic components on the circuit board and the automatic assembly of electronic equipment. Among them, the automatic welding technology of electronic components better demonstrate the current automatic electronic assembly technology. For instance, many self-developed automated placement devices have appeared in the Chinese market after long-term development, which take an important position in the production of electronic products. Currently, though automatic placement technology has replaced the traditional manual one, the mainstream placement machine on the market still reflects obvious shortcomings in terms of cost, structure and performance. Nevertheless, the high-speed placement machine possesses the characteristics of stable and reliable operation, whose accuracy and response speed can meet the demand of modern high-speed mass production lines. In recent years, the SMT industry has seen a new development trend in which various new technologies are continuously introduced into the placement machine control system, which makes the industry demonstrate obvious advantages in automation, intelligence, flexibility, miniaturization, and high speed, thus further improving the overall performance of the placement machine [4].
3.4 Intelligent Control of Temperature
In the manufacturing industry, temperature control technology has been widely applied by petrochemical, non-ferrous metals and other industries in various key processes. Particularly, in the production of precision instrument, temperature control has become the key to determining whether the product is qualified. Since traditional temperature control technology can hardly meet the current development needs of various fields, the widespread application of intelligent temperature control systems based on automatic control technology has become an inevitable trend [5]. The intelligent temperature control system, which generally includes a main control unit, a temperature detecting unit, a display unit, an input unit, a communication interface, an execution unit and the like, can perform functions such as real-time temperature measurement, display, data conversion, transmission, and temperature adjustment. The main control module generally includes conventional control devices such as microcomputer, single chip microcomputer, FPGA or PLC. After the user sets the temperature through the keyboard and starts the system, the temperature sample module collects real-time temperature according to a certain frequency and sends back data through the serial communication module. At the same time, the signals are converted into digital ones to be transmitted to the display unit for display. With the advancement of science and technology, more and more industrial and scientific research fields highly rely on temperature control systems. There is no doubt that in the future temperature control systems will become more precise, smaller and lighter, and more durable. In addition, it will be combined with artificial intelligence to continuously improve its intelligence so as to meet the application needs of various industries.

4. Trends in Automatic Control Technology
With the development of cutting-edge technologies such as computer technology, network communication technology, and power electronics technology, the theory of automatic control has become increasingly mature and found wide application in the industrial field. At present, the development of industrial automation control keeps moving towards intelligence, networking and integration. According to its current development and problematic issues, there is no doubt that the development of industrial automatic control technology in the next decade will show the following characteristics:

1. Low-cost industrial automatic control based on industrial PCs will become the mainstream;
2. PLC technology will evolve towards miniaturization, networking, PC and openness;
3. The DCS system designed for the integration of measurement, control and management will become a crucial technology in industrial control;
4. The control system and field bus technology will achieve continuous integration;
5. The instrument will feature more obvious digitization, intelligence, networking and miniaturization.

In summary, the automatic control technology is an ever evolving technology, whose wide application in the industrial field has greatly promoted the industrialization process and demonstrates broad development prospects. Therefore, the industrial automatic control technology keeps a natural trend towards intelligent, networking, and integration.

5. Conclusion
In recent years, the automatic control theory system has been continuously enriched, and the automatic control technology has found wide application and played an increasingly important role in social development. Therefore, it is not hard to predict that, in the next ten years, industrial automation will continue to take the lead in industrial development and keep promoting social progress.

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