

# Discussion on the Application Ideas of Automation Technology in Modern Mechanical Systems

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## Abstract

This article delves deeply into the application ideas of automation technology in modern mechanical systems. Firstly, the relevant concepts of automation technology and modern mechanical systems were expounded, and the significance of applying automation technology to modern mechanical systems was analyzed, including aspects such as improving production efficiency, enhancing product quality, and strengthening system reliability and flexibility. Then, the specific applications of automation technology in modern mechanical systems were elaborated in detail, covering numerical control technology, industrial robot technology, sensor technology, automatic detection and monitoring technology, etc. At the same time, the challenges faced in the application process were discussed, such as technical complexity, talent shortage, cost issues, etc., and corresponding solutions were proposed. Finally, the future development trends of automation technology in modern mechanical systems are prospected, aiming to provide useful references for the wider application and in-depth development of automation technology in modern mechanical systems.

**Key words:** Automation technology; Modern mechanical system; Application ideas; Industrial robot.

## 1. Introduction

In today's era of rapid global technological development, automation technology has become one of the core forces driving transformation in the industrial field. With the increasingly fierce market competition, enterprises' demands for production efficiency, product quality and cost control are constantly rising. Traditional manual operation and simple mechanical control methods are no longer able to meet the needs of modern industrial production. The emergence of automation technology provides an effective way to solve these problems. It can achieve the automation, intelligence and efficiency of the production process, significantly enhancing the competitiveness of enterprises <sup>[1]</sup>.

Modern mechanical systems, as important carriers of industrial production, their development level directly reflects a country's industrial strength. From automobile manufacturing to aerospace, from electronic information to mechanical processing, modern mechanical systems are widely applied in various fields, providing a solid foundation for people's lives and production. However, traditional modern mechanical systems often encounter problems such as low efficiency, low precision and poor flexibility during operation, making it difficult to adapt to the rapid changes in market demand. Therefore, applying automation technology to modern mechanical systems to achieve their automated upgrading and intelligent transformation has become an important trend in current industrial development <sup>[2]</sup>.

The application of automation technology in modern mechanical systems not only enhances production efficiency and product quality, but also reduces labor intensity and human errors, bringing significant economic and social benefits to enterprises. For instance, in automotive manufacturing enterprises, automated production lines can enable rapid and efficient production of automobiles, significantly shortening the production cycle. In the aerospace field, automation technology can ensure the processing accuracy and assembly quality of components, and enhance the safety and reliability of aircraft <sup>[3]</sup>. Therefore, in-depth research on the application ideas of automation technology in modern mechanical systems holds significant theoretical and practical significance.

## 2. Overview of Automation Technology and Modern Mechanical Systems

### 2.1 The Concept of Automation Technology

Automation technology is an extremely comprehensive interdisciplinary subject that integrates knowledge and technologies from multiple fields such as control theory, computer technology, sensor technology, communication technology, and systems engineering [4]. The core objective is to adopt various automatic control devices and systems to automatically monitor, control, optimize and manage the production process, mechanical equipment, management activities, etc., so that the system can operate efficiently and stably in accordance with the predetermined procedures and requirements, reduce or eliminate manual intervention, and achieve the automation and intelligence of the production process [5].

The development of automation technology has gone through multiple stages. Early automation technologies were mainly based on simple mechanical and electrical control, such as the governor of a steam engine and the starting control of an electric motor. With the development of electronic technology, especially the emergence of computer technology, automation technology has entered a new stage of digitalization and intelligence. Modern automation systems typically employ programmable logic controllers (PLCS), distributed control systems (DCS), industrial control computers, etc. as control cores, combined with various advanced sensors and actuators, to achieve precise control and real-time monitoring of complex systems [6].

At present, automation technology is developing towards a highly integrated, intelligent and networked direction. High integration refers to the combination of multiple automation technologies and equipment to form a unified and efficient automation system. Intelligentization refers to the utilization of artificial intelligence technologies, such as machine learning and deep learning, to endow automated systems with the capabilities of autonomous learning, autonomous decision-making, and autonomous control. Networking refers to the realization of interconnection and remote monitoring among automation systems through technologies such as the Internet and the Internet of Things, as well as the global management and collaborative operation of the production process [7].

## **2.2 The Concept of Modern Mechanical Systems**

Modern mechanical systems refer to complex systems composed of multiple mechanical components, electronic elements, control systems, etc., which can achieve specific functions such as processing, manufacturing, transportation, assembly, etc. [8]. Compared with traditional mechanical systems, modern mechanical systems have higher precision, stronger functions and better adaptability, which can meet the demands of modern industrial production for high efficiency, accuracy and flexibility.

Modern mechanical systems are widely applied in numerous fields such as automotive manufacturing, aerospace, electronic information, and mechanical processing, and they are an important foundation for the development of modern industry. In the field of automotive manufacturing, modern mechanical systems have achieved high-precision processing and automated assembly of automotive parts, enhancing the production efficiency and quality of automobiles. In the aerospace field, modern mechanical systems can manufacture high-precision and high-performance aircraft components, ensuring the safety and reliability of aircraft [9].

## **3. The Importance of Applying Automation Technology to Modern Mechanical Systems**

### **3.1 Enhance Production Efficiency**

Automation technology can enable the continuous and efficient operation of modern mechanical systems, reducing downtime and manual operation links in the production process. For instance, on an automated production line, mechanical equipment can automatically complete various processing tasks according to preset programs without the need for frequent human intervention, thereby significantly shortening the production cycle and enhancing production efficiency. Meanwhile, automation technology can also enable the collaborative operation of multiple mechanical devices, further enhancing production scale and efficiency.

### **3.2 Improve Product Quality**

The automatic control system features high precision and high stability, capable of precisely controlling the operating parameters of modern mechanical systems and ensuring the consistency and stability of product processing. Through automated detection and monitoring technologies, the quality indicators of products can be monitored in real time, and quality problems in the production process can be discovered and corrected promptly, thereby effectively improving product quality and reducing the rate of defective products.

### **3.3 Enhance the Reliability and Flexibility of the System**

Automation technology can conduct real-time monitoring and fault diagnosis of modern mechanical systems, promptly identify potential faults in the system and issue early warnings, so as to take corresponding maintenance measures, prevent the expansion and deterioration of faults, and improve the reliability of the system. In addition, automation technology can also rapidly adjust the operating parameters of mechanical systems and production processes in response to changes in production tasks, achieving production flexibility and enhancing the enterprise's adaptability to market changes.

### **3.4 Reduce Labor Intensity and Costs**

The application of automation technology can reduce manual operations, lower the labor intensity of workers and improve the working environment. Meanwhile, as automated production can enhance production efficiency and reduce the rate of defective products, it also minimizes the waste of raw materials and the input of production costs. In addition, automation technology can also achieve optimized management of the production process and reduce the operating costs of enterprises.

## **4. Specific Applications of Automation Technology in Modern Mechanical Systems**

### **4.1 Numerical Control Technology**

Numerical control technology is one of the important applications of automation technology in the modern mechanical processing field. It controls the movement and processing of the machine tool through digital signals, achieving the automation and precision of the processing process. CNC machine tools feature high precision, high efficiency and high flexibility. They can process parts of various complex shapes and are widely used in industries such as automobiles, aerospace and mold manufacturing. Numerical control technology can also be combined with computer-aided design (CAD) and computer-aided manufacturing (CAM) technologies to achieve integrated design and manufacturing, further enhancing production efficiency and product quality.

### **4.2 Industrial Robot Technology**

An industrial robot is a machine device capable of performing tasks automatically. It features high flexibility and adaptability and can replace human labor to complete various dangerous, arduous and repetitive tasks. In modern mechanical systems, industrial robots are widely used in production processes such as welding, assembly, handling, and spraying. Industrial robots can be programmed to set different working procedures and movement trajectories to achieve the flexibility of multi-variety and small-batch production. Meanwhile, industrial robots can also be integrated with other automated equipment to form automated production lines, further enhancing production efficiency and the level of automation.

### **4.3 Sensor Technology**

Sensors are the "sensing organs" of automated systems. They can convert various non-electrical signals such as physical and chemical quantities into electrical signals for subsequent signal processing and control. In modern mechanical systems, sensor technology is widely applied in condition monitoring, fault diagnosis, quality inspection and other aspects. For instance, by installing temperature sensors, vibration sensors, pressure sensors, etc. on mechanical equipment, the operating status of the equipment can be monitored in real time, and any abnormal conditions of the equipment can be detected promptly. Installing photoelectric sensors, proximity sensors, etc. on the production line can achieve automatic detection and sorting of products.

### **4.4 Automatic Detection and Monitoring Technology**

Automatic detection and monitoring technology is an important means to ensure the normal operation of modern mechanical systems. It utilizes various detection devices and sensors to conduct real-time monitoring and analysis of the operating parameters of mechanical systems, product quality, etc., and feeds back the monitoring results to the control system so as to adjust the operating status of the system in a timely manner. Automatic detection and monitoring technology can achieve visual management and quality control of the production process, enhancing the stability and reliability of production. For instance, in automotive manufacturing enterprises, by establishing a complete automatic detection and monitoring system, the entire production process of automobiles can be tracked and monitored to ensure that every vehicle meets quality standards.

### **4.5 Flexible Manufacturing System (FMS)**

Flexible manufacturing systems are a type of manufacturing system that is uniformly controlled by computers, variable, and highly automated. They integrate numerical control technology, industrial robot technology, automatic transportation

technology, etc. They can quickly adjust production equipment and process flows according to changes in production tasks, achieving efficient and flexible production of multiple varieties and medium and small batches. Flexible manufacturing systems feature a high level of automation and intelligence, capable of enhancing production efficiency, reducing production costs, and shortening production cycles. They represent an important development direction for modern mechanical manufacturing enterprises to achieve transformation and upgrading.

## **5. Challenges and Solutions of Automation Technology in the Application of Modern Mechanical Systems**

### **5.1 Challenges Faced**

Automation technology involves multiple disciplinary fields and has a high level of technical complexity. The application of automation technology in modern mechanical systems requires the organic integration of multiple technologies such as mechanics, electronics, control, and computers, which poses very high demands on the technological strength and R&D capabilities of enterprises. Meanwhile, with the continuous development of automation technology, the pace of system updates and replacements is accelerating. Enterprises need to constantly invest a large amount of funds and human resources in technological upgrades and renovations to maintain their competitiveness.

The application of automation technology in modern mechanical systems requires compound talents who are proficient in both mechanics and automation technology. However, at present, there is a relative shortage of such professional talents in our country, and the quantity and quality of relevant professional talents cultivated by colleges and universities still cannot meet the market demand. Enterprises face considerable difficulties in introducing and cultivating talents in automation technology, which to some extent restricts the promotion and application of automation technology in modern mechanical systems.

The application of automation technology requires a large amount of funds for purchasing equipment, software and technological research and development. For some small and medium-sized enterprises, their limited financial strength makes it difficult for them to bear the high cost of automation transformation, thus affecting the popularization of automation technology in modern mechanical systems. In addition, the operation and maintenance of automated systems also require certain costs, including expenses for equipment repair, software upgrades, personnel training, and other aspects.

### **5.2 Solution Strategy**

Enterprises should increase their investment in the research and development of automation technology, strengthen cooperation with universities and research institutions, establish a mechanism for cooperation among industry, academia and research, and jointly carry out research and development of automation technology. Through technological innovation, the complexity of automation technology can be reduced, the reliability and stability of the system can be enhanced, and the application costs of enterprises can be lowered. At the same time, enterprises should also pay attention to the development trends of automation technology, promptly introduce and absorb advanced technological achievements, and enhance their own technological level and competitiveness.

Colleges and universities should, in accordance with market demands, optimize their professional Settings and curriculum systems, strengthen practical teaching links, and cultivate more compound talents who can adapt to the application requirements of automation technology in modern mechanical systems. Enterprises should enhance cooperation with universities, establish internship bases and talent cultivation bases, provide students with practical training opportunities, and at the same time actively introduce outstanding external automation technology talents to enrich the enterprise's talent team. In addition, enterprises should also enhance the technical training for their existing employees to improve their application ability of automation technology and professional proficiency.

When applying automation technology, enterprises should, based on their own actual conditions and development strategies, formulate reasonable automation transformation plans to avoid blind investment and excessive transformation. In terms of equipment selection and procurement, the cost-effectiveness of the equipment should be fully considered, and automated equipment that suits the production needs and economic strength of the enterprise should be chosen. At the same time, enterprises should also enhance the operation management and maintenance of automation systems, increase the utilization rate and service life of equipment, and reduce operating costs.

## **6. Future Development Trends of Automation Technology in Modern Mechanical Systems**

With the continuous development of artificial intelligence technology, future automation technology will move towards an intelligent direction. Intelligent modern mechanical systems will possess the capabilities of autonomous learning, autonomous decision-making and autonomous control. They can automatically adjust operating parameters and production strategies in response to changes in the production environment and tasks, achieving more efficient, precise and flexible production. For instance, intelligent robots will be able to continuously optimize their work procedures and movement trajectories through machine learning and deep learning algorithms, thereby enhancing work efficiency and quality.

Automation technology will be further integrated with other related technologies to form more complete automation solutions. For instance, the integration of automation technology and Internet of Things (iot) technology will enable the interconnection and remote monitoring of modern mechanical systems, allowing enterprises to have real-time access to the operational status of equipment and production data, and achieve intelligent management of the production process. The integration of automation technology and big data technology will analyze and mine the vast amount of data generated during the production process, providing decision support for enterprises and optimizing production processes and resource allocation.

Against the backdrop of global advocacy for energy conservation, emission reduction and sustainable development, the application of automation technology in modern mechanical systems in the future will pay more attention to greenness. The automated system will reduce energy consumption and environmental pollution by optimizing control algorithms and operation modes. For instance, by adopting intelligent energy-saving control technology, energy supply is automatically adjusted based on the actual operational requirements of the equipment, achieving efficient energy utilization. Adopt environmentally friendly automated equipment and materials to reduce waste emissions and environmental pollution during the production process.

## 7. Conclusion

The application of automation technology in modern mechanical systems is an inevitable trend in the development of modern industry. It is of great significance for improving production efficiency, enhancing product quality and strengthening the competitiveness of enterprises. This article explores the application ideas of automation technology in modern mechanical systems, analyzes its significance, specific applications, challenges faced and solutions, and looks forward to future development trends. Although automation technology still faces some challenges in the application of modern mechanical systems, with the continuous advancement of technology and the gradual resolution of problems, automation technology will play a more important role in modern mechanical systems and promote the development of modern industry to a higher level. Enterprises should fully recognize the significance of automation technology, actively introduce and apply it, strengthen technological research and development as well as talent cultivation, so as to adapt to the demands of market changes and industry development and achieve sustainable development.

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