Research on the influence of the integration of robot and intelligent manufacturing on the industrial upgrading of manufacturing industry based on engineering practice

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Abstract: This paper discusses the influence of the integration of robots and intelligent manufacturing based on engineering practice on the upgrading of manufacturing industry. Intelligent manufacturing, with its characteristics of high information and intelligence, has brought the improvement of production efficiency and product quality to the manufacturing industry. As an important part of intelligent manufacturing, robot technology plays a key role in the automation and intelligent transformation of production lines. The research shows that the combination of robot and intelligent manufacturing can significantly improve production efficiency, reduce production costs, and enhance the decision-making ability and flexibility of enterprises. However, this integration process also faces challenges such as inconsistent technical standards, data security risks and talent gap. Therefore, it is suggested to strengthen technology research and development, promote standardization, strengthen data security measures and train professionals, so as to give full play to the integration advantages of robots and intelligent manufacturing and promote the transformation, upgrading and high-quality development of manufacturing industry.

1. Introduction

Intelligent manufacturing, with its characteristics of high information, intelligence and flexibility, has brought a leap in production efficiency and improved product quality to the manufacturing industry. Robot technology, as an important part of intelligent manufacturing, plays an important role in the automation and intelligent transformation of production lines with its high precision, high efficiency and stable working performance [1].

With the progress of science and technology and the constant changes of the market, the manufacturing industry is facing unprecedented challenges and opportunities. On the one hand, consumers' demand for personalized and diversified products is growing day by day, which requires the manufacturing industry to have the ability to respond quickly to market changes; On the other hand, the rising labor cost and labor shortage are increasingly prominent, forcing the manufacturing industry to seek more efficient and intelligent production methods [2]. It is in this context that the integration of robots and intelligent manufacturing has become an inevitable choice for the upgrading of manufacturing industry.

The influence of the integration of robots and intelligent manufacturing based on engineering practice on the industrial upgrading of manufacturing industry is deeply discussed. By analyzing the application of robot technology in intelligent manufacturing, and the improvement of intelligent manufacturing on manufacturing process, product quality, production cost, decision-making process and flexibility, the great potential of the integration of robot and intelligent manufacturing in promoting the industrial upgrading of manufacturing industry is revealed. At the same time, we will also pay attention to the challenges and problems that may be faced in this integration process, and put forward corresponding countermeasures and suggestions to provide useful reference for the transformation and upgrading of manufacturing industry.

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2. Analysis of the influence of the integration of robot and intelligent manufacturing on the upgrading of manufacturing industry

2.1. Improvement of production efficiency

The combination of robot and intelligent manufacturing realizes the high automation and intelligence of production process. Through advanced sensors, control systems and algorithms, robots can accurately perform tasks, reduce human errors and improve the consistency and stability of production. For example, in the automobile manufacturing industry, the welding robot can work continuously and the welding quality is stable, which greatly improves the production efficiency [3]. With the introduction of flexible manufacturing system (FMS), the production line can quickly adapt to the production requirements of different products and reduce the downtime caused by product replacement. The application of robots in FMS, such as automatic loading and unloading and assembly, further shortens the production cycle and improves the production flexibility and response speed [4].

Using big data and machine learning technology, intelligent manufacturing system can monitor equipment status in real time and predict potential failures, thus realizing predictive maintenance. This not only reduces the unexpected downtime, but also reduces the maintenance cost. According to statistics, predictive maintenance can reduce the downtime of equipment by more than 20% and significantly improve the production efficiency [5]. According to the actual case of a manufacturing enterprise, after the introduction of robot and intelligent manufacturing technology, its production efficiency increased by 30%, the qualified rate of product quality increased by 15%, and the production cost decreased by 25% [6]. These data fully demonstrate the remarkable effect of the integration of robots and intelligent manufacturing on the improvement of production efficiency.

2.2. Product quality improvement

The integration of robot and intelligent manufacturing realizes the whole process monitoring and real-time detection of the production process by introducing advanced sensors and Internet of Things technology. This kind of seamless monitoring can find the abnormal situation in production in time, reduce human error and ensure the stability and consistency of product quality. The introduction of automatic production line has significantly improved the production efficiency and product accuracy. Robots perform repetitive and high-precision tasks in the production process, which reduces the errors caused by manual operation, thus improving the consistency and reliability of products.

Intelligent manufacturing system analyzes and processes the massive data generated in the production process in real time through big data analysis technology. The feedback mechanism based on data can continuously optimize the production process, improve product quality and realize continuous improvement. Using artificial intelligence and machine learning algorithm, intelligent manufacturing system can intelligently predict and maintain equipment. By analyzing the equipment operation data, potential faults can be found in advance, and preventive maintenance can be carried out to avoid production interruption and quality problems caused by equipment faults [7]. Intelligent manufacturing system has a high degree of flexibility, and can quickly adjust production plans and technological processes according to market demand. The combination of robot and intelligent manufacturing makes it possible to customize, meet the diverse needs of consumers and ensure the quality of products.

2.3. Production cost reduction

The integration of robot and intelligent manufacturing can adjust production plan and resource allocation in real time and respond to order changes quickly through intelligent scheduling system. For example, robots can optimize energy use and reduce ineffective and excessive operations through energy-saving mode, thus reducing the operating cost of equipment [8]. Intelligent manufacturing technology can monitor the running state of production line in real time, find and solve problems in production in time, and improve production efficiency and stability. In addition, when the robot performs the task, it adjusts the movement speed and energy distribution through

intelligent control algorithm to achieve maximum energy saving [9]. The data in Table 1 shows that the integration of robots and intelligent manufacturing has significantly improved the production efficiency of manufacturing industry in many aspects, and promoted the industrial upgrading and high-quality development of manufacturing industry.

Table 1 Improvement of production efficiency

Application field/research object	Production efficiency improvement data
Industrial robot application	The labor productivity of enterprises using robots is 7.45% higher on average.
	For every 10% increase in the amount and quantity of robots used, the labor productivity of enterprises will increase by about 0.11% and 0.32% respectively.
Intelligent manufacturing system	After a large customer implemented an all-round intelligent upgrade through robots and MES production management system, the production efficiency was significantly improved.
AI technology application	AI deeply digs and analyzes big data through machine learning algorithms, and can predictively maintain equipment failures, thus reducing downtime and maintenance costs and improving production efficiency.
Intelligent production line	Intelligent production line makes the production process more accurate, fast and flexible through the combination of highly automated equipment and AI technology.
Output value scale of intelligent manufacturing	In 2017, the output value of China's intelligent manufacturing industry was nearly 1.5 trillion yuan, and it is estimated that the output value will exceed 2.7 trillion yuan by 2020.
	In 2023, the output value of intelligent manufacturing in China has exceeded 3.2 trillion yuan, with a compound annual growth rate of over 16%.

Lean production management mode under the background of intelligent manufacturing, through real-time data analysis and intelligent decision-making, can adjust production plan and scheduling more flexibly and avoid resource waste and idleness. For example, Siemens optimizes production planning and resource allocation through intelligent production scheduling system to improve production efficiency and flexibility [10]. Intelligent manufacturing information system can reasonably adjust the cost management mode of enterprises and strengthen the effectiveness of cost control. Through refined management, enterprises can more accurately capture the changes in market demand, adjust production plans in time, and avoid overcapacity or insufficient supply.

2.4. Decision process optimization

Robots and intelligent manufacturing systems can realize real-time collection of all kinds of data in the production process, including multi-dimensional information such as equipment running status, production efficiency, energy consumption and product quality. These data are immediately captured and transmitted to the central processing system through advanced sensing technology and Internet of Things technology. Using big data analysis, machine learning and other technologies to deeply mine and analyze these massive data, we can find potential problems and optimization space in the production process.

Traditional manufacturing industry relies on experience and historical data to make decisions, which is insufficient in the rapidly changing market. After the integration of robot and intelligent manufacturing technology, enterprises can make decisions based on the latest and most comprehensive information by using the ability of real-time data collection and analysis, and realize significant optimization [11]. This includes reducing equipment failures and costs through predictive maintenance, improving efficiency and resource utilization by production optimization,

implementing strict quality control to improve product qualification rate and customer satisfaction, and improving supply chain management to better meet market demand, optimize inventory and enhance supply chain flexibility.

2.5. Enhanced flexibility and synergy

The integration of robot and intelligent manufacturing significantly enhances the flexibility of production scheduling, the synergy of supply chain management, the agility of responding to changes in market demand, and the efficiency of cross-departmental cooperation. Intelligent scheduling system dynamically adjusts production plan and resource allocation according to real-time demand to ensure efficient operation; The interconnection of all links in the supply chain is realized through the Internet of Things, which improves the information transmission efficiency and response speed; Real-time data analysis and forecasting model enable enterprises to respond to market changes quickly and optimize production and inventory strategies; Intelligent manufacturing system supports flexible conversion between personalized customization and mass production to meet diversified needs; The unified information platform promotes real-time collaboration and data sharing among internal departments, and improves the accuracy of decision-making and operational efficiency.

3. Challenges and countermeasures of the integration of robot and intelligent manufacturing

3.1. Challenges faced

(1) Technical standards are not unified

In the process of the integration of robot and intelligent manufacturing, due to the differences in technical standards between different manufacturers and countries, the interconnection between devices has become a major problem. This inconsistency of technical standards not only increases the difficulty of system integration, but also limits the flexibility and expansibility of intelligent manufacturing system.

(2) Data security risk

Intelligent manufacturing system relies on a large number of data collection, processing and analysis, which involve sensitive contents such as production process, process parameters and customer information. Once the data is leaked or used maliciously, it will bring serious economic losses and reputation damage to the enterprise. Therefore, data security has become a problem that must be paid attention to in the process of integration of robots and intelligent manufacturing.

(3) Talent gap problem

The integration of robot and intelligent manufacturing needs compound talents who know both robot technology and intelligent manufacturing. However, such talents are relatively scarce in the current market, and it is difficult to meet the needs of enterprises for the transformation and upgrading of intelligent manufacturing. The talent gap has limited the speed and depth of the integration of robots and intelligent manufacturing.

3.2. Countermeasures and suggestions

(1) Strengthen technology research and development and promote standardization

The government and industry organizations should increase their support for the research and development of robots and intelligent manufacturing technologies, and encourage enterprises, universities and scientific research institutions to cooperate to jointly develop core technologies and products with independent intellectual property rights. At the same time, we should actively promote the formulation and unification of technical standards to provide a strong guarantee for the interconnection between equipment.

(2) Strengthen data security measures

Enterprises should establish a sound data security management system and strengthen the security protection in the process of data collection, storage, processing and use. At the same time, advanced data encryption technology, access control technology and security audit technology

should be adopted to ensure the security and traceability of data. In addition, the government should also strengthen the formulation and improvement of data security laws and regulations, and provide legal support for the data security of enterprises.

(3) Cultivate professionals to meet market demand

Universities and vocational colleges should strengthen cooperation with enterprises, adjust specialty settings and course contents according to market demand, and cultivate compound talents who know both robotics and intelligent manufacturing. At the same time, the government and enterprises should increase investment in personnel training, provide internship opportunities and career development platforms, and attract more outstanding talents to join the field of robotics and intelligent manufacturing.

The integration of robot and intelligent manufacturing faces challenges such as inconsistent technical standards, data security risks and talent gap. In order to promote the integrated development of robots and intelligent manufacturing, it is necessary to strengthen technical research and development, strengthen data security measures and train professionals. Only in this way can we give full play to the integration advantages of robots and intelligent manufacturing, and promote the transformation and upgrading of manufacturing industry and high-quality development.

4. Conclusion

The integration of robot and intelligent manufacturing based on engineering practice has a significant impact on the upgrading of manufacturing industry. The integration of robot and intelligent manufacturing has significantly promoted the upgrading of manufacturing industry, improved efficiency, reduced human errors and enhanced production stability through automation and intelligent production processes. Predictive maintenance based on big data and machine learning reduces the downtime and cost of equipment, ensures the stability and consistency of product quality, and promotes continuous improvement. In addition, the intelligent scheduling system optimizes the resource allocation, and reduces the running cost by combining the robot energy-saving mode, while the refined management and real-time data analysis improve the response accuracy of enterprises to changes in market demand and avoid the imbalance between production capacity and supply. This fusion also optimizes the decision-making process, making the decision based on the latest data more accurate and effective. However, this integration process also faces challenges such as inconsistent technical standards, data security risks and talent gap. In order to meet these challenges, it is necessary to strengthen technology research and development, promote standardization, strengthen data security measures, and cultivate compound talents who know both robotics and intelligent manufacturing.

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