

Research on Efficient Processing Technology of Mechanical Manufacturing and Automation

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Abstract: With the rapid development of science and technology, intelligent control technology is widely used in machinery manufacturing and automation. In view of this background, this paper discusses the connotation of intelligent control technology, analyzes the problems in its application in machinery manufacturing and automation, points out the shortcomings in processing technology, and puts forward a more efficient processing technology scheme, which has important practical significance for promoting the efficient application of this technology in machinery manufacturing and automation industry, enhancing industrial competitiveness and helping manufacturing industry to transform and upgrade to intelligence.

Keywords: Mechanical manufacturing; Automation; Intelligent control technology; Application strategy

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Nowadays, the global manufacturing industry is facing the urgent need of intelligent transformation. According to the strategic plan of *Made in China 2025*, by 2025, the scale of intelligent manufacturing equipment industry in China is expected to reach three trillion yuan, with an average annual growth rate of more than 20%. This trend reflects the great potential of intelligent control technology in improving production efficiency, reducing energy consumption and ensuring product quality. In recent years, the intelligent manufacturing system represented by German "Industry 4.0" has brought far-reaching influence to the global manufacturing industry, emphasizing the realization of equipment interconnection, real-time data analysis and adaptive production control by intelligent means. As a big manufacturing country in the world, China is accelerating the deep integration of intelligent control technology and mechanical manufacturing. Intelligent robots, fuzzy control algorithms, digital twins and other technologies are gradually being applied to key fields such as automobiles, aerospace and high-end equipment manufacturing, which has significantly improved the competitiveness and technical level of the industry. However, in the face of the complex and changeable production environment and the demand of intelligent transformation of traditional equipment, how to maximize efficiency and optimize stability at the processing technology level still needs to formulate scientific strategies and strengthen technical cooperation and resource integration.

1. Overview of Intelligent Control Technology

Intelligent control technology is a comprehensive technology that combines automatic control theory, computer science, artificial intelligence, operational research and other multidisciplinary knowledge. This technology breaks through the dependence of traditional control methods on accurate mathematical models and has outstanding characteristics such as self-learning, self-adaptation and self-organization.

In the scene of mechanical manufacturing and automation, the intelligent control system can sense the changes of various parameters in the production process in real time, and use the built-in intelligent algorithm to make rapid analysis and decision, so as to accurately regulate the running state of mechanical equipment. For example,

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the intelligent robot on the assembly line of automobile parts can automatically adjust the grasping strength and assembly angle according to the subtle differences of parts to ensure the consistency of assembly quality, which is beyond the reach of traditional fixed program control. Common intelligent control methods include fuzzy control, neural network control and expert system control. Fuzzy control imitates human fuzzy reasoning thinking and introduces fuzzy language variables into control rules, which is suitable for complex and difficult to accurately model systems. Neural network controls and simulates the structure of biological neurons, and builds models according to a large number of samples, which has strong nonlinear mapping ability and can cope with changeable working conditions; Expert system control mainly relies on domain expert knowledge to build knowledge base and inference engine to provide professional decision support for production process.

2. Application of Efficient Processing Technology in Mechanical Manufacturing and Automation

(1) Technical adaptability issues

Machinery manufacturing covers many sub-fields, from large ship manufacturing to micro-precision instrument processing, and the production processes of different products vary widely. In the process of transplanting intelligent control technology, it often faces the dilemma of being unaccustomed to the existing manufacturing process. On the one hand, some old machinery and equipment were not designed with intelligent control interfaces at the beginning, so it is difficult and costly to rebuild later. Forcibly connecting to intelligent control systems may lead to poor signal transmission and frequent compatibility failures. For example, some machine tools that have been in service for many years have aging electrical circuits and closed control systems, so it is difficult to seamlessly connect with new intelligent sensing devices, which limits the pace of intelligent upgrading. On the other hand, the development of intelligent control algorithm is mostly based on idealized model assumption, and the complex working conditions such as oil pollution, dust and electromagnetic interference in actual production easily make the algorithm deviate from the expected performance, resulting in the decline of control accuracy and the increase of defective products, which can not meet the requirements of high-precision manufacturing.

(2) System stability issues

The complexity of intelligent control system far exceeds that of traditional control system, and it integrates a large number of hardware devices and software modules. On the hardware level, intelligent sensors, controllers, actuators and other components are prone to performance drift and even hardware failure due to environmental factors such as temperature and humidity under long-term high-intensity operation. Taking high temperature environment as an example, the parameters of electronic components will change in this environment, which will lead to the increase of sensor measurement error, and then affect the feedback accuracy of the whole control system. In terms of software, intelligent control software has a large amount of code and complex logic, and there are risks of loopholes and compatibility problems. When the system encounters sudden abnormal data impact or performs multi-task switching, the software may fall into an unstable state such as deadlock and collapse, causing production interruption and bringing huge economic losses to enterprises. With the increasing demand of system networking, hacker attacks, malware intrusions and other events emerge one after another, which also pose a serious threat to the stable operation of intelligent control system.

(3) Shortage of professionals

With the vigorous development of intelligent control technology, the mechanical manufacturing industry is thirsty for talents with multiple abilities. Such talents should not only be proficient in the principle of mechanical manufacturing technology, but also be familiar with the construction and operation and maintenance of various mechanical equipment, and also master the cutting-edge technical knowledge such as intelligent control algorithm

development and system debugging. However, the current education system training mode is relatively backward, the integration of mechanical specialty with automation, computer and other professional courses in colleges and universities is insufficient, and students lack practical ability after graduation, so it is difficult to quickly adapt to the needs of enterprise intelligent transformation. The continuing education system for on-the-job personnel is not perfect, the internal training resources of enterprises are limited, and the knowledge update of technicians is slow, which can not meet the challenges brought by the rapid iteration of intelligent control technology. The talent gap makes many enterprises have the intention to vigorously promote the application of intelligent control technology, but the progress is slow due to the lack of professional human support, which restricts the overall process of industry intelligence.

3. Efficient Machining Process Optimization Strategy in Mechanical Manufacturing and Automation

(1) Optimizing the process adaptation scheme

In view of the transformation problem of old equipment in the implementation of efficient processing technology, a phased and systematic optimization strategy should be adopted. First of all, the running state of the equipment is comprehensively evaluated, and the weak links of the equipment are identified by using advanced technologies such as nondestructive testing and signal analysis, and the key points suitable for transformation are clearly defined. For example, high wear parts are identified by vibration monitoring, and the compatibility of control system is evaluated by electrical signal analysis. For key nodes, special switching modules or interface switching devices are designed to make old electrical systems compatible with modern sensors and control systems and realize stable data transmission. In the aspect of process adaptation, combined with the changeable factors in the actual production environment, an adaptive optimization algorithm based on field data is introduced. By deploying a real-time data acquisition system, we collect information about equipment operation and material processing, and use machine learning algorithm to mine data rules and dynamically adjust processing parameters. For example, in forging process, forging pressure and speed control can be intelligently optimized according to different material characteristics, real-time heating temperature fluctuation and production conditions to ensure product quality consistency and maximize production efficiency. This flexible adaptation scheme can significantly improve the applicability and stability of efficient processing technology in complex environment.

(2) Strengthening the system stability safeguard measures

In order to ensure the reliable operation of high-efficiency machining technology in machinery manufacturing and automation, the system stability should be strengthened from two aspects: hardware level, providing professional industrial environment control measures for the machining system, and designing industrial cabinets integrating functions such as temperature and humidity adjustment, dust prevention and electromagnetic shielding to ensure the key equipment to run in a constant and suitable environment. Select high-reliability industrial-grade components, and carry out strict aging test, durability verification and redundancy design to reduce the hardware failure rate from the source. In the process of equipment installation, vibration reduction measures and protective casing should be adopted to reduce the interference of vibration, impact and other factors in the production environment to the equipment and further improve the stability of hardware operation. On the software level, the whole process of software testing system, including unit testing, integration testing and system testing, is constructed to simulate all kinds of extreme production conditions and abnormal data input, discover and repair potential vulnerabilities in time, and ensure the stability of software under high load. The real-time operating system is introduced to optimize the task scheduling and priority allocation algorithm to ensure the response speed and execution accuracy of the system when multiple tasks are concurrent. At the same time, an emergency response mechanism is designed for the processing control system, which can quickly switch to the safe mode when

encountering sudden abnormality, so as to avoid the loss caused by system collapse.

(3) Accelerating the training and introduction of professional talents

In order to promote the wide application of efficient processing technology in mechanical manufacturing and automation, it is urgent to establish a perfect talent training and introduction mechanism. Educational institutions should speed up the reform of curriculum system and build an interdisciplinary professional curriculum system with mechanical manufacturing as the core and integrating automation, artificial intelligence and advanced manufacturing technology. The curriculum should pay equal attention to theory and practice, and design case teaching and experimental projects around practical problems in efficient machining technology. Strengthen cooperation with well-known machinery manufacturing enterprises, and jointly establish an internship training base, so that students can directly participate in production practice and hone their skills in a real industrial environment. As the main body of technology application, enterprises should strengthen internal training, and regularly invite experts in the field of efficient processing technology to hold special lectures and customized training courses. The training content should cover the application of emerging processing technology, equipment operation and maintenance, fault handling, system debugging and optimization and other practical needs to help employees quickly master cutting-edge technologies. Online and offline training methods are adopted to provide flexible learning choices for technicians in different positions, ensuring wide training coverage and outstanding results. At the same time, enterprises should encourage on-the-job employees to take professional qualification examination or external study plan, so as to create more opportunities for employees' career development and retain core technical talents.

4. Conclusion

Efficient processing technology is an important driving force for the development of machinery manufacturing and automation. Although there are challenges such as insufficient adaptability, system stability and talent shortage in the promotion process, these problems will be solved step by step with the technical optimization, system reliability improvement and professional talent training. In the future, high-efficiency processing technology will go deep into all aspects of machinery manufacturing, promote industrial upgrading in an intelligent, flexible and green way, provide support for improving production efficiency and quality, help China's manufacturing industry move towards a leading position in the world, and write a new chapter in manufacturing power.

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