Research on the Application of Computer Numerical Control Technology in Mechanical Manufacturing

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Abstract. The transformation and upgrading of machinery manufacturing industry is inseparable from the innovation of the industry and the utilization of new technologies. The continuous progress of computer numerical control tech and its utilization in the field of machinery manufacturing greatly promote the integration, automation and intelligent development of machinery manufacturing industry, so it has important research value. Based on this, this paper first analyzes the connotation and typical functions of computer numerical control (CNC) tech, then studies the structure and design of CNC device in mechanical manufacturing, and finally gives the typical utilization of CNC tech in mechanical manufacturing.

Keywords: CNC, Mechanical Manufacturing, Utilization

1. Introduction

With the iterative progress and maturity of computer tech, it has been widely and deeply studied and popularized in many fields, especially the utilization of computer tech represented by numerical control tech in the field of mechanical manufacturing, which greatly promotes the improvement of mechanical manufacturing level and efficiency. At present, China has become a global manufacturing power, and is facing a critical stage of transformation from a manufacturing power to a manufacturing power [1]. The transformation and upgrading of machinery manufacturing industry is inseparable from industrial innovation and the utilization of new technologies. The continuous progress of computer numerical control (CNC) tech and its utilization in the field of machinery manufacturing are promoting the development of machinery manufacturing industry towards integration, automation and intelligence. It can be seen that with the blessing of CNC tech, the market competitiveness and production efficiency of machinery manufacturing enterprises will be significantly improved and expanded.
At present, under the background of global economic integration, the industrial competition between countries is becoming more and fiercer. If China wants to smoothly realize the transition to a powerful mechanical manufacturing country, it needs to further strengthen the utilization and integration of computer information tech, especially numerical control tech in mechanical manufacturing, so as to realize the continuous breakthrough and innovation of mechanical manufacturing. On the other hand, as China's basic pillar industry, the machinery manufacturing industry plays an important supporting and auxiliary role in the healthy development of other industries. Therefore, the improvement of the informatization level in the field of machinery manufacturing will significantly drive the transformation and upgrading of the whole society and industry as well as the optimization of economic structure.

In addition, there are still many problems and deficiencies in the use of CNC tech in the field of machinery manufacturing, mainly in the lack of personnel who can use and operate relevant numerical control machinery, especially the high-quality talents who can effectively develop CNC equipment. Moreover, because the utilization of numerical control tech in mechanical manufacturing needs a large amount of early investment, it makes it difficult for some enterprises that are too short-term in pursuit of short-term benefits to make the decision to carry out transformation and upgrading investment. Therefore, in the current field of mechanical manufacturing, the utilization of numerical control tech still has great room for improvement and potential for improvement.

In a word, as a tech that relies on computer system to output control instructions, the organic utilization of CNC tech in the field of mechanical manufacturing promotes the improvement of the level of mechanical manufacturing information, and the organic integration of mechanical manufacturing industry with computer and network information industry [2]. The utilization of numerical control tech in the field of mechanical manufacturing promotes the fine development of mechanical manufacturing, promotes the improvement of manufacturing efficiency and the significant decline of manufacturing cost, and will be more deeply applied in the future. Therefore, the research on the utilization of CNC tech in mechanical manufacturing has important engineering practice value.

2. Connotation and typical functions of CNC tech

2.1. Computer digital control and numerical control tech

As an automatic method of programmable control for machining, measuring and assembling with the help of numbers, characters or other symbols, CNC tech adopts digital control method to realize automatic control for a certain working process [3]. Specifically, in the field of mechanical manufacturing, it mainly using CNC machine tools to achieve automatic control of the machining process. CNC system is a numerical control system with computer as the core, and its structure is shown in Figure 1 below.
2.2. Composition and function of CNC device

The CNC device is mainly composed of main moving parts, feed moving parts, supporting parts, special devices and auxiliary devices [4]. The operation panel is a tool for information exchange between the operator and the numerical control device, which is a unique part of the CNC device. The input and output device is an interactive device between CNC system and external devices [5]. The interactive information is usually the part processing program. The programmed part processing program recorded on the control medium will be input into the CNC system or the debugged part processing program will be stored or recorded on the corresponding control medium through the output device.

In addition, CNC unit is mainly composed of computer system, position control board, PLC interface board, communication interface board, special function module and corresponding control software, so as to realize the functions of program processing, information feedback, software and hardware coordination, reasonable organization and scheduling. Servo unit, driving device and measuring device are the main components to ensure the sensitive and accurate tracking of CNC device instructions, so as to realize the forming movement and cutting movement of mechanical parts. PLC, I/O circuit and device are used to complete the I/O control related to logic operation and realize the execution of I/O control [6]. By receiving the CNC command, converting it into the corresponding control signal, controlling the auxiliary device to complete the corresponding switching action of the machine tool, and outputting the command to control the working state of the CNC system and complete the corresponding manufacturing action.

2.3. Classification of CNC devices

According to the difference of process usage of CNC device, it can be divided into cutting, forming, special machining and other categories represented by assembly and measurement. According to the difference of control function of CNC device, it can be divided into point control numerical control system, line control numerical control system and contour control numerical control system. According to the difference of the number of linkage axes, the numerical control device can be divided into single axis and multi cycle linkage device. According to the different types of feed servo system, CNC devices can be divided into open-loop CNC system and full closed-loop and semi closed-loop CNC system [7].

![Figure 1. Architecture of typical numerical control system](image-url)
In addition, the data conversion of CNC tech in mechanical manufacturing is first transferred from the processing program to the decoding, and then the cutter compensation processing and interpolation processing are carried out. The program enters the servo system to realize the forming movement, and the cutting movement is controlled by PLC. The difference between the mechanical manufacturing process under CNC and the traditional mechanical manufacturing process is shown in Figure 2 below.

![Figure 2. Difference between CNC and traditional mechanical manufacturing process](image)

3. **Structure and design of CNC device in mechanical manufacturing**

3.1. **Typical characteristics of CNC device**

The main motion and feed motion of CNC device are driven by separate servo motor [8]. The transmission chain is short, the structure is relatively simple, and the motion relationship is coordinated and controlled by the computer. The mechanical structure has high static characteristics, dynamic stiffness, damping accuracy, wear resistance and thermal deformation resistance. The automatic graphic programming of CNC device takes graphic elements as input mode. From the source of programming data, the input, display and modification of parts and tool geometry, the dynamic simulation display of machining process, and the generation of NC machining program are all obtained in the way of graphic interaction.

3.2. **Design of CNC device**

The design of CNC device mainly includes the determination of the overall design scheme, the selection of parameters and the matching of Electromechanical. Secondly, at the design level of main drive system, including drive system, motorized spindle, automatic chuck and power tool holder [9]. In addition, in the design level of feed transmission system, it mainly includes the determination of transmission scheme, the design and matching of efficient transmission parts. Other systems include CNC rotary table, tool changing manipulator, tool system, cooling and chip removal system. The output system model of numerical control device is shown in Figure 3 below.
4. Utilization of CNC tech in mechanical manufacturing

4.1. Utilization of CNC tech in mechanical manufacturing

The typical utilizations of CNC tech in mechanical manufacturing mainly include industrial field, machine tool equipment, automobile industry, industrial production mechanical equipment and utilizations in machining. Among them, the utilization in the industrial field is mainly to replace manual work, complete complex tasks in harsh working environment, reduce the intensity of human work, and improve the control accuracy. Secondly, the utilization in the machine tool equipment level can ensure the production quality and improve the production efficiency [10]. In addition, the utilization in the automotive industry realizes the production mode of small batch and variety, and realizes the rapid processing and production, especially the significant improvement of virtual manufacturing, flexible manufacturing and integrated manufacturing. The utilization in the field of machining helps to realize the rational allocation of resources and ensure the profits of machinery manufacturing enterprises.

4.2. Utilization trend of CNC tech in mechanical manufacturing

With the iterative development of computer intelligent tech, the future utilization of CNC tech in mechanical manufacturing will develop towards high-speed operation, high-precision processing, complex function, intelligent control, open system, parallel drive and interactive network. Among them, speed and accuracy are two important indicators of CNC equipment, they are the eternal goal of CNC tech, and directly related to the efficiency and quality of mechanical manufacturing. Secondly, compounding is a method by which the equipment can realize a variety of processing methods. In addition, intelligent control refers to adaptive control of machining process and intelligent optimization and selection of machining parameters. Open architecture is a system that can realize system functions on different platforms and interoperate with other system utilizations. Interactive networking refers to the future of CNC tech support network communication protocol, realize remote network control, diagnosis, training and resource sharing.

5. Conclusion

In summary, the utilization of numerical control tech in the field of mechanical manufacturing promotes the fine development of mechanical manufacturing, promotes the improvement of manufacturing efficiency and the significant decline of manufacturing cost, and will be more deeply applied in the future. In this paper, through the study of the connotation and typical functions of CNC
tech, the classification and functions of CNC devices are analyzed. Through the analysis of the structure and design of CNC device in mechanical manufacturing, the design points of CNC device are studied. Through the research on the utilization of CNC tech in mechanical manufacturing, this paper analyzes the typical utilization fields of CNC tech in mechanical manufacturing and its future utilization trend.

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