Honing Technology based on Intelligent Manufacturing Technology

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Abstract: As the key technology of hole precision machining, honing plays an important role in many important fields, such as aerospace, military industry, automobile and precision hydraulics. In recent years, with the development of intelligent technology, the integration of honing technology and intelligent technology has set off a new revolution in the field of honing.

1. Introduction

Since the 1980s, artificial intelligence technology has been gradually applied to the manufacturing field. Intelligent manufacturing technology and intelligent manufacturing system are proposed, and then modern manufacturing modes such as lean manufacturing, virtual manufacturing and rapid response manufacturing appear. Integration and intelligence have gradually become the characteristics of the next generation manufacturing system. Intelligent products, intelligent production lines, intelligent workshops and intelligent engineering are emerging. Intelligent manufacturing is not a simple traditional product transformation and technological breakthrough, but the deep integration and integrated innovation of information technology and manufacturing industry. It processes manufacturing data and information into knowledge through technical means such as deep learning, migration learning and enhanced learning, so as to realize the intelligent manufacturing and service of knowledge. It is the key path to realize the transformation of China's manufacturing industry from large to strong. Honing is an effective machining method for inner hole finishing. It can not only remove large machining allowance, but also improve the dimensional and geometric accuracy of inner hole and reduce the surface roughness of inner hole. For difficult machining materials with high hardness, high wear resistance, high heat resistance and high corrosion resistance (such as titanium alloy, stainless steel and superalloy), there are great machining difficulties in honing, especially in deep hole honing. Therefore, how to ensure the smooth progress of honing and what measures are taken to improve the honing accuracy and efficiency are the main research contents of honing technology for difficult to machine materials, including the selection of appropriate honing oilstone and reasonable honing technology.

2. Intelligent Manufacturing Technology

As an advanced intelligent manufacturing technology, the goal of intelligent manufacturing

technology is to realize the intellectualization of the whole manufacturing enterprise value chain and the deep integration of intelligent technologies such as expert system, machine learning, artificial intelligence, cloud computing, data mining, neural network, Internet of things and machine vision with manufacturing technologies such as product design, product manufacturing and product assembly. It has formed various forms of intelligent manufacturing technologies, such as information physical integration technology, advanced perception technology based on the Internet of things, intelligent scheduling and optimization technology based on big data, intelligent service technology based on cloud manufacturing and so on[1]. Through the intelligent perception, intelligent reasoning, intelligent decision-making and intelligent control of resources in the manufacturing process, with the support of Internet of things, big data and cloud computing technology, the intelligent level of manufacturing process (including product design, processing, assembly and other links), enterprise management and service in the whole product life cycle is improved. Through the mutual cooperation between man and machine, the dynamic response of product demand and the rapid development of new products can be realized, the production and supply chain network can be optimized in real time, the optimization of cost, efficiency and energy consumption can be ensured, and the automation and flexibility of the whole manufacturing system can be significantly improved.

3. Honing Technology

Honing is a kind of low-speed grinding. The honing oilstone is bonded with adhesive or clamped on the special honing head by mechanical method. The honing head is driven by the main shaft of the honing machine tool to rotate and move up and down. The oilstone is expanded through the feed expansion cone in the honing head, and a certain pressure is applied to the hole wall for feed movement to realize honing[2]. Honing is widely used in mass production in automobile, tractor and bearing manufacturing industry, as well as in mass production in all kinds of machinery manufacturing. Such as honing cylinder liner, connecting rod hole, oil pump nozzle and hydraulic valve body hole, shaft sleeve, gear hole, automobile brake wheel cylinder, master cylinder hole, etc. This technology can be widely used in the finishing or finishing of holes of various shapes, and the machining of outer circle, spherical surface and inner and outer annular surface.

4. Honing Technology Based on Intelligent Manufacturing Technology

4.1 Intelligent Automatic Operation to Realize Full Closed-Loop Intelligent Control

Vision ultimate intelligent high-speed honing machine can fully realize unmanned intelligent operation, and has developed from traditional manual control to full closed-loop intelligent control. It can be used not only by a single machine, but also by multiple machines in parallel or series to form a honing system. The system integrates industrial robot, on-line automatic measurement system, automatic burr brushing device, automatic workpiece alignment device and workpiece conveying system[3]. In the honing process, various systems cooperate with each other to realize intelligent unmanned operation. While the machining efficiency is greatly improved, the machining accuracy and dimensional consistency are guaranteed. Firstly, the industrial robot can realize automatic loading and unloading, clamp the workpiece to the preset position, and then the workpiece reaches the honing station, measuring station and deburring station respectively through the conveying system. Using Vu high-speed honing machine, it can also be combined with a variety of external conveying devices such as conveying raceway, material tray, workpiece turntable and conveying raceway + material tray to form a fully automatic processing unit. Secondly, the automatic measuring device realizes automatic on-line measurement through a precision gauge, and

the measurement results are fed back to the control system to compensate for the wear of sand bars[4]. In addition, the measuring device can also measure multiple sections of the workpiece, the section position can be programmed, and the measurement results can be fed back to the control system, controlled by the control system to realize automatic shape correction.

4.2 High Speed and High Precision Motion to Realize High Efficiency and High Precision Machining

Vision ultimate intelligent high-speed honing machine adopts double drive reciprocating form, the spindle and fixture can move back and forth, and its stroke speed and stroke acceleration are greatly improved. Due to the use of linear motor driven fixture, the travel speed of high-speed honing machine can reach up to 200 m / min and the travel acceleration can reach up to 60 m / S2. When machining small hole parts, the equipment can realize up to 40 times / s reciprocating, while the traditional honing machine can only achieve up to 4 ~ 5 times / s reciprocating. It is this key technology that makes the machining efficiency of high-speed honing machine several times higher than that of traditional honing machine[5]. At the same time, the spindle speed of Vu high-speed honing machine is also greatly improved, up to 12000r / min, which can ensure a high grinding linear speed even when machining small holes, so as to ensure the machining efficiency and accuracy; N-E surface quality.

4.3 New Honing Tool

Vision ultimate intelligent high-speed honing machine adopts a new generation of honing tools, combined with the spindle self centering system, which can achieve high tool rotation accuracy. On the one hand, the new tool form further improves the machining efficiency. The maximum expansion of single honing can reach 100 um, integrating the advantages of reaming, honing and inner circle grinding. For the machining that needs 4 ~ 5 processes in traditional honing, only one process can meet the requirements by using Vu honing machine; On the other hand, the roundness and cylindricity of the workpiece after processing are also more accurate. The tool expansion mode of cylindrical surface makes the tool centering high and has a constant tool expansion path. A process can achieve high accuracy and the accuracy consistency is guaranteed[6]. At the same time, there is a cutting fluid channel in the honing rod. During honing, the cutting fluid is sprayed from the inside of the tool and directly onto the surface of the machined inner hole, which is conducive to chip removal and makes the honing bar not easy to be blocked. The workpiece material has little impact on the tool, and the failure probability is much lower than that of the traditional honing rod. Due to the relative tightness of the space and the large grinding contact area, the heat generated by grinding is difficult to dissipate. If the cooling is not good, it is easy to burn the workpiece surface, which will affect the machining quality and service performance of the workpiece surface. The cooling effect can be greatly improved by spraying cooling oil internally to effectively prevent grinding burns. Moreover, in the honing process, the honing sleeve is in contact with the workpiece, and the honing rod has no contact. Only the honing sleeve needs to be replaced, and the honing rod can be used permanently in theory, which greatly reduces the use cost.

4.4 Advanced Control System

Control system is the soul of intelligent honing manufacturing system. The vision ultimate intelligent high-speed honing machine adopts an intelligent electric control system. The control system has the characteristics of high precision, high reliability and high sensitivity. Combined with the processing requirements and process steps, the control system can accurately coordinate the

joint work of various complex devices, realize intelligent processing, detection, feedback and adjustment, and ensure the highest processing efficiency and accuracy. Firstly, because Vu intelligent high-speed honing machine uses linear motor to move at high speed, how to achieve its high-speed stability and position accuracy is an important task of the control system. The system designs an S-shaped acceleration and deceleration trajectory planning algorithm to limit the acceleration to realize high-speed flexible reciprocating motion. Through multiple kinematic constraints, it produces a continuous acceleration speed control curve to avoid the impact on the mechanism[7]. For different configurations of parameters such as feed speed, stroke and kinematic constraints, automatically classify and determine a reasonable S-shaped acceleration and deceleration control strategy to optimize the processing time, ensure high accuracy at the reversing position and realize the stable and accurate control of high-speed reciprocating motion, which is of great significance for blind hole processing. Secondly, the precision servo feed system is directly related to the machining accuracy. The system adopts nano precision data sampling interpolation algorithm to realize high-precision fairing interpolation control in the control system. At the same time, the control accuracy (pulse equivalent) of the control system can be adjusted according to needs to meet a wide range of accuracy control requirements[8]. Thirdly, the control system has good expansion performance. According to the measurement signal fed back by the precision on-line measurement system, the honing processing is closed-loop controlled, and the processing is stopped when the processing requirements are met. At the same time, when multiple machines are processed in series, the system can expand the honing function. According to the measurement signal fed back by the measurement system, the control system can automatically allocate the machining allowance of each station to realize precision honing. It is the precise and powerful control ability of the intelligent honing control system that each system can organically integrate and coordinate the work, give full play to the efficiency of each part, and achieve high machining accuracy and machining efficiency.

5. Conclusion

Looking forward to the future, intelligent technology will penetrate into all departments of industrial production. Intelligent honing products have become an inevitable trend. Intelligent honing technology has a good market prospect and broad development space. Based on the development experience of intelligent honing products in the past, we will deepen international cooperation and exchange, accurately grasp the trend of future advanced technology from an international perspective, constantly strengthen the research and development of intelligent cutting-edge technologies, and strive to become a honing product manufacturing enterprise with international competitiveness and a leader in the domestic hole precision machining industry.

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