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RESEARCH ARTICLE

DESIGN OF POLAR COORDINATE WHEEL HUB MARKING MACHINE

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ARTICLE DETAILS

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ABSTRACT

In response to the problems of unclear printing, different printing positions, low efficiency, and complex operation in the process of marking the surface of domestic wheel hub production enterprises, a wheel hub automatic marking system composed of adaptive positioning, polar coordinate feeding, and automatic marking is designed. The positioning module is controlled by a photoelectric sensor and a servo motor together to stop the wheel hub at a predetermined position for marking. Polar coordinate marking machine, with high marking efficiency and easy control.

KEYWORDS

Pneumatic marking; polar coordinate feeding, adaptive positioning; Egg embryo

1. INTRODUCTION

With the rapid development of China's national economy, cars have become a common means of transportation in recent years. More and more cars are driving on highways, so the manufacturing volume of cars has also significantly increased, and enterprises related to the production of automotive parts have flourished. In order to standardize the products, the manufacturing enterprises of wheel hubs have marked the relevant information of the products on the surface of the wheels. This not only facilitates the management of the products by the enterprise, but also meets the basic understanding of the products by consumers. However, the technology for processing and labeling the surface of wheel hubs by domestic enterprises is not yet complete, and the process is complex and rough, which cannot meet the needs of automated production. Therefore, this technology is a key topic of our research (Zhang and Zhang, 2014; Xiong et al., 2013; Xu et al., 2015).

The marking technology of the wheel hub refers to printing necessary product information such as wheel diameter and width dimensions on the surface of the wheel hub during the machining process. The information marked on the aluminum alloy wheel hub should be clearly written, stored for a long time, and should not damage the quality of the wheel hub. Exquisite and reasonable marking can make the wheel hub more aesthetically pleasing and have a better sense of layering compared to other similar products (Wu et al., 2008).

At present, in China, enterprises often regard marking as the last step, simply printing the marked characters and graphics on the surface of the wheel hub through physical methods, which is relatively primitive. The biggest drawback of using this processing method is its low efficiency, limited marking content, and the difficulty in achieving unified specifications due to human factors during the processing. Most importantly, it cannot be used in large-scale automated production processes (Alan et al., 2002; Lee and Hong, 2017; Yuan et al., 2012).

In response to these challenges faced by domestic enterprises, this project has developed a pneumatic marking machine that utilizes PLC technology. I hope it can provide some reference significance for enterprises and other workers to explore this technology.

2. DESIGN OF WHEEL HUB MARKING MACHINE

2.1 The Overall Design of The Marking Machine

The marking technology of wheel hubs refers to the process of marking necessary instructions on the surface of the wheel hub, such as the diameter and width dimensions of the wheel hub. The printing effect should be clear and beautiful, neat and organized, and stored for a long time. To differentiate from other similar wheels and improve the overall quality.

The marking machine system consists of four modules as a whole, including control, marking, positioning, and polar coordinate feeding modules.

- The control module is mainly controlled by PLC to achieve the positioning, feeding, and marking of the marking system.
- The positioning module effectively stops the wheel hub in a predetermined position and achieves tight work when it is transported onto the conveyor belt.
- The marking module implements pneumatic marking of the wheel hub.
- The polar coordinate feeding module enables accurate positioning of the marking process.

2.2 Design of Actuator

- Hydraulic actuated robotic arms have great gripping strength, characterized by smooth movement, impact resistance, and good explosion-proof performance. However, hydraulic components require high precision and sealing performance.
- The advantages of pneumatic starting are convenient air supply, fast action, simple structure, and convenient handling. But the speed is unstable and the air pressure is too high, so the snatching ability is low.
- The common driving method for robotic arms is electric drive. Its advantages are convenient power supply, fast response, and large

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driving force. It is convenient for signal calculation, transmission, and processing, and can choose a variety of variable control schemes.

- Mechanical drive is only used in fixed environments for movement.
- According to the requirements of the project, we choose the electric drive method and use a stepper motor as the driving component.

3. Design of Positioning Module

The distance from the starting point of hub transportation to the marking position is three meters. When the hub is displaced by three meters on the conveyor belt, the motor stops working. The hardware settings of this system include Mitsubishi PLC, conveyor belt motor, photoelectric rotary encoder, Panasonic VFO system BMV0042GK variable rate device, etc. The working principle of this system is to connect the motorized shaft of the photoelectric encoder and the transmission rod on the same shaft. The transmission rod drives the mechanical shaft of the photoelectric decoder to move, output pulse signals, and use the efficient counting ability of PLC. The high-speed counter command accumulates the number of pulses emitted by the encoder. When the current value accumulated by the high-speed counter is the same as the preset value, it is interrupted, and the motor is controlled by the frequency converter to end working, This enables accurate positioning of the conveyor belt's operating distance.

Hub positioning: When the hub is sent to the positioning station through the conveyor belt, the photoelectric detection switch is turned on to detect whether the hub is in place. If it is not in place, the PLC sends a pulse signal to control the clamping device (robotic arm) to rotate and position. When the photoelectric switch shows that it is tightened in place, the next station is activated.

In the system, a closed-loop control system is composed of PLC, cylinder, grating ruler for measuring the movement of cylinder piston, and electromagnetic valve as the core of control calculation, as shown in the workflow below.

4. Design of Polar Coordinate Feed Module

Install a rotary operating platform driven by a stepper motor on the operating platform. In this system, when the stepper motor receives a feed pulse, the rotary operating platform rotates Δα The feed of the original horizontal stepper motor becomes polar feed in polar coordinates, and the polar stepper motor feeds when it receives a pulse Δ/ Mm. During the marking process, the marking head rotates around the main shaft, with the polar motor working to complete the polar feed, while the rotary operating table rotates to complete the circumferential feed. The previous operating table remains stationary.

When the detection system of the feeding machine detects that the wheel hub has reached the bottom of the marking head and is clamped, the PLC sends a pulse signal based on the trajectory of the graphics or characters to be marked, and the stepper motor is driven to operate by the ring distributor and power amplifier. Pulse signals can control the location, speed, and rotation direction of the stepper motor. At the same time, the PLC sends a signal to the solenoid valve, causing it to be in a high-frequency on/off environment, driving the marking head to work at high frequencies, and ultimately completing the marking of characters.

5. Conclusion

The polar coordinate wheel hub marking machine realizes the automatic connection between the wheel hub marking machine and the transmission, and automatically discharges the material after the marking is completed. The fully automatic transmission positioning system of the wheel hub is used to ensure accurate positioning of the wheel hub and clamping during marking. The automatic follow-up system of the wheel hub marking machine can automatically adjust the position of the marking machine in three dimensions according to the size of the wheel hub to be marked, completing the automatic marking control of the wheel hub. The marking process is fully automatic.

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