Trouble-Shooting and Analysis of Mechanical Structure of CNC Equipment Based on Internet of Things

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Abstract: Based on the analysis of the current reliable mechanical structure of CNC equipment, this paper introduces a new method--Internet of Things technology into the troubleshooting analysis of the mechanical structure of CNC equipment, and establishes a system structure for troubleshooting the operation of CNC equipment based on the Internet of Things. Aiming at the problems of equipment management such as the ineffective supervision of many equipment in the CNC equipment group, inadequate maintenance and CNC structure troubleshooting system based on networking technology. The overall design and hardware and software design of the system are introduced, and the Internet of Things technology is introduced to make the numerical control equipment an intelligent terminal that generates transparent data information, and stores and analyzes the data generated in the production and management links during troubleshooting. The composition of the system hardware and software is introduced, the design process of the system hardware is explained in detail, and the circuit of each part of the hardware is established; the function and use technology of each part of the system software are introduced, and the realization method of the system is studied and developed Prototype system. The development and application of the system show that the scheme is an effective method to solve the reliability failure analysis problem of CNC equipment.

1. Introduction

Generally speaking, numerical control equipment facilities are very sophisticated, and a complete numerical control equipment contains a number of different components, such as numerical control devices, servo units, mechanical devices, and so on. In the course of use, various failures often occur in the operation of CNC equipment. Numerical control equipment is a kind of extremely complex mechatronics high-tech products, it is the “worker machine” of the equipment manufacturing industry, and the key equipment to revitalize the manufacturing industry. Among the many indexes of numerical control equipment, users have extremely high requirements for the reliability indexes of numerical control equipment [1]. If the CNC equipment is unreliable and high performance cannot be maintained, its availability will be lost. Therefore, reliability technology has become a bottleneck in the development of national numerical control equipment, and improving the reliability of domestic numerical control equipment has become the unanimous voice of the industry [2]. Most of the reasons for the low reliability of CNC equipment originate from the design and assembly stages, but the running process is the most direct reflection of the reliability of the CNC equipment. Therefore, to improve the reliability, the reliability of the CNC equipment must be measured during processing. control.

The Internet of Things is formed by connecting any item with the Internet of Things according to an agreed protocol through information sensing equipment such as infrared sensors, radio frequency identification and global positioning systems, and exchanges and communication of information in the new network to achieve intelligence A network of identification, location, tracking, monitoring and management. The CNC equipment operation monitoring and troubleshooting system based on the Internet of Things technology collects various dynamic parameters in the operation of the CNC equipment in real time, and transmits them to the information system through a wireless network to complete the real-time display and processing of the data, and process it. The results are fed back to

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manufacturers, users and government management, so as to realize real-time monitoring and troubleshooting of equipment [3]. The establishment of equipment safety monitoring system can firstly realize fault troubleshooting and alarm, reduce the occurrence rate of equipment failure, and improve the repair speed of faulty equipment; secondly, it can obtain equipment operation reliability data in real time, and at the same time provide accurate assessment and provision of equipment real-time reliability level Data and technical guarantees.

2. Requirements for the Mechanical Structure of Cnc Equipment

Starting from the structural characteristics and application scenarios of the numerical control equipment, it is necessary to ensure that the numerical control equipment meets the following requirements in terms of operating performance. First, the higher dynamic stiffness and static stiffness of the equipment [4]. It is necessary to control the elastic deformation of numerical control equipment components in the long-term operation process to the greatest extent to ensure the surface quality and processing accuracy of the equipment. Second, reduce the thermal deformation of the equipment. Related maintenance and repair work must meet the requirements of reducing equipment heat, find the heat source of the equipment, and share the heat source from the digital equipment. At the same time, cooling control is performed on the heat source that plays an important role. Locally heat the low-temperature area of the equipment to avoid thermal deformation of the equipment caused by the temperature difference on the surface of the equipment, and to maintain the structure of the equipment. Third, reduce the transmission gap and friction generated during long-term operation [5]. Fourth, improve equipment accuracy retention and service life. Maintenance operators should maximize the wear resistance of key equipment components. Use different lubricants for different raw materials to improve the running smoothness of the equipment hardware system.

3. The Troubleshooting Process of the Mechanical Structure of Cnc Equipment Based on the Internet of Things Cnc

3.1 Hardware Analysis of Mechanical Structure of Numerical Control Equipment

The hardware part of the CNC equipment operation monitoring and troubleshooting system is composed of sensor data and CNC system interaction circuit, sensor and RFID interaction circuit, general control circuit, GPRS communication circuit, RFID electronic tag and power supply, as shown in Figure 1.

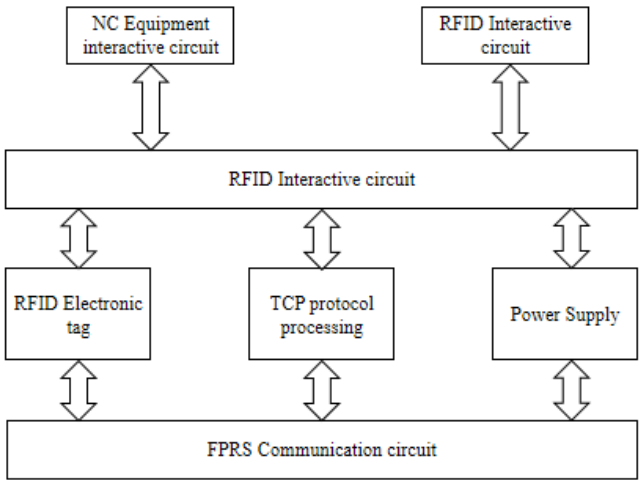

Fig.1 Overview of Hardware Functions of Cnc Equipment

The hardware circuit can collect all kinds of information in real time, realize uninterrupted monitoring of the operation status of the numerical control equipment, and promptly alarm for

hidden safety hazards. Due to the length of the article, not every hardware implementation is elaborated in this book, only the important ones are selected for detailed explanation.

3.2 Numerical Control Equipment Sensor and Numerical Control Interactive Circuit

Numerical control equipment operation monitoring and troubleshooting system needs to monitor multiple parameters, which belong to different sensors or parts of the numerical control system. These data must be connected to multiple L/0 interfaces to be transmitted to the hardware system. The subsequent upgrade of the system leaves a certain margin. The processor selected for the total control circuit of the system in this article is STM32F103. STM32F103 is a medium-capacity enhanced single-chip microcomputer, 32-bit, ARM core-based microcontroller USB with 64 KB or 128 KB flash memory, using ARM32-bit Cortex-M3 core, operating frequency of 72 MHz, with rich enhanced I/ O port, which contains 2 12-bit ADCs and 9 communication interfaces. The processor fully meets the design of the system.

The sensor data acquisition circuit mainly completes the collection of various parameters that affect the reliability of the numerical control equipment. In the design of the acquisition module, it is first necessary to perform signal conditioning on the signal transmitted by the sensor to transform it into a suitable voltage signal. The strong electric signal also needs to carry on the optocoupler isolation circuit design, in order to improve the anti-interference of the system [6].

4. Analysis of the Running Program of Numerical Control Equipment Based on the Internet of Things Numerical Control

The module mainly realizes the collection, storage and statistical analysis of the operation status data of the numerical control equipment. These data mainly include the start-up time, processing time, repair time, maintenance time, shutdown time, failure time, etc. of CNC equipment, which is the basis for the reliability evaluation of CNC equipment. As the data is constantly updated, the reliability indicators obtained by the system in this article are also constantly updated. With the continuous increase of data, the results obtained are more and more accurate, realizing the real-time evaluation of the reliability indicators of CNC equipment.

All parts of CNC equipment need regular maintenance, but in fact, many users ignore the importance of equipment maintenance, making the equipment cause large and small failures due to poor maintenance [7]. This module builds a maintenance monitoring system through the secondary development of the numerical control system, which monitors the maintenance items in real time throughout the entire process, and displays the items detected to require maintenance on the maintenance interface. Only the user is responsible for all maintenance items (including: hydraulic oil level, lubricating oil level, air conditioning vents, complete machine, oil cooler temperature, hydraulic gauge pressure, lubricating oil pressure, pneumatic system pressure, hydraulic leakage, cutting cleaning and Cleaning and sanitation, etc.) After maintenance activities are carried out, the CNC equipment can continue to operate normally.

5. Fault Diagnosis of Mechanical Structure of Numerical Control Equipment Based on Internet of Things Numerical Control

Mechanical failure mainly refers to the failure of the spindle, feed motion system, guide rail, etc., which makes the functions of the CNC equipment unable to fully or partially perform.

Based on the characteristics of the Internet of Things numerical control, a comprehensive analysis of the numerical control equipment is the first, and the accuracy does not meet the design requirements. Numerical control equipment has very high requirements for accuracy. If the accuracy does not meet the requirements during processing, there may be different factors. For example, the equipment is in an impact state during transportation, and the installation firmness during installation is not high. Therefore, we must conduct an all-round investigation of the accuracy of the entire equipment, especially the key inspection of the guide rail pair. The problems arising during the inspection shall be summarized in time, adjusted again and reinforced. Second,

high cutting vibration may also cause certain failures in the mechanical structure of CNC equipment. There are many reasons for the large cutting vibration, for example, the bearing tightness is not enough, the intermediate gap is too large; the gap between the spindle and the box is too large; there is any looseness of the linkage screw between the spindle box and the bed. In order to better eliminate this fault, we should make specific solutions according to the specific situation [8]. Third, the headstock may also have the disadvantage of greater noise. When the numerical control equipment is working, the headstock noise should generally not exceed 78db. If the noise of the spindle box of the numerical control equipment exceeds this value, there may be a fault. There are many reasons for this phenomenon. For example, the internal components of the main shaft are not balanced; the gap between gears and gears is uneven; the length of the transmission belt is not uniform; for these phenomena, the bearings can be replaced or repaired, the transmission belt can be adjusted or replaced, the balance work should be done again, and the gap should be adjusted. Make the gear and gear gap more uniform. Fourth, the gears and bearings are damaged. There are many reasons for this phenomenon, such as excessive pressure; excessive bearing tightness, and little lubrication measures [9]. In view of the above situation, we can appropriately adjust the pressure according to the schematic diagram, replace the parts, reset the tightening force, and strengthen the lubrication effect.

Numerical control equipment has many research and damage problems, but the main problem is that the use time is too long, and the foundation and bed level have changed to a certain extent, which makes the local area debt and excessive. At the same time, if it is used extremely quickly in a short period of time or used for a long period of time, it may also cause serious losses in some areas. Strengthen the lubrication effect of the guide rail and maintain the lubrication pressure. Carry out regular maintenance and protection for the equipment.

There is no lifting motion in the workbench. The reason for this failure is mainly due to a problem with the control system, which did not do a good job of signal input in time [10]. At the same time, insufficient hydraulic pressure, damage to the lifting cylinder, etc. may also cause failure of the rotary table. The indexing index of the worktable is not in place, and top teeth or wrong teeth may appear. Since the indexing index of the numerical control equipment is not in place, the top gear or the wrong gear is mainly due to the insufficient number of pulses in the input system.

6. Conclusions

This paper uses the above-developed CNC equipment mechanical structure troubleshooting system to conduct a practical trial on a domestic equipment company. During the trial process, the system realized the real-time monitoring of the company's numerical control equipment, mainly including: real-time collection of processing data and operating data of the equipment user manufacturer; b) realized the continuous update of the reliability index of numerical control equipment; realized the numerical control Mandatory maintenance during equipment operation; real-time monitoring of the operation process of CNC equipment is realized. Based on the Internet of Things numerical control, the Internet of Things numerical control technology is applied to the numerical control equipment group, which improves the operation management and maintenance level of the numerical control equipment, and realizes the remote monitoring and troubleshooting of the working conditions and processing information of the numerical control equipment itself, and enables the later operation and maintenance of the numerical control equipment Has been effectively guaranteed. Based on the reliable operation and accurate data of the Internet of Things, the CNC can accurately troubleshoot the monitoring data, reduce the incidence of equipment failures, and achieve the expected functions.

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