Networked Remote Monitoring System for NC Turret Punch Press

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Abstract. With the rapid development of the modern technology, 3G network technology has become increasingly widespread. Using the high speed transmission characteristics of 3G network technology, the system components of a remote monitoring system based on 3G for NC turret punch press (NCT) is proposed, which solve slow transmission rate, narrow bandwidth besides faults of other network used in NCT. Based on the analysis of the 3G network technology application in the remote monitoring, the application architecture of the remote monitoring system is presented that suits for NCT, and a complete design plan of hardware and software is provided to achieve 3G technology applying to remote monitoring of NCT. A reference to network management and maintenance for manufacturing equipments is given.

Introduction

NC turret punch press (NCT) is a leading-edge product in pressure processing equipments, which is combined with electricity, liquid and gas, and also an important symbol of the modern production. With the wide application of information, networking and intelligentize in the manufacture equipment, the intelligent processing and monitoring function of NCT has become the main development characteristics and future trends. According to the technical characteristics and field requirements of digital and intelligent production of NCT, it is a key problem of NCT network management and monitoring to design superior performance of production data acquisition, control terminal and selection of appropriate network communication mode. The feasibility of 3G communication technology in NCT network application is analyzed in the paper. Combined with remote monitoring and single chip technology, a kind of remote real-time monitoring system is put forward based on 3G network technology for NCT.

At present, NC machine tools mostly use RS232, RS485, GSM, GPRS and other communication technologies, but they have lacks of wiring inconvenience, poor compatibility, low transmission rate of data collection terminals and so on. In fact, they can only do some simple data transmission. For the rapid and large data stream of remote real-time monitoring, they cannot meet the requirements effectively. In contrast, 3G network technology has the advantages of more significant bandwidth, data transmission security and a higher transfer rate, and its bandwidth can carry images, audio, streaming video and other media data [1]. 3G technology applied to the remote monitoring system for NCT can be suited well for the real-time operational states monitoring, real-time data acquisition, online fault diagnosis and manufacturing information fusion.

System Components of Remote Monitoring Based on 3G for NCT

The remote monitoring system based on 3G for NCT is mainly composed by NCT remote monitoring and management center, 3G communication system and field data acquisition terminal. The remote monitoring and management center mainly manages and controls the whole system, completes the human-computer interaction, establishes the network link, manages the equipment and person, and sets parameters. 3G network is a medium of communication for the whole system, so it can realize the
function of communication protocol conversion and data transmission upper and lower transmission. The field data acquisition terminal is the core of the whole system, it can mainly complete real-time data acquisition, processing and transmission of the NCT, and also can receive and perform data and instructions of the remote monitoring and management center.

In the system, the field data acquisition terminal and the remote monitoring center that distribute in different processing workshop or region, realize upper and lower transmission of relevant production data through wireless communication technology based on 3G, make the monitoring terminals become interactive whole. Internet is used to realize the interconnection between remote monitoring management center and 3G network. The remote monitoring and management center for NCT is connected to the Internet, using the router that supports full agreement to implement the 3G communication.

Remote Monitoring and Management Center for NCT

Hardware Components

The remote monitoring and management center based on 3G for NCT is mainly composed by two modules: hardware and application software. The hardware system includes head monitoring machine, application workstation and data server, which communicate with each other through the Intranet/Internet, in order to achieve a complete management and data sharing platform. The head monitoring machine is mainly responsible for the establishment of a link between the network and the transit of the data transmission, and also can maintain the IP address assignment of all access terminals and configure the field real-time monitoring terminal. When need to acquire the field real-time monitoring terminal data, according to the equipment configuration parameters, the instructions will be sent to the terminal, while terminal completing response then the acquisition data will be back to the workstation. The monitoring application and management software is installed on application workstation, which can provide system maintenance, communication management, application and service management. The data server mainly processes all kinds of data collected by real-time monitoring terminal. According to the characteristics of 3G network that can’t be accessed directly, this paper presents a new solution method, adding DDNS-dynamic domain name service to the server, therefore, to easily realize the access of external network and interconnect the 3G network and the existing cable network [2]. The field data acquisition terminal itself can't be accessed directly, but the application of data access, analysis, processing and other application services for the field data acquisition system can be finished by the server’s DDNS service and the external network IP. The data server provides supports for the data resource sharing and network security, so that the terminal-users can have the safe and reliable wireless remote monitoring application for NCT at anytime and anywhere.

Software Function

The monitoring center software runs on the application workstation and head machine, including application management, communication management, service management, database management, communication access and human-computer interaction module. The monitoring system software functional division is shown in Figure 1. The monitoring software mainly completes acquisition and summary data from the real-time monitoring terminal, configures and controls the terminal equipment operation, stores the terminal operating data, and also completes the classification, processing, analysis task for the collected data. At the same time, it can establish the fault alarm and diagnosis processing mechanism. When the field real-time monitoring terminal gets abnormal signal, operate the failure emergency processing program, such as control the NCT emergency shutdown, alarm and transmit fault data etc. When the remote monitoring center gets the relevant fault information, together with the field terminal to complete the fault handler, and also analyze and record data that got before and after the fault, for finding and excluding fault to provide reliable technical basis.
Selection of 3G Communication Standards

3G is the 3rd Generation, meaning for the third generation mobile communication technology, it is a new generation communication system that can combine wireless communication with Internet and other multimedia communication [3]. In May 2000, ITU-T (International Telecommunication Union) determined four mainstream wireless interface standards: the W-CDMA, CDMA2000, TD-SCDMA.

W-CDMA is the Wideband Code Division Multiple Access, it is specifically formulated by 3GPP, based on GSM MAP core network, UTRAN (UMTS terrestrial wireless access network) as the wireless interface of the third generation mobile communication system. At present, WCDMA has Release 99, Release 4, Release 5, Release 6 and other versions [4]. CDMA2000 (Broadband CDMA technology) is developed by the narrow band CDMA (CDMA IS95) technology, also known as CDMA Multi-Carrier, which also has CDMA2000, CDMA2000 1xRTT, CDMA2000, CDMA2000 several versions. CDMA2000 is fully compatible for CDMA (is-95) system, which brings significant benefits for the continuity of the technology and increases the maturity and reliability, also makes CDMA2000 transfer from the second to the third generation mobile communication which becomes the most smooth transition selection. TD-CDMA called the Time Division- Synchronous CDMA, the 3G standard is alone developed by the Chinese mainland. On June 29th, 1999, the China former Ministry of Posts and Telecommunications Research Institute of Science and Technology (Datang Telecom) proposed to ITU. WIMAX stands for Worldwide Interoperability for microwave access, also known as the 802·16 wireless metropolitan area network, it is another broadband wireless connectivity solution for businesses and home users to provide the 'last mile' [5]. On October 19th, 2007, the wireless communication approved in the international telecommunication union in Geneva conference which becomes the fourth global 3G standard after the WCDMA and CDMA2000 and TD-SCDMA.

In the above four standards, W-CDMA is the most widely used, and also the most mature industry chain. In practical industrial applications, it can realize high network speed, network evolution smooth, higher spread spectrum gain, wide network coverage. In water conservancy, meteorology, environmental protection power facilities, wind power equipments, automobiles, home appliances are also widely used, so this system design uses this standard.

Design of Field Real-time Monitoring Terminal

NCT is mainly composed by numerical control system, servo system, electrical system, transmission system, machine bed and other auxiliary equipments [6]. The data types needed to monitor include...
vibration, temperature, switch quantity, pressure, video, rotational speed, sound, stress and strain etc., so we need to choose the sensor of analog or digital quantity according to the need.

**Hardware Module of Real-time Data Acquisition**

The real-time monitoring terminal is designed based on ARM embedded system, and the hardware design diagram is shown in the Figure 2. The hardware includes Micro control unit MCU(S3C6410), the data acquisition module (analog signal acquisition and digital signal acquisition), W-CDMA module [7] (Huawei's MU203), display module, audio video module, external storage module etc. Micro control unit MCU is the whole field real-time monitoring terminal center, which can complete mass data processing work of terminal. In this system, Samsung S3C6410XH-66 is used, which kernel is ARM1176JZF-S, and the optimized result can reach 1 GHZ, so that it can meet the requirements of real-time data acquisition processing speed, power consumption and stability. Other interfaces include the Ethernet RJ45 interface, audio interface, video interface, the convenient expansion for USB interface, and output interface connected the LCD display device linking the NCT system. The collected data can be sent back to the data terminal server, or stored up to the SD card that can reach 32G.

![Figure 2. The hardware design diagram.](image)

**Real-time Data Acquisition Software Module**

![Figure 3. Field real-time monitoring terminal flow chart.](image)
After starting the field real-time monitoring terminal system, firstly, initialize the W-CDMA communication module, through AT commands to initialize the parameters setting of the MU203 and establish a data connection with the remote monitoring and management center. Finally, run the terminal detecting procedures, if the remote command information is detected, it will receive and then transmit to the MCU to process.

MU203 uses the UTMS network, the serial interface is a 60-pin B2B full-duplex UART port. Through the monitor terminal software, users send AT command to collaborate with MU203. MU203 module needs SIM to log on network, and complete data storage, user authentication and information encryption algorithm. MCU will transmit the collected real-time operational states from NCT and all kinds of sensor data through the serial port communication to MU203. Then MU203 sends the data to the remote monitoring management center, finally complete the system communication data transmission. NCT field real-time monitoring terminal flow chart is shown in Figure 3.

Conclusions

The remote monitoring system for NCT uses the 3G network as data communication platform, and makes full use of the 3G’s advantages: high network data transmission speed, high bandwidth data transmission. Considering the complex structure of NCT’s electricity, gas, hydraulic pressure, and with the development trends of automation, intelligent, network, it has the ability of a variety of acquisition data type, high precision, high real-time performance data transmission, flexible and easy extension. With the constant improvement of the 3G network construction, the machine vision, fault self diagnosis, all kinds of production information software will be integrated together, and the monitoring management also will be implemented at anytime and anywhere, so the application of 3G network technology will play a significant role in promoting our country’s manufacturing information.

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References


