

Design of remote monitoring system for 3D printing nano diamond film

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Abstract. The rapid development of the 3D printing industry has had a positive impact on all walks of life. Compared with the traditional manufacturing industry, 3D printing could not only shorten the design and manufacturing cycle, but also had great advantages in manufacturing accuracy. With the rapid development of cloud computing in recent years, the combination of cloud services and 3D printing had produced a new production model. This paper proposed to use single-screw extrusion 3D printer to prepare nanodiamond films. In order to monitor the printing process, cloud servers were used to monitor 3D printing remotely. This paper designed a remote control and monitoring system based on cloud platform, Alibaba Cloud server was used to integrate information resources, and finally made remote control of 3D printing equipment, remote video monitoring of printing process, and used image processing to preliminarily judge the integrity of printed objects.

1 The preface

3D printing technology was a new construction technology adapted to digitalization and intellectualization, which can greatly improve the construction efficiency and reduce the loss of raw materials [1]. 3D printing was called additive manufacturing due to its manufacturing characteristics. According to the product digital model, 3D graphics could be formed by using slicing software to print a certain part and the overall advanced manufacturing technology^[2]. The research of Chinese academician Lu Bingheng showed that 3D printing has obvious advantages and practical value in many industries^[3-4]. The technology achieved complex and diversified production structure, intelligent and automatic production process, saves raw materials and labor costs, so it was widely used in major manufacturing industries.

Cloud computing was not only a way of data storage and processing, but also a new way of thinking. To be exact, cloud computing can provide a service platform for configuration, computing and storage according to the needs of users. Cloud computing, as a new service method, needed to be fully automated and highly stable central server support when facing a lot of data [5]. Based on cloud platform technology, intelligent development can be achieved in different product areas [6].

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Like diamond, nano-diamond has special properties due to its unique structure [7]. Diamond has been widely studied for its excellent physical properties, such as good optical transmission, chemical stability and high mobility of electrons and holes [8-9]. In response to the CPC Central Committee's call for innovative, coordinated, green, open and shared development, in this design, nanocrystalline diamond with large surface area advantage was used to replace monocrystalline silicon, and 3D printing technology was used to replace high energy consumption and high pollution monocrystalline silicon preparation technology. Remote control and monitoring of printing equipment based on cloud platform.

2 Overall scheme design of the system

2.1 Overall design of the system

In order to reduce the idleness of a large number of manufacturing resources and break away from the stand-alone mode, users could choose 3D printers independently to meet the needs of private customization and more humanized services. The overall design of system functions was as follows:

The upper computer was started by software and transplanted to the cloud server. The FDM type 3D printer could access remote control through the whole network of the cloud server.

Real-time monitoring of working parameters enabled the system to set and monitor printing parameters in real time.

The system could monitor the printing condition of printed matter by using sensors and make preliminary judgment.

The cloud server was established, and the client could access the equipment operation, personnel management, video monitoring and other resources through the web page. Based on the above functional requirements, the system was composed of control system, video acquisition system, cloud platform, etc., as shown in Figure 1.

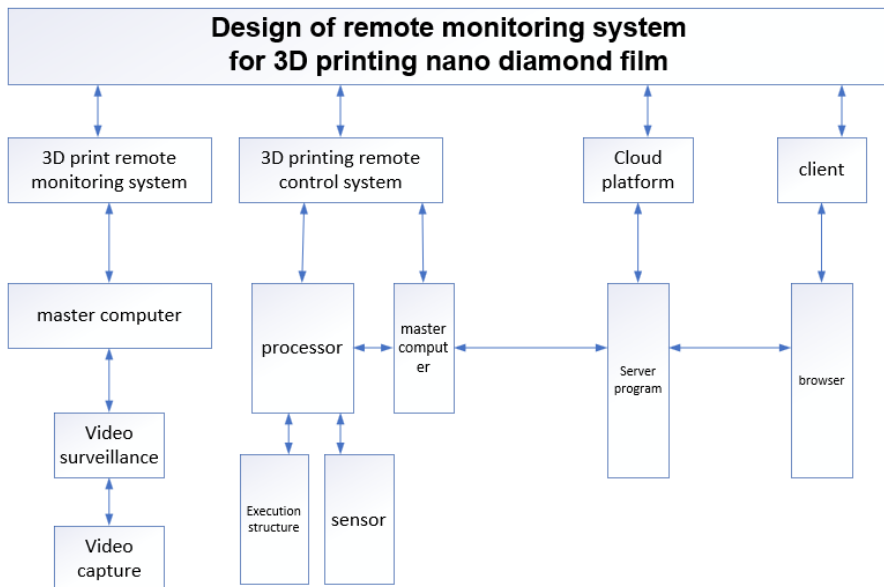


Fig. 1. Overall design drawing of the system.

2.2 Selection of 3D printer related devices

The 3D printer processor determined the accuracy and processing speed of the printer. In this paper, the ARM series 32F407 chip was used. This control chip had low power consumption and fast speed in information processing, which can meet the requirements of system timeliness. The temperature sensor adopted NTC thermistor, which is characterized by high sensitivity, fast response, compact structure, simple installation, wide temperature range, good stability and high reliability. Stepper motor was an important part to execute the commands of the upper computer system, which controls the movement of the XYZ axis of the printer. Its accuracy and response ability affected the printing speed and the quality of finished products. Therefore, 42 closed-loop stepper motor was adopted in this design.

2.3 Selecting the server and client

This paper used a small cloud service lightweight server provided by Alibaba Cloud. Lightweight servers included all resources, such as instance specifications, block storage, mirrors, snapshots, bandwidth, and security groups. Lightweight application servers could be configured through management or API. The running speed and processing speed could meet the requirements of the system, and the development was simple and the maintenance was convenient.

The web version client design used HTML technology for web page development, mainly used HTML and CSS for web page construction, used HTTP protocol data transmission, and used GET for login verification, and accessed the resources stored on the cloud platform, all used open source.

3 Design of remote control system

3.1 Control system structure

The FDM3D printer processor used STM32F407, and the control system mainly included the processor STM32F407, 220V AC power supply, DC motor, motor drive module, print nozzle, thermistor, material breakage detection module and cooling fan. The system structure was shown in Figure 2. The control system was mainly used to execute the command of the upper computer. For the setting of parameters, the upper computer used the WiFi serial communication to set the temperature of the printer's print nozzle and the temperature of the hot bed, and used the parameters returned by the sensor to correct.

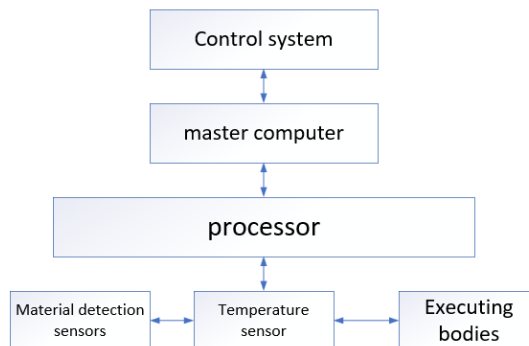


Fig. 2. System structure block diagram.

3.2 Master computer and communication of control system

The communication between the upper computer and the cloud server was to use the WiFi transmission module ESP0809, and established a connection with the cloud platform through the WiFi module to complete the data transmission and control command execution with the cloud server. Figure 3 was the data transmission flow chart. The data receiving was based on the monitoring of the port, whether the data request receives the request, then received the data packet, saved it to the local server, and then called the data in the packet.

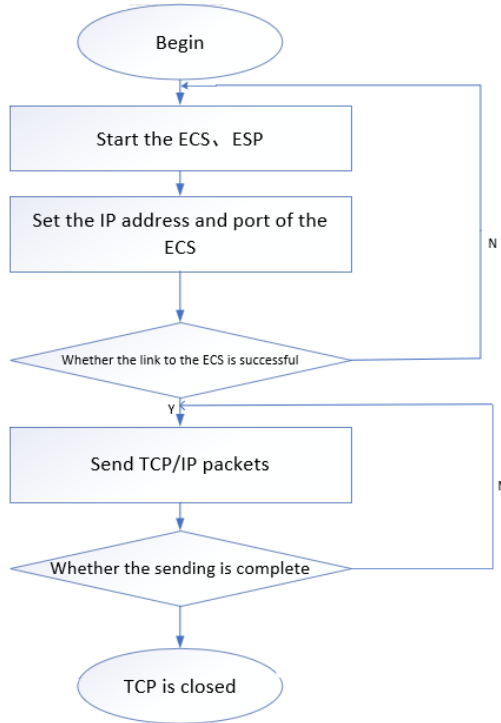


Fig. 3. Data transmission flow chart.

4 Construction of cloud server and design of client

4.1 Construction of ECS

The lightweight server of Alibaba Cloud used in this article is the simple application server selected according to the system requirements. It is characterized by fast processing speed, easy to build cloud servers, rapid establishment of cloud servers that adapt to the system, and fully meets the system needs.

After the MySQL database was established, it connected with local data, completed the editing environment, installed and used browsers and servers, and migrated the web-based web page monitoring system to the cloud platform, including the establishment of APIs. Then the control system was ported to the cloud server through API, and for the sake of network security and port call, the web page security settings and port opening settings were completed, and the required cloud platform was finally built.

4.2 Design of web client

The client of this design adopted B/S architecture. Compared with the traditional C/S architecture, the B/S architecture can cross platforms, and does not need specific clients. The B/S architecture mode based on web technology, simple software installation, maintenance and update. At the same time, users only needed a browser to access the system. Because all function additions only needed to be operated and completed in the background, the system had good scalability^[10].

Using the B/S architecture, the system was divided into four modules. The first was the login module, which is used for user login. After successful login, the system entered the main interface. The main interface was divided into equipment management, personnel management, parameters and monitoring interfaces. The equipment management mainly included equipment list and equipment operation record group. The personnel management included personnel list, and the parameters and monitoring module included print data setting and video monitoring. The system function module was shown in Figure 4.

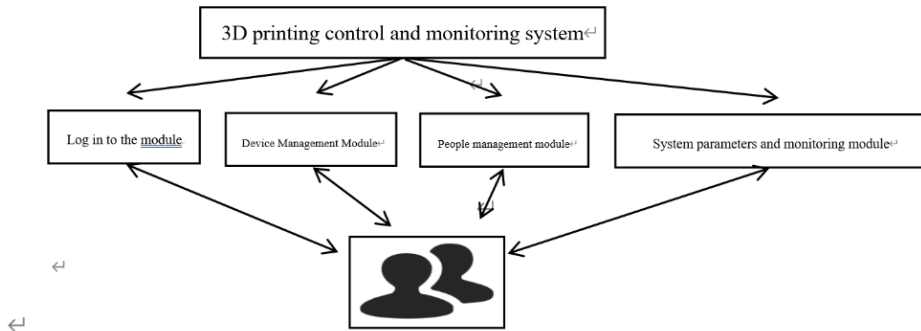


Fig. 4. System function module diagram.

5 Summary

Based on the relevant technology of the 3D printing remote control and monitoring system of the cloud platform, this paper developed a process that could be used to print nano-diamond films in 3D, and could realize remote monitoring of printers through the cloud platform. This design realized the remote control of FDM type 3D printers through the whole network access of ECS. In order to better and more intuitively display the operation of the device and facilitate client maintenance, HTML+ssc+js language and zend and MySQL database software were used to design the web client database. This article used Alibaba Cloud as the system's cloud server, and installed Apache, Tomcat, JDK, eclipse, and MySQL software to build the cloud server for remote control and monitoring of 3D printers. The safety settings of the firewall, the port settings, the settings of the communication HTTP and TCP were performed, and the remote access function of the cloud server was completed.

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