Online 3D Printing Remote Monitoring and Control System Based on Internet of Things and Cloud Platform

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Abstract. For the situation where 3D printers have not been widely popularized, and there is a high demand for 3D printing, a visual and controllable online 3D printing cloud platform technology based on the Internet of Things is proposed. The main components of the system consist of a remote terminal module (based on the Arduino mega2560 main control board), a remote communication module (using the ESP8266 wireless module) and a web-side web page. The system uses the Arduino UNO controller as the control core to coordinate the stepper motor drive of the 3D printer, real-time temperature detection of the nozzle body, real-time image return and heating system. The required data is transmitted to the server and finally realized on the webpage end. The user can observe the real-time data on the webpage side, and the printing progress, etc., and can also control the printer on the webpage side, thereby realizing the purpose of 3D printing remote control.

Keywords: 3D printing · Internet of Things · Remote control · Real-time monitoring

1 Introduction

The concept of 3D printing had emerged as early as 19th century, and was subsequently promoted and developed globally in the twentieth century. 3D printing, compared with the original traditional production process, uses additive manufacturing as brand-new technology and combines the characteristics of many fields such as hardware control, molten materials, machinery, etc. Through selective bonding layer by layer stacking method, 3D printer manufactures parts using bonding materials such as wire plastic or photocurable resin. According to the path witch automatically generated

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by machine, it could print out the pre-designed parts quickly layer by layer [1–3]. Because of the unique advantages of 3D printing, it has become a development direction in the industrial field. With the rapid development of 3D printing technology, it has been widely used in many fields such as Aerospace, Medical Equipment, Automotive Molds, Bioreforestation, Electronic Devices, and Architectural Design [4–6].

The emergence of 3D printing has had a huge impact on the manufacturing industry. The arrival of the 3D printing era provides a new solution which combines the Internet technology and 3D printing technology. Through the terminal wireless network technology, 3D printing has transformed from the "simple manufacturing" of the original single device to the "intelligent manufacturing" of the network information-ization [4]. We could remotely control 3D printers by changing the format of limited transmission data to wireless transmission data.

2 Research Status and Development Trend

As early as 1988, a company in the United States introduced the first commercial-purpose model for the masses based on the first proposed 3D printer principle using liquid photosensitive resin curing technology, which enabled the public to have a preliminary understanding of 3D printing technology [7]. In 1992, the concept of "3D printing technology" was proposed by two professors at the Massachusetts Institute of Technology in the United States, brought the 3D printing to the public and began to be noticed by everyone [8]. Along with the rapid development of RP, a serious of 3D printing technology like Three-dimensional Printing, FDM, Laser Selective Melting

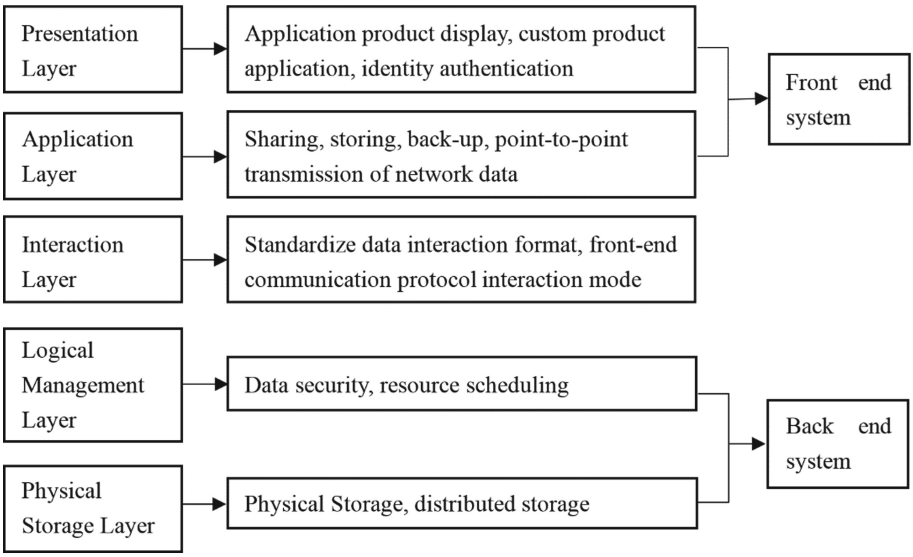

Fig. 1. Cloud platform overall application architecture diagram

Molding, Selective Laser Sintering, Electron Beam Melting Deposition Molding, Layered Solid Modeling etc. have been developed.

In recent years, with the development of emerging industries such as Information, Internet and Electronic Technology, the subject of the Internet of Things has been developed. It is based on computer and Internet-based technologies. Through the combination of the Internet of Things and 3D printers, it is basically possible to control the 3D printer inside the LAN (Local Area Network). The current development direction of 3D printing is the combination of monitoring technology and new technologies of the Internet of Things to do remote multi-machine joint printing.

3 3D Printing Cloud Platform

According to the overall needs of the website, the overall structure of the customized printing platform is as follows:

3.1 Presentation Layer

The part that the user directly touches is the presentation layer part of the application, which can have a general display of the product. It can be a web interface, and the user interacts with the website through operations.

3.2 Application Layer

By storing the data to implement the functions of the application layer, data storage, modification, backup and peer-to-peer transmission of the late data can be performed. The overall functionality is greatly enhanced by packaging the data and providing a connection interface.

3.3 Interaction Layer

The browser connects to the server through the interaction layer. The data interaction layer transmits the data of the browser to the server, but the premise is that the data format must be unified, and the same communication protocol must be observed. We choose to use Http communication, it ensures the stability and reliability of communication and prevents data loss.

3.4 Logical Management Layer

Through the logical management layer to interact with the data. Coordinating multiple servers to work together through algorithms, managing these devices collaboratively, and then performing resource allocation and data scheduling through distributed management methods.

3.5 Physical Storage Layer

As the lowest layer of the entire platform architecture, physical devices can be used to store data information, and redundant resources can be integrated for reasonable allocation, saving space and improving efficiency. As in Fig. 1.

4 Overall Design of System

The entire system framework is based on web pages, cloud platforms, local LAN gateways, and 3D printers. Information exchange through a LAN connection.

The user sends a connection request to the 3D printer through a prescribed instruction which is used to connect web side with the cloud platform. After parsing this request through the 3D printing cloud platform, the required request is sent to the 3D printer, waiting for the 3D printer to confirm. When the 3D printer receives the request, it feeds back the status to the cloud platform according to its own situation and then feeds back to the user terminal. As in Fig. 2.

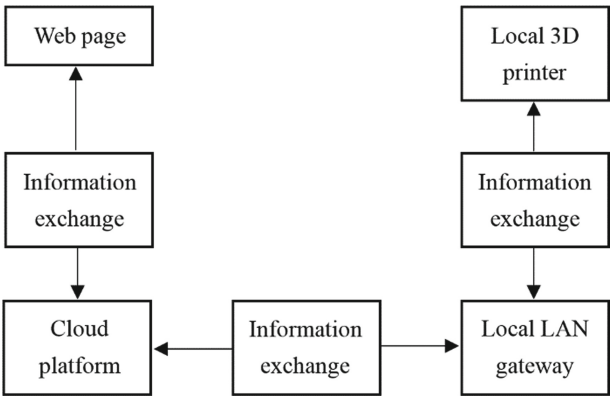

Fig. 2. System overall design

5 Data Storage System

First, the user on the web side uploads the model file to the web page, and then the web client sends the model file to the server. The server receives the model file and stores it in the cloud storage space. Finally, the URL (Uniform Resource Locator) address of the model file is written into the data table. We can find the corresponding model file by URL address. As in Fig. 3.

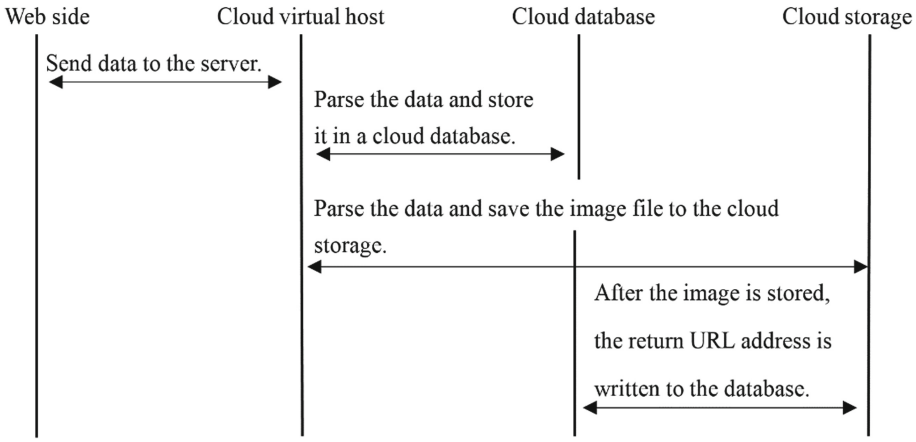

Fig. 3. Model storage implementation process

6 System Development

6.1 Log in System

The login interface serves as the website facade. In order to verify the user's login rights, the user name and password are verified, and the user behavior is recorded. This site uses HTML CSS (Hyper Text Markup Language, Cascading Style Sheets) styles to design the site. As in Fig. 4.

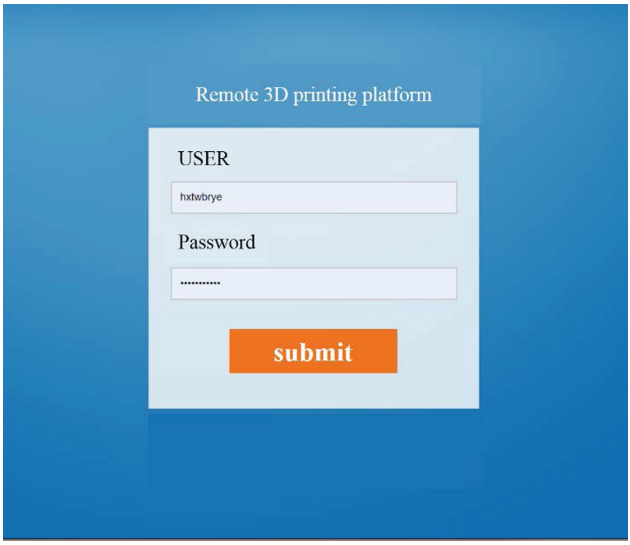

Fig. 4. Login interface diagram

6.2 System Main Interface

The main interface of the system is shown in the figure, which can display device information and member management options. It allows simple operations for websites and 3D printers. As in Fig. 5.

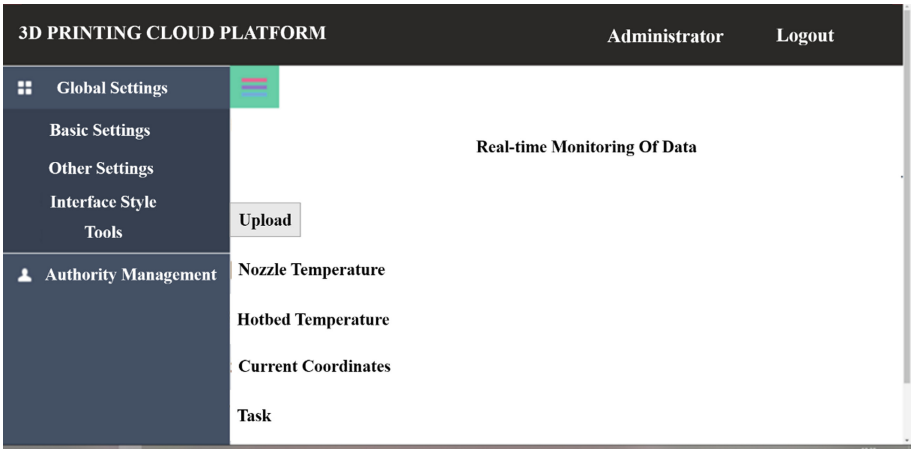

Fig. 5. System main interface

7 Conclusion

1. Analyzed the necessity of connecting 3D printers into the network under the development of contemporary technology, and paid attention to the development of 3D printing. And introduced the 3D printing cloud platform.
2. Analyzed and studied the architecture and features of the Alibaba Cloud platform, and actually purchased the server for debugging.
3. The organization of the cloud platform was introduced in detail, and the front end and back end of the platform were designed. The characteristics and structure of each part are explained separately.
4. Establish a local and network remote connection channel to ensure that the data of the 3D printer can be uploaded to the website in real time for real-time data display.
5. Starting from practical problems, combined with actual needs, the 3D printing cloud platform is realized to realize remote monitoring, information transmission, data monitoring and other functions. And introduce the specific implementation of each function.

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References

1. Sun, Z.Q.: Development status and prospects of China's 3D printing industry. Jiangsu Sci. Technol. Inf. (6), 19–20 (2014). (Chinese)
2. Chapiro, M.: Current achievements and future outlook for composites in 3D printing. Reinf. Plast. **60**(6), 372–375 (2016)
3. Duda, T., Raghavan, L.V.: 3D metal printing technology. IFAC-PapersOnLine **49**(29), 103–110 (2016)
4. Jin, T., Ma, J., Yang, L.C.: Design of remote control system of 3D printer based on WiFi. Transducer Microsyst. Technol. **37**(11), 109–112 (2018). (Chinese)
5. Hwa, L.C., Rajoo, S., Noor, A.M., Ahmad, N., Uday, M.B.: Recent advances in 3D printing of porous ceramics: a review. Curr. Opin. Solid State Mater. Sci. **21**(6), 323–347 (2017)
6. Zhang, S., Xu, Y.S., Sun, S.S., Zang, W.H., Sun, J., Gu, X.Y.: A review on the progress of 3D printing materials. China Plast. **30**(1), 7–14 (2016). (Chinese)
7. Li, D.F., Chen, J.M., Yuan, Y.P., Huang, K., Fang, H.B.: Development and application of stereo lithography apparatus. Beijing Univ. Technol. **41**(12), 1769–1774 (2015). (Chinese)
8. Walker, J.M., et al.: Real-time process monitoring of core shifts during metal casting with wireless sensing and 3D sand printing. Addit. Manuf. **27**, 54–60 (2019)