Remote Monitoring Method for Transplanting Process in Greenhouse Based on B/S Network

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Abstract. Transplanting operation is an important part of seedlings cultivation in greenhouse. Remote real-time monitoring, data storage and control of transplanting operations are beneficial to acquire the data of greenhouse transplanting operations in real-time and guide the production of greenhouse transplanting operations through data analysis. This research proposed a remote monitoring method based on the B/S network technology. Firstly, take the server installed with the MySQL as the core and save the transplanting process data which is collected by the field terminal to the database. Secondly, build a Web server with the IIS 7.0 platform and design the websites with Adobe Dreamweaver software. Finally, display and storage the data of the transplanting process in real-time through the websites which are accessing the database. After testing, this remote monitoring method of the greenhouse transplanting operation is effective and reliable, and it has certain theoretical reference significance for the intelligent control of transplanting operations in greenhouse.

Introduction

Transplanting operation is an important part of seedlings cultivation in greenhouse. At present, with the widespread use of greenhouse transplanters, transplanting operations are moving towards mechanization, automation, and intelligence [1-2]. Nowadays, the greenhouse transplanter already can realize automatic identification of qualified or unqualified seedlings in the trays, and automatic transplanting the unqualified seedlings by the good ones, such as the PIC-O-Mat series produced by Visser in the Netherlands and the RTW series produced by RAPID in America. However, current research on remote monitoring of greenhouse transplanting operations is still not too much. With remote monitoring, it is beneficial to acquire the data of greenhouse transplanting operations in real-time, and guide the production of greenhouse transplanting operations. B/S (Browser and Server) network technology is a network structure widely used in various remote monitoring applications [3-8]. Based on B/S network technology, this paper proposed a remote monitoring method, which use the server connects with the field terminal to storage data, and designs the Web software to realize real-time monitoring and control of remote transplanting operation process. This study has certain theoretical reference significance for the intelligent control of greenhouse operations.

Overall Monitor System

Remote monitoring data of transplanting operations mainly includes the following contents: the working status of the transplanter, the total transplanting seedlings number in a period, the number of qualified/unqualified seedlings that transplanter identified and so on. All the data are come from the sensors and controllers in the greenhouse. The main sensors and controllers of the greenhouse transplanter are shown in Figure 1, which includes industrial cameras, stepper motors, photoelectric switches, encoders, motion controllers and so on. The photoelectric switch can detect the number of trays to acquire the total number of transplanting seedlings. Industrial cameras can detect the number
of qualified or unqualified seedlings number. Stepper motor and encoder can detect the working state of the transplanter.

Transplanting operation data are collected and sent to the field terminal (IPC Industrial Personal Computer), and the field terminal is connected with the server via TCP/IP. There is a database software designed to store the data on the server. Web server is set up to interact with the server's database. The mobile devices such like laptop, tablet or mobile phone can monitor the transplanting process via the website in browser. The overall monitoring system structure is shown in Figure 2. This paper is focus on the remote monitoring system design.

Remote Monitoring Method

The remote monitoring system of the transplanting operation is based on B/S network technology. B/S (Browser/Server) network is a network structure mode. This network structure centralizes the core part of the system's functional implementation to the server, and it simplifies system development, maintenance, and use. On the client side, web browser is the main application software. This structure uses a browser software such as Internet Explorer, and the server installs SQL Server, MYSQL or other databases. Then the clients can use the browser interacts with the database through the Web Server.
Remote monitoring of transplanting operations mainly includes three aspects: server software design, database management and web server design.

**Server Software Design**

Use Qt integrated development environment to design the server software, which is responsible for displaying transplanting process parameters on the software interface, providing online data monitoring and connecting database.

**Database Management**

Selects MySQL as the database management software, establishes the transplanting process database system with this software. Then design data tables, and manage production monitoring data.

**Web Server Design**

Built web server with IIS 7.0 platform, it is an important part of the remote monitoring center. The function of the web server is to read the field transplanting process data from the database form, and the data will be sent to web server pages to be provided to users by B/S network technology.

Through B/S network technology, the system could be able to convey the data for the majority of users to achieve multi-user access. The web server mainly includes three modules: Log in/out and register module, basic information module and monitoring system module, as shown in Figure 3.

![Web Server Structure](image)

The data of the files in the monitoring system module on the web server are obtained by reading the transplanting process database data table through Ajax technology. The realtimeAJAXZM.asp file is a background processing file for Ajax technology. As a pure background file, this file does not have a web interface. The realtimeAJAXZM.asp file implementation process is shown in Figure 4. Its function is based on the url parameter test accepted by Request.QueryString(). When the parameter test value is 1, the Ajax instruction is derived from the realtimeAJAXZM.asp file. The technology directly reads the latest data of each sensor in the database transplanting process data table and outputs the data in the format of the Array() array.

In the monitoring system module, there is chart display function. The chart in the Website displays 31 data points at a time which means 31 days data of one month. The web page file directly reads the data in the database table through ADO technology, saves the latest 31 data as an array in Array() format, and generates a graph, and passes the Ajax in the background. The technology acquires the latest data in the database every 10s, generates the latest data points and deletes the leftmost data points, and regenerates the graph.
Test and Analysis
The server used in this system is Dell’s PowerEdge R720 Rack Mount Chassis, which is an x86 server running the Windows Server 2008 operating system. Built the connection between the field terminal and the server and do the test on the browser. The monitoring system web pages is shown in Figure 5.

As shown in the browser, key information such as the total number of transplanting seedlings, the number of qualified/unqualified seedlings and the transplanter working status can be obtained in real-time. The browser also has a series of functions such as historical data statistics. The webpage data are refreshed every 10s, and the remote monitoring speed response is fast, which can meet the real-time monitoring requirements.
Summary
For the improvement of greenhouse transplanting work, this paper proposed a remote monitoring method based on the B/S network technology. Firstly, take the server installed with the MySQL as the core and save the transplanting process data which is collected by the field terminal to the database. Secondly, build a Web server with the IIS 7.0 platform, and design the websites with Adobe Dreamweaver software. Finally, display and storage the data of the transplanting process in real-time through the websites which are accessing the database.

After testing, the important information of the field transplanting operation can be monitored in real-time through the web browser on the mobile terminals, and the functions such like chart display, data storage are working well. The remote monitoring method of the greenhouse transplanting operation is effective and reliable. This study has certain theoretical reference significance for greenhouse intelligent control.

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