CHEMICAL ENGINEERING TRANSACTIONS
VOL. 46, 2015
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet
Guest Editors: Peiyu Ren, Yancang Li, Huiping Song

ISBN 978-88-95608-37-2; **ISSN** 2283-9216
DOI: 10.3303/CET1546124

Design of Greenhouse Environment Remote Monitoring System Based on Android Platform

Li Zhang*, Congcong Li, Yushen Jia, Zhigang Xiao

College of Mechanical & Electrical Engineering, Agricultural University of Hebei, Baoding, Hebei province, 071001, China.
80756373@qq.com

To meet the needs of remote monitoring of greenhouse environment parameters, combined with embedded technology and 3G communication technology, a scheme of greenhouse environment parameter information real-time monitoring and control based on the Android phone platform is proposed in this paper. The paper gives the system's overall design, describes the design of each module, writes greenhouse environment remote monitoring software running on Android phone, and adds intelligent monitoring expert system in the design. The practical results show that the system is stable and reliable, and it has the characteristics of monitoring convenient and good scalability.

1. Introduction

As an important form of modern agriculture, greenhouse cultivation has been paid more and more attention. The main characteristics of modern greenhouse are to introduce sensor technology, embedded technology, wired and wireless communication technology in the design of greenhouse environment monitoring and control system. Rehmana, et al. (2015) and Chaudhary, et al. (2011) reported. Greenhouse environmental monitoring is to obtain the most suitable growth and development environment by changing the internal environment factors (temperature, humidity, light intensity, etc.). Early monitoring system of greenhouse environment monitoring system is mainly based on the local computer, and the monitoring terminal is based on the local computer, and the other part of the greenhouse environment monitoring is carried out by the wireless way, including the short distance Bluetooth, Zigbee network and GPRS network communication. Raul lonel and et al. (2012) reported.
Android system is the name of the open source mobile phone operating system which is based on Linux platform, and is made by Google Company in 2007. It is composed of the operating system, middleware, user interface and application software. This means that all the world's operating system software development platform can be developed through the Android open platform to develop a human-computer interaction and interface exquisite Android application. Garousi, et al. (2013) reported. This paper describes in Android according to different greenhouse crops to develop suitable soil moisture, soil temperature, air CO2 concentration and light strength parameters, and set the appropriate threshold to send alarm information to the mobile terminal, according to the actual requirement of the automatic water supply, ventilation, lighting and other operations. Meloa and et al. (2014) reported. Users can monitor the information management of the greenhouse monitoring information management applications to smart phones, tablet PCs and other mobile terminal equipment. In addition, users can give full play to the mobile characteristics of the terminal, to monitor the greenhouse crop growth at real time, and to develop the corresponding crop growth plan, and truly achieve the information of agricultural production.

2. System basic structure

2.1 Basic structure

System design is divided into two parts: hardware and software. The hardware part is mainly composed of the core module, data acquisition module, video capture module, control module, 3G network module, Android mobile phone remote monitoring module, etc.. The software part is composed of Android mobile phone application software and expert database system. System design target is that users can use the Android

Please cite this article as: Zhang L., Li C.C., Jia Y.S., Xiao Z.G., 2015, Design of greenhouse environment remote monitoring system based on android platform, Chemical Engineering Transactions, 46, 739-744 DOI:10.3303/CET1546124

mobile phone to remotely monitor and control the greenhouse through 3G network. The overall design of the system is shown in figure 1.

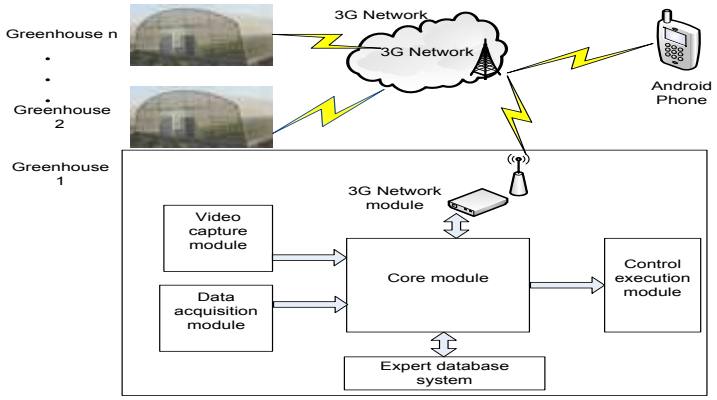

Figure 1: System overall design

2.2 Module function

The core module is responsible for the exchange of data in the system, the functions of the encoding and decoding, control, storage and so on. It is the data processing center of the whole system. Core module control system work flow is shown in figure 2. Data acquisition module can perceive the changes of environmental parameter, and the acquisition of information is transmitted to the core module through wireless transmission protocol. Srbinovskaa and et al. (2014) reported. The main collection includes temperature, air humidity, soil moisture, light intensity, CO_2 concentration and other greenhouse environment parameter information. The video capture module collects the video information from the surveillance camera, and the data is transmitted to the core module. Control execution module is used to control the system's control instruction, and the environmental parameters are changed by controlling the temperature and indoor equipment. 3G network modules are a bridge to realize remote monitoring and data exchange between the mobile client and the core module.

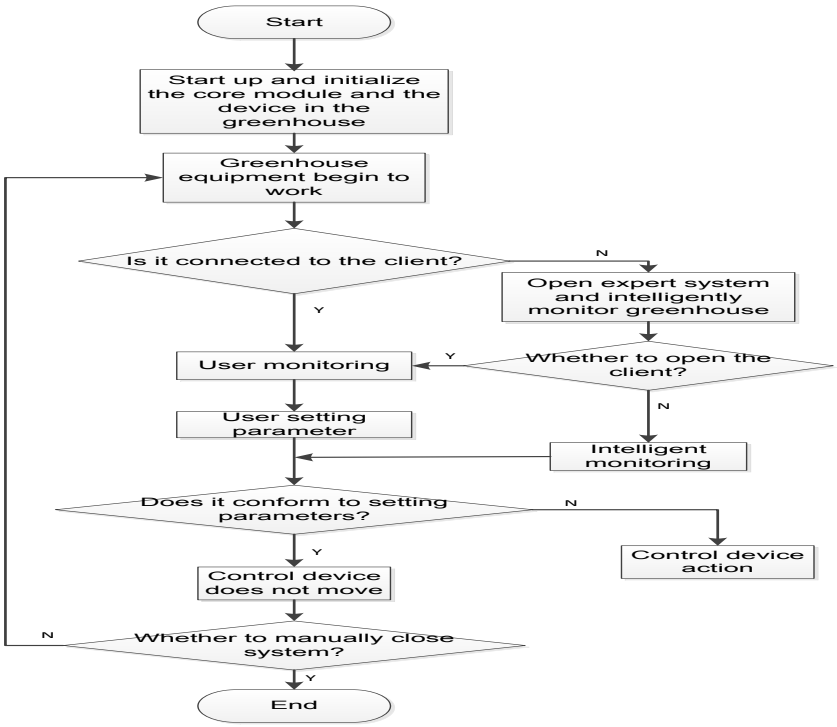

Figure 2: Core module control system work flow

Android mobile remote monitoring module is based on the 3G network module. When the greenhouse environment remote monitoring software is opened, the system is in the user mode. The software can obtain real-time acquisition of greenhouse environment parameter information and video information from the 3G communication module, and presents to the user, that is to achieve remote monitoring functions. Martinovića and et al. (2014) reported. After the user gets information, the instruction can be sent out through the software. The instruction is transmitted to the core module in the 3G network. After the processing, the instruction is transmitted to the control module, and the corresponding device can change the greenhouse environment parameter, that is to realize the remote control function. The expert system is added to the system, which is used to process the remote monitoring software of the greenhouse environment. The system automatically transfers to the intelligent monitoring mode, so as to achieve the goal of unattended. Finally, the core module is added to the SQLite database, LCD panel and other equipment, in order to control the environment data storage and system working state.

3. Design of intelligent monitoring software

3.1 Sever software design

Client application software is the greenhouse environment monitoring software running on the Android mobile phone. Android mobile application software is the key to realize remote monitoring and human-computer interaction. Firstly we must build Android development platform, and then open the Eclipse software to program Android application software. Jason Morris (2011) reported. The steps are: (1) Building AAP (Android Application Project); (2) Configuring the varied .xml information of the View, including TextView, EditView, ListView, Button and etc.; (3) The main program is written in Java file and uses the hierarchical structure and programs by the interface provided by the writing software. The life cycle of the program is managed by setting Activity Manager and jumping and transferring data between the programs are conducted by Intent. The incident of the Android system is registered and monitored by setting Broadcast Receiver. Service is office services called by a specific Activity or Context object and uses content providers to exchange and share data between the program and for the video information need to use Manager in the process to access images, sound, video, strings, layout files, etc.; (4) obtain the appropriate authority by registration in the AndroidManifest.xml file; (5) generating the .apk file to the Android emulator to run debugging; (6) the .apk file will be downloaded to the mobile phone after debugging success and connect the 4G network to the actual work test.

The server Responsible for side of the site monitoring use Studio Visual programming environment C++/MFC language to program, because of the need to initialize the monitoring device. In the transmission of network communication, the system uses a stable and reliable TCP socket transmission protocol to achieve the communication between the server and the client and achieve the stabile image transmission. C++/MFC under Visual Studio environment is adopted to realize the control of the server side of the device initialization control and use the stable and reliable TCP socket transmission protocol to achieve the communication between the server and the client to achieve the stabile image transmission. TCP flow socket programming communication model is shown in figure 3.Socket communication process is completed by CSocket class of MFC, while the camera control and image acquisition is completed through the SDK. CCapVideo can achieve video capture and create a new TCP thread in the capture of the video image processing. The captured video images are converted into a continuous JPG/JPEG format image stored in the data buffer. The thread continues to accept client connection requests and the image is sent to the client.

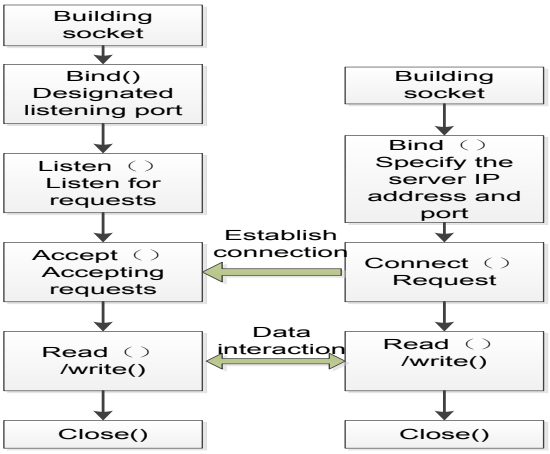

Figure 3: TCP flow socket programming communication model

3.2 Software design of smart phone client

The system is based on Android operating system smart phone. In the client software design processing, it mainly use the functional modules of Android software platform and use a variety of API interface components provided by Android in the application layer. After the first open operation, the mobile client needs the user to add the remote monitoring host IP and the network port number to realize the network communication connection with the host. The user can save the registration information in the phone the later operation. The client login interface design is shown in figure 4.

The development of mobile client software is developed using Android plug-in, which is based on the Eclipse tool, and choosing the API language part of Android called by Java. Hoog and et al. (2011) reported. In order to achieve the function, the MainVideoMonitor, VideoConn, VideoSocket, MonitorVideoView and VideoThread are mainly built. Through the VideoSocket, remote server is connected by the IP address and port number of the binding server. The test point picture is show in figure 5.

Figure 4: Client login interface design

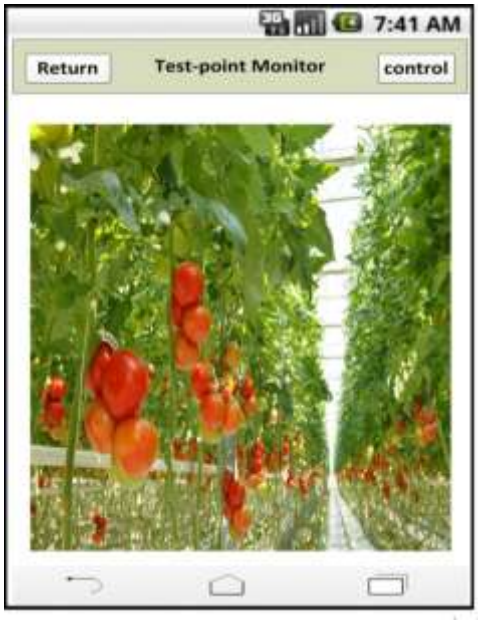

Figure 5: The test point picture

3.3 Sensor temperature and humidity display module

In the sensor management interface, click the sensor number or name, and enter the sensor details interface. The temperature and humidity information of the sensor and the current temperature and humidity data are displayed. If the current temperature and humidity data is beyond the threshold, the data is displayed as red. The interface is shown in figure 6.

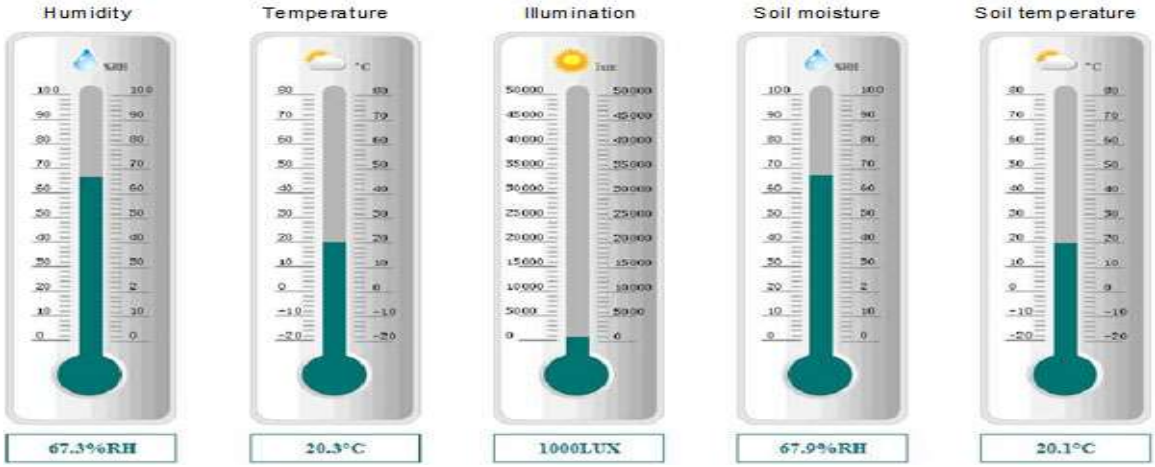

Figure 6: Interface of real-time sensor data

4. Conclusions

This system is designed for Android smart phone, using C++/MFC of Visual Studio and the Eclipse's Android programming tools to achieve the greenhouse smart phone monitoring system. It makes full use of the Android platform source code to achieve open source code, closely links to the current mainstream technology, and has strong cross platform and secondary development portability. Practice shows that the data exchange of client software and core module is reliable, client interface is easy to operate, the acquisition of greenhouse environment information is in real-time, video information is clear, the equipment of greenhouse are in normal operation after accepted the control instruction, the greenhouse environment parameters can be regulated, and the application in Android client software is easy to be popularized. The whole system is advanced, reliable and convenient. This design improves the real-time performance of the user to the greenhouse environment change, and is conducive to the realization of the unattended goal, and promotes the

development of the intelligent greenhouse. At the same time, this scheme can be used as a part of the development of remote monitoring of the Internet of things and can be applied on other areas of modern facilities agriculture.

Acknowledgments

This work was supported by Baoding Municipal Science and technology Bureau research projects (15ZN012, 15ZN008).

References

AndroidSDK. 2005. Android Development Tools. URL: http://www.eclipse.org/downloads/.

Chaudhary D.D., Nayse S.P., Waghmare L.M. 2011. Application of Wireless Sensor Networks for Greenhouse Parameter Control in Precision Agriculture, International Journal of Wireless & Mobile Networks, 3(1): 140-149. DOI: 10.5121/ijwmn.2011.3113.

Devine S.M. 2012. Android architecture: attacking the weak points, Network Security, Volume 2012, Issue 10, Pages 5–12, doi: 10.1016/S1353-4858(12)70092-2.

Gao J.X., Du H.Q.. 2011. Design of Greenhouse Surveillance System Based on Embedded Web Server Technology, Procedia Engineering, Volume 23, Pages 374–379, PEEA 2011, doi: 10.1016/j.proeng.2011.11.2516.

Garousi V., Kotchorek R., Smith M. 2013. Chapter 5 – Test Cost-Effectiveness and Defect Density: A Case Study on the Android Platform, Advances in Computers, Volume 89, Pages 163–206, doi: 10.1016/B978-0-12-408094-2.00005-9.

Hoog A. 2011. Chapter 2 – Android hardware platforms, Android Forensics Investigation, Analysis and Mobile Security for Google Android, Pages 41–63, doi: 10.1016/B978-1-59749-651-3.10002-0.

Ionel P., Vasiu G., Mischie S. 2012. GPRS based data acquisition and analysis system with mobile phone control, Measurement, Volume 45, Issue 6, Pages 1462–1470, doi: 10.1016/j.measurement.2012.03.003.

Martinovića G., Simonb J., 2014. Greenhouse microclimatic environment controlled by a mobile measuring station, NJAS-Wageningen Journal of Life Sciences, Volumes 70–71, Pages 61–70, doi: 10.1016/j.njas.2014.05.007.

Meloa L., Abreub J., Silvab T. 2014. Mobile Applications for Natural Parks: Guidelines Study for the Development of a Mobile Device Application, Procedia Technology, Volume 16, Pages 263–268, doi: 10.1016/j.protcy.2014.10.091.

Mesas-Carrascosa F.J., Verdú Santano D., Meroño J.E., De la Orden M.S., García-Ferrer A.. 2015. Open source hardware to monitor environmental parameters in precision agriculture, Biosystems Engineering, Volume 137, Pages 73–83, doi: 10.1016/j.biosystemseng.2015.07.005.

Ojhaa T., Misraa S., Raghuwanshib N.S. 2015. Wireless sensor networks for agriculture: The state-of-the-art in practice and future challenges, Computers and Electronics in Agriculture, Volume 118, Pages 66–84, doi: 10.1016/j.compag.2015.08.011.

Rehmana A., Abbasib A.Z., Islamb N., Shaikhb Z.A. 2014. A review of wireless sensors and networks' applications in agriculture, Computer Standards & Interfaces, Volume 36, Issue 2, Pages 263–270, doi: 10.1016/j.csi.2011.03.004.

Service, N.P. 2013. NPS Chesapeake Explorer - Applications Android no Google Play Retrieved 28-09-2013, from http://goo.gl/BB8STk.

Srbinovskaa M., Gavrovskia C., Dimceva V., Krkolevab A., Borozanb V.. 2014. Environmental parameters monitoring in precision agriculture using wireless sensor networks, Journal of Cleaner Production, Volume 88, Pages 297–307, doi: 10.1016/j.jclepro.2014.04.036.