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# The research and design of the Android-based facilities environment multifunction remote monitoring system\*

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**Abstract.** For the actual demand of national facilities environment remote monitoring system combined with mobile Internet technology is cheaper, simpler to operate and better performance of mobility management. This article describes the research of the Android-based facilities environment multifunction remote monitoring system that based on the Android Smartphone as the terminal, was combined with wireless camera, relay group, wireless AP + temperature and humidity (light intensity) sensor and so on. The system implements remote facilities environment factors monitoring, real-time video monitoring, maintenance and management for remote server. The test and application shows that is stable, cheap, good mobility and easy to operate, it is a strong practicality and application prospects.

**Keywords:** Mobile Internet; Android Smartphone; Facilities Environment; Remote Monitoring

## 1 Introduction

With the rapid development of Chinese agricultural facilities environment remote monitoring system is an important factor to improve facilities for agricultural production automation and efficient<sup>[1]</sup>. In recent years, the national agricultural engineering researchers used computer-controlled technology, web technology, GPRS and GSM technology<sup>[2,3]</sup> based on the PC (Personal Computer), PDA (Personal Digital Assistant) application terminal, develop and design a range of facilities environment remote monitoring and control systems<sup>[4,5]</sup>, has played a positive role in promoting the development of Chinese agricultural facilities.

This year, with the rapid development of mobile Internet and networking technology continues to mature, especially the world's rapidly growing popularity of smart phones, the mobile network terminals application is more widely. In the present facilities of agricultural environmental monitoring system, there are lots of PDA

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application terminal for greenhouse control system, but because the PDA is a single function, and development environment in the human-computer interaction, cross-platform performance is poor, limiting the effect of promotion and application of its facilities in agricultural environments. In recent years, the Android operating system and Android Smartphone has been rapid development, especially the launch of the Android 3G Smartphone fewer than 1000 Yuan (RMB), the Android Smartphone market share in Chinese rising [6]. In the one hand, the Android smart phone is the set of calls, multimedia, Internet smart terminal; it is not only inexpensive, but also multifunction[7]. The other hand, the Android operating system is open source and free, it not only reduces the system development costs, but also has a better human-computer interaction technology because of object-oriented Java language supporting. Therefore, Android Smartphone application terminal with mobile Internet technology has a positive meaning to build multi-purpose environmental monitoring system for Chinese agricultural facilities to further improve our facilities for agricultural automation and intelligent.

The article describes the system is based on Android technology, Socket technology and Java technology, group of wireless relay, wireless sensors and wireless cameras, over Android application terminals, research and development facility environment based on the Android multi-function remote monitoring system.

## 2 System architecture design

The article based on Android Smartphone application terminal for the real facilities environment monitoring system status, combines the working principle of wireless cameras and wireless sensors, and gives the design of system architecture. The figure of system architecture shows as Figure 1:

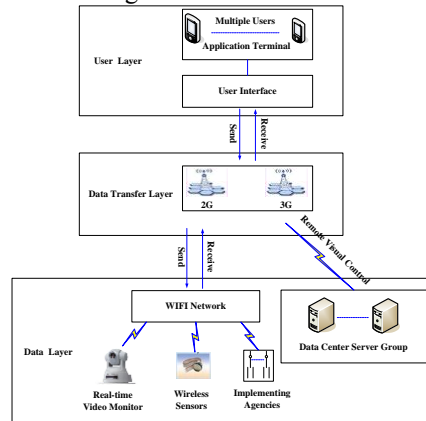


Figure 1 System architecture

As Figure 1 shows, the system architecture contains user, data transfer and data layers. User layer is based on the Android Smartphone application terminal for sending and checking relevant instruction and information by human-computer interaction. Data transfer layer refers to the entire system operation that depends on network environment. The system is connected to the Internet by WIFI or 3G network

for data transmission. Data layer contains video, environmental factors (temperature and humidity, light intensity) collection of information, such as, sun visor, water screen, heating and other facilities environmental site implementing agencies, as well as for data storage, centralized management of servers in the data center, and so on.

### 3 System design and implementation

The system based on the Android Smartphone application terminal to achieve the following three main features:

- (1) Implementation remote real-time video monitoring of the facility agriculture;
- (2) Combination of wireless relay group and wireless sensors such as temperature and humidity, light intensity, remote real-time monitoring to agricultural environment;
- (3) Remote control of facility agriculture data center servers.

Core system class diagram is Figure 2:

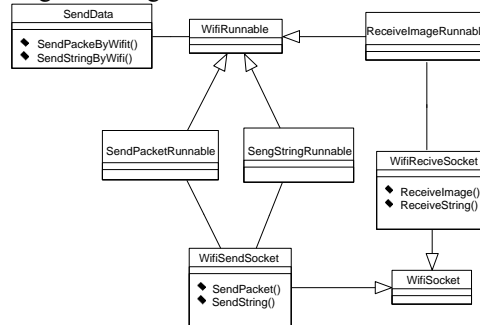


Figure 2 System class diagram

As Figure 2 shows, This article achieves the SendData, SendPacketRunnable, SengStringRunnable, WifiSendSocket, WifiRecvSocket, ReceiveImageRunnable, and other core classes by overriding methods of the parent class and inheritance and overrides the appropriate methods. The core class diagram design for code optimization and integration of the system of development laid the Foundation important technologies.

#### 3.1 System design and realization of real-time video monitoring

Aiming at the wireless camera command protocol, used Android technology and Socket Technology, The article Completed remote real-time video monitoring and control function based on Android Smartphone. The technical route process as shown in Figure 3:

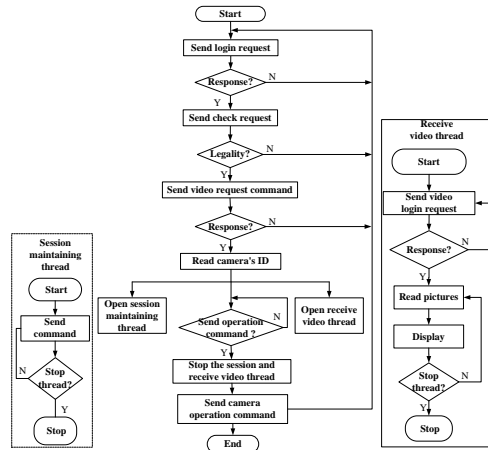


Figure 3 Technical route flowchart

You can see from Figure 3, this opening session and video get the thread method, to achieve the functionality of video transmission and session continued. At the same time, this article also uses memory auto clean mechanism, thereby ensuring that the video transmission in the process, due to lack of memory of the Terminal and is causing the lockup issues.

### 3.2 Design and implementation of system facilities environment monitoring module

The module to temperature humidity and light strength sensor for information collection Terminal, to wireless AP for frontal network access device, to wireless following electrical group for implementation body control device, and to the Android smart phone for application terminal, achieved remote real-time monitoring facilities environment within temperature humidity, illumination strength. It is able to through remote control unlimited following electrical group to achieve remote real-time control facilities environment system, its system implementation flowchart as Figure 4:

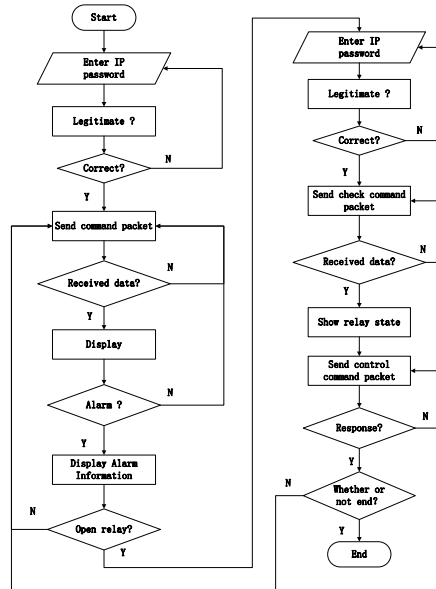


Figure 4 Facilities environment monitoring system flowchart

As shown in Figure 3, the article point to the transfer protocol for wireless sensor to achieve the real-time data acquisition terminal for data transmitted to mobile terminals, automatic alarm when facilities environment exceeds a predetermined value. At the same time, using wireless relay group for weak electricity to force electricity controlling. It achieves that mobile terminal directly control facilities environmental site visor, water screen, heater and functions of system.

### 3.3 Design and implementation of remote server control module

This module is primarily in Smartphone application for terminal objects server-control. It achieves remote management features and maintains a data center server by Android mobile phone with coordinate positioning technologies and Socket like technologies. Its server control activity figure as shown in Figure 5:

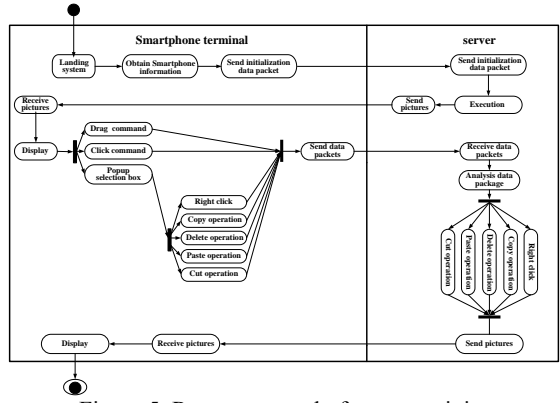


Figure 5 Remote control of server activity

The article point to the achievement of control server from Android mobile phone by Socket technology and Android technology. As the remote control of server activity figure shows, the module achieves following functions: When the user clicks the phone screen, a click command sent to the server. When the user double-clicks on a mobile phone screen, a double-click command sent to the server. When a user under the mobile phone screen, pop up the dialog box that you are able to choose right click, delete, copy, cut, paste operations. At the same time it is able to do function over PC such as IE browsing, file management, system management, and so on.

#### 4 System integration and implementation

The system application program development environment is built over JDK +Eclipse +Android SDK+ADT. It support for the JAVA programming language<sup>[8]</sup>. It is better than QT application development platform based on C/C++ on security, human-computer interaction, and cross-platform<sup>[8,9]</sup>.

In this development environment, using Android, Java and Socket technology, combine human-computer interaction technology with Android, to integrate and apply for facility environment multifunction remote monitoring system based on Android. The user operations flowchart as shown in Figure 6:

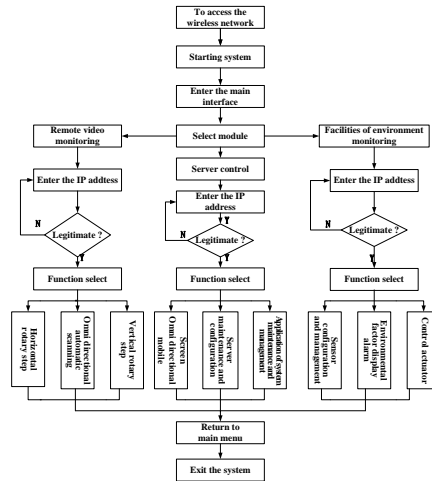


Figure 6 System user operations flowchart

This system is applied by the agricultural science and technology achievements transformation Fund "Test and demonstration of Yunnan information service platform for Standardization of characteristic fruit and vegetable production ". The part of system interface as shown in Figure 7:



Figure 7 Part of system interface

## 5 Discussion and conclusions

The system uses the mobile Internet technology, to Android Smartphone application for the Terminal, combined with wireless data collection Terminal, using Android technology research and development "facility environment multifunction remote monitoring system based on Android", achieved through the Android Smartphone to remote facilities environment monitoring of video information, environmental factors, as well as the ability to remotely controlling, managing, and maintaining a data center server.



Display of system features and application effect:

(1) Using Android technology, based on the major mobile Internet devices – smart phones replace traditional PC, and applied to the facilities environment monitoring systems, reducing the cost of system development and investment;

(2) Compared with the single network applications such as PDA Terminal, Android smart phone applications more powerful, more large and universal application, have better market infrastructure and its application development environment based on JAVA language to make them better human-computer interaction and cross-platform performance;

(3) The system is feature-rich, secure and reliable, reducing labor costs, and good mobile performance by actual application in project. It gets very good application value.

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