Study on the Construction of an Agriculture Cultivating System with a Smart Phone Controller

Kyung Mog Lee

***Abstract*—An agriculture cultivating system with an agriculture growing room and some cultivating equipment was constructed by a power line communication method and with a remote controller smart phone. The system consisted of a central controller PC, a cultivating control module, a remote control smart phone, and an agriculture cultivating room. As for the communication between the central controller PC and the cultivating control module, the power line communication technique was used. The system had two kinds of modems: a central side and a receive-side, which communicated to each other in a half-duplex asynchronous FSK 2400 bps data rate. As a remote control smart phone, a Samsung Galaxy SHW-M130K model was used. The phone was programed in android language on the Gingerbread version and used as a remote monitoring and controlling device. Then, the system was tested by measuring the response time of the entire system, at local loop back and at remote loop back. The agriculture cultivating room statuses were shown graphically on the smart phone screen according to the device's setup conditions. It was much more convenient to use a smart phone than a key board or a mouse on the PC.**

***Index Terms*—remote smart phone controller, cultivation system, android programming application, PLC communication, home network**

I. Introduction

DUE TO THE EXPLOSIVE SPREAD OF THE SMART PHONE AND THE RAPID DEVELOPMENT OF INFORMATION TECHNOLOGY, the applications of the smart phone were widely developed in a variety of fields, such as: internet news, games, industry applications, and general living information. Information technology was also used to develop applications for the agriculture cultivating system[1][2][3][4] .

Home Power Line Communication(PLC) technology was used in home networking systems because it is easy to use without any additional wiring[5][6][7]. And the response time of the home network system was measured in the difference length of a protocol [8][9][10].

The Bluetooth communication is easy to use to connect the phone and environment devices[11][12].

In this paper, a smart phone application was developed on the agriculture cultivating system, which could be monitored and controlled remotely. This research consisted of four parts: a remote controlling smart phone, a central control PC, a cultivating control module, and an agriculture cultivating room. The central control PC was informed by the cultivation control module of the environmental conditions of the room, such as: the temperature, humidity, sun light intensity, and the equipment' statuses. All the received information was saved on the PC's database. The saved data could be organized in daily, monthly, or yearly report form. Then, to make the best cultivating environment condition for the agriculture growth, the PC sent the equipment controlling signal to the module.

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II. Body Of Paper

In this paper, an agriculture cultivating system was constructed by using the PLC technique, which was controlled remotely with a smart phone. The system consisted of four modules: a remote controlling smart phone, a central control PC, a cultivating control module, and an agriculture cultivating room. The cultivation control module was measuring all the environmental conditions of the agriculture cultivating room with the following sensors: temperature sensor, humidity sensor, and photo detector. Also, it controlled all the agriculture cultivating equipment, such as: a roof motor, a spring cooler water pumper, a cooling fan, and a heater. The smart phone as a remote controller was programed in android language to show, on the screen, the values of the room's environmental conditions in numbers. The phone provided some graphical buttons with which to control the room's maintaining equipment. The temperature and the humidity of the room were drawn on the screen according to the received information from the PC.

As an experiment, some of rose moss flowers were implanted into soil. After measuring the humidity of the soil, when the humidity was lower than 30%, the control PC made the spring cooler operate to spread water to the soil. When the room temperature was under 10 ^{o}C, the heater was made to be turned on, so that the inside temperature be maintained its warmth. But, as the temperature became over 40 ^{o}C, the cooling fan started to ventilate outside air into the room in order to cool the room. After measuring the light intensity of the sun, it controlled the cover of the room to be opened when the sun was strong enough for the growth of the flowers, or to be closed when the sun was not strong enough.

The communication specification between the central control PC and the Smart phone was in 9600 bps Bluetooth communication, and between the PC and the cultivation control module, it was 2400 bps FSK.

Fig. 1 shows an agriculture cultivation system using a smart

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phone and a central control PC. The central control PC was connected in 9600 bps Bluetooth serial communication to the phone through a Donggle device plugged to a USB port of the PC. The COM-1 port of the PC was connected in 9600 bps serial data rate to a central PCL modem which was plugged into the power line.

The cultivating module was also connected through a receiver-side modem, which was plugged to the same power line. These modems were communicating to each other in serial 2400 bps asynchronous FSK. The distance between them was about 50 meters long. By changing the distance between them, the system response was measured.

The PC gathered all the environmental data of the cultivating room by performing PLC communication, and sent all the necessary control signals to the cultivating module to set the maintaining equipment. The cultivating control module was built on the electric circuit board with an ATMEL's 89C2051 Microprocessor. The microprocessor measured the temperature and the humidity of the room, and collected the statuses of all the maintaining equipment of the room which were sent to the central control PC. And, the module set all the equipment at the same statuses according to the received control signal from the PC.

As for the cultivating maintaining equipment in the room, there were a step motor to open the roof of the house, and a cooling fan to ventilate the outside air into the inside, a spring cooler to spread water, and a heater to increase the temperature of the room.

After the cultivating module had sent all of the collected information to the central control PC by PLC communication, the PC stored all the data in a database. The database was made by Microsoft. Then, the data was analyzed in daily, monthly, or yearly based graphs. Those graphs were shown on the screen of the PC, and sent to the smart phone where they were shown graphically, as well.

Fig. 2 shows the detailed system connection of a central control PC and a smart phone remote controller. Fig. 2(a) is the smart phone remote controller, and Fig. 2(b) shows the central control PC connected to the power line through the central-side PLC modem.

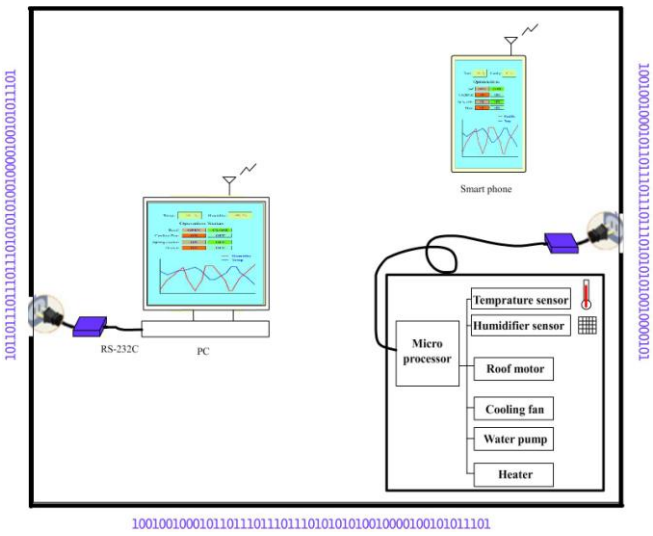

Fig. 1. an agriculture cultivating system using a smart phone and a central control PC.

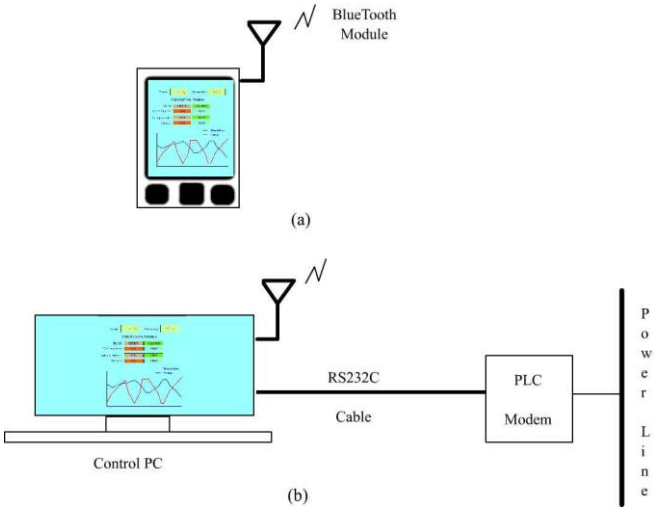

Fig. 2. Detailed system connection of a central control PC and a smart phone remote controller. (a) the smart phone remote controller (b) the central control PC connected to the power line.

Fig. 3 shows the screen of a smart phone as a remote controller. After having received all the room's temperature and humidity values from the PC, the smart phone showed the data in numbers and with graphs in the form of daily, monthly, or yearly report. And, the maintaining facilities' setting statuses were shown on the same screen of the phone, too. And, the phone provided the facilities' control buttons to remotely control the maintaining equipment. On a button being clicked, the phone sent the control signal, corresponding to the button function, to the central control PC so that the equipment could be set to the commanded state. The phone was communicating in Bluetooth with the PC to read all the data, such as: temperature, humidity inside of the room, and sun light intensity outside of the room.

Fig. 4 shows the diagram of the program blocks of the constructed system. The remote controller smart phone was a Samsung Galaxy, model number SHW-M130K. The android build number was Gingerbread, and Firmware version 2.3.6.

And, the module for the Bluetooth communication between the phone and the PC was made by a company called Shenzhen Ipopman Technology Limited, and was the model of a mini Bluetooth 2.0 Adapter dongle, of which specification was a Bluetooth V2.0 Class 1 (class 1 is manufacturer rated). The maximum wireless distance of the module was 100 meters (as per Bluetooth class 1 standard).

The agriculture cultivating module was built with an ATMEL 89C2051 microprocessor. All the PLC modems were using the ST7537HS1 chips of SGS-THOMSON's company. The modulation rate was in half duplex asynchronous 2400 FSK. The central-side PLC modem was connected to the COM1 port of the PC with RS-232C serial cable. The communication environment was clear and quite without any noise generating devices such as motors.

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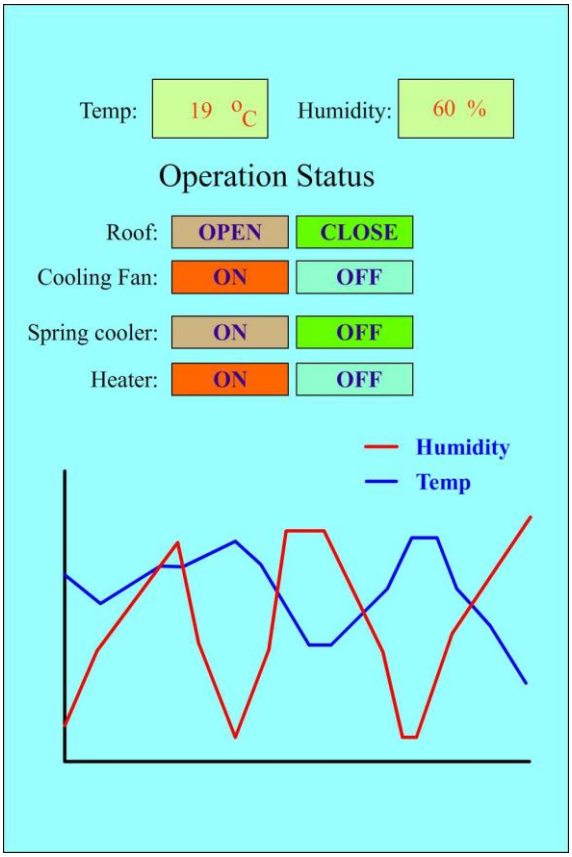

Fig. 3. The screen of a smart phone as a remote controller.

The receiver microprocessor of the AT89C2051 was programmed to use four ports as outputs for the device control and six ports as inputs: such as four for the device's on/off statuses, one for the temperature and humidity sensor, and the other for the photo sensor. The receive-side PLC modem was connected to the AT89C2051 microprocessor. As the temperature and humidity sensor package, a DHT 11 was used. The chip was made by a company called AOSONG.

The PLC modems were communicating in the Polling process, so there were two kinds of stations, a primary one and a secondary one. The central-side PLC modem was the primary station and the receive-side the secondary. Also, the remote controller smart phone was treated as a secondary station.

The primary modem broadcasted in half duplex the "Ready to receive" protocol, and awaited the "ACK(acknowledgement)" protocol from a secondary modem in the same way as the Stop-and-Wait process.

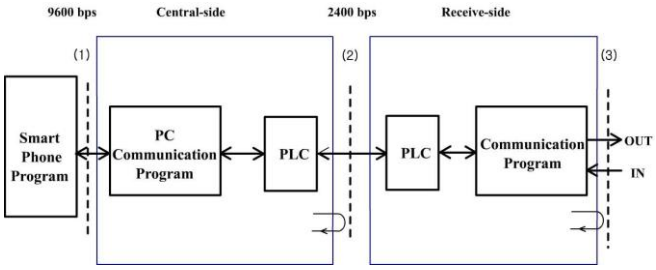

Fig. 4. Diagram of the program blocks of the constructed system.

The ACK protocol contained data of the smart phone's control command or of the statuses of the home electric devices.

The PC program checked the ACK protocol from the smart phone for the control command. When there was a command, it sent the ″Ready to receive″ protocol with the device control signal corresponding to the button command. Then, the program checked the ACK protocol from the receive-side modem for the device status and changed the color of the device picture on the screen into the corresponding status.

III. Conclusion

In this paper, an agriculture cultivation system was constructed with the PLC technology and controlled remotely with an android smart phone. The system consisted of a smart phone, a central control PC, a cultivating control module, and a cultivating room. The cultivating control module was made with an ATMEL 89C2051 microprocessor. The central control PC was programed to show, on the monitor screen, all of the environmental information of the room, such as: temperature, humidity, sun light intensity, and all of the maintaining equipment' setting statuses. By the control buttons on the phone, the system could be controlled remotely. As a remote control smart phone, Samsung Galaxy SHW-M130K model was used. And an android program was developed on the Gingerbread version for the phone to be used as a remote monitoring and controlling device.

It was much more convenient to control the cultivating equipment by the remote control smart phone than by the keyboard or by the mouse of the PC.

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