Room Environment Monitoring System From PDA Terminal

Sung-Ju Oh[1] and Wan-Young Chung[2]
[1]Graduate School of Software,
[2]Division of Internet Engineering,
Dongseo Univ, Busan 617-716, Korea
Tel: +82-51-320-1756, Fax: +82-51-327-8955
E-mail: wychung@dongseo.ac.kr

***Abstract*-The room environment monitoring and controlling system by PDA terminal was designed and fabricated. An RF wireless sensor module with several air quality monitoring sensors was developed for indoor environment monitoring system in home networking. The module has various enlargement for various kinds of sensors such as humidity sensor, temperature sensor, CO_2 sensor, flying dust sensor, and etc.**

The developed wireless module is very convenient to be installed on the wall of a room or office, and the sensors in the module can be easily replaced due to well designed module structure and RF connection method. To reduce the system cost, only one RF transmission block was used for sensors' signal transmission to 8051 microcontroller board in time sharing method.

In this home networking system, various indoor environmental parameters could be monitored in real time from RF wireless sensor module. Indoor vision was transferred to client PC or PDA from surveillance camera installed indoor or desired site. Web server using Oracle DB was used for saving the visions from web-camera and various data from wireless sensor module.

I. INTRODUCTION

In the near future all electronic appliances in a home will be networked: PCs, telephones, stereos, refrigerators and even washing machines. Heating and air conditioning, previously controlled by a single, fixed, manual thermostat, can now be managed by an intelligent controller with remote-access capabilities[1,2]. Recently with increasing living standards and expectations for comfortableness, the use of residential air conditioning is becoming widespread. The control and monitoring of indoor atmosphere conditions represents an important task with the aim of ensuring suitable working and living spaces to people. However the comprehensive air quality monitoring which include humidity, temperature, CO_2, flying dust particle density, and etc. is not so easy to be monitored and controlled[3.4].

In this study, RF wireless sensor module with optimal communication condition was developed and indoor air quality in a room or office could be monitored by web-based monitoring system together with other home networking system. Several offices and rooms can be monitored from terminal PC or PDA(Personal Digital Assistant) by using wireless sensor modules which are attached on the wall of the office or the room. The monitoring results in serve computer were saved and can be monitored following after.

II. SYSTEM DESIGN

Figure 1 shows system configuration of this study. The environment of room or office was monitored via internet from PC terminal or PDA. Several sensors such as temperature sensor, humidity sensor, CO_2 sensor, flying dust sensor were built in a RF transmitter board for monitoring indoor environment conditions. These input sensors were chosen in considering parameters of comfortableness and helpfulness for human being. Commercial discrete sensor device can be built in a socket module for analog and digital sensors, and the adaptation was carried in software at server PC.

Several power switches which include lamp switches in room, power switches of consumer electronics can be controlled via stand-alone 8051 microcomputer board, and surveillance camera was installed surveillance room or indoors from unintended break.

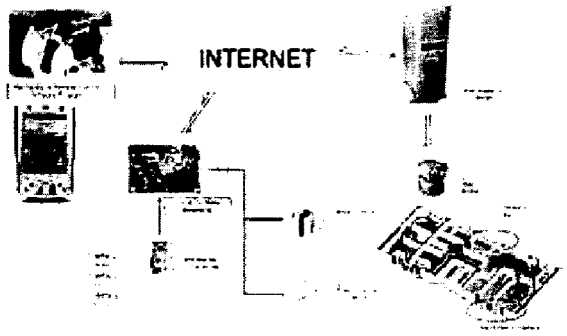

Fig.1 System configuration of home networking system in this study.

In this system, stand-alone 8051 microcontroller board was designed and fabricated as a server board. The right side of Fig. 2(a) shows the block diagram of the designed 8051 microcontroller board and Fig. 2(b) shows the fabricated board. The 8051 microcomputer, which received control signals from PC or PDA terminals via internet, and give turn-on or turn-off signal for the power switches and some motors indoor.

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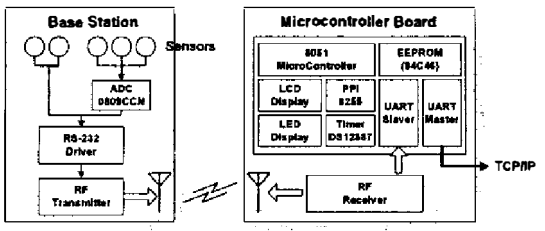
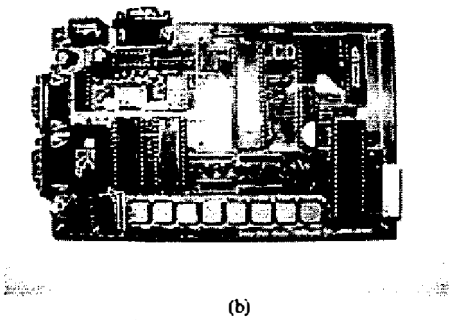
The control signals for lighting, heating, air conditioning and switching electric appliances can be sent from PC or PDA terminal via TCP/IP(Transmission Control Protocol/Internet Protocol) or from push button switches on 8051 microcontroller board. This board was connected to internet through RS232 UART(Universal Asynchronous Receiver /Transmitter)



(a)



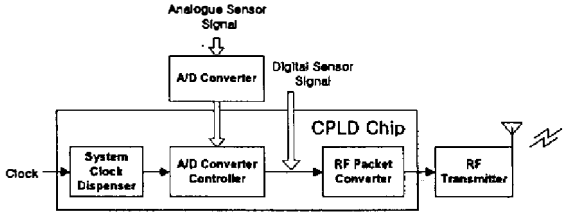
(b)

Fig. 2 Block diagram of fabricated stand-alone 8051 microcomputer board: (a) Block diagram of a wireless sensor module(right) and 8051 microcontroller board(left), (b) The fabricated 8051 microcontroller board.

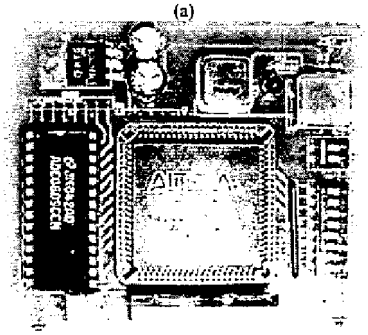
Wireless sensor transmitter and receiver modules were also design and fabricated by using a CPLD(Complex Programmable Logic Device) chip for simple system structure separately. The left side of figure 2(a) is the block diagram of the designed wireless sensor transmitter board.

Figure 3 shows more detail block diagram of the wireless sensor board and the fabricated board. As a input sensor for indoor environment monitoring, analogue and digital sensors can be used together as shown in Fig.3(a). The commercialized UHF data transmitter and receiver module chips(TX2 transmitter, RX2 receiver, Radiometrix Ltd., England) were used as RF transmitter and receiver separately. The transmitter can send the RF data up to the distance of maximum 100 m in 433 MHz. However in practice field, the transmitter can send data safely within 10 m in room or office. To reduce system size and increase the operating speed of RF transmitter board, most of circuit of this system with the exception of A/D converter and RF transmitter were integrated in CPLD chip(Altera Ltd., USA).

RF receiver part was composed of CPLD chip with function of Fig.4(a) and most of the function with the exception of RF receiver and RS-232 driver were integrated in a CPLD chip for same reason of RF transmitter board. Figure 4(b) shows the fabricated RF receiver board part. The CPLD was designed by VHDL(VHSIC Hardware Description Language) and Max plus+II was used as a design tool package. A 10,000 gate level CPLD chip was used for the chip design separately.

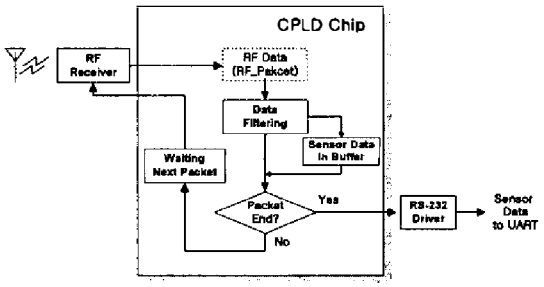


(a)

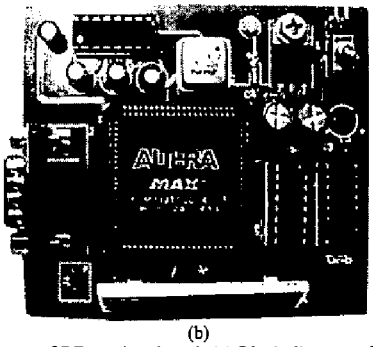


(b)

Fig. 3 Structure of wireless sensor transmitter board: (a) Block diagram of the board, (b) The fabricated transmitter board



(a)



(b)

Fig. 4 Structure of RF receiver board: (a) Block diagram of the board, (b) The fabricated receiver board.

In a remote control and monitoring system, flow sequence diagram of server program which manage sensor data received via control board and PDA connection was shown in Fig. 5.

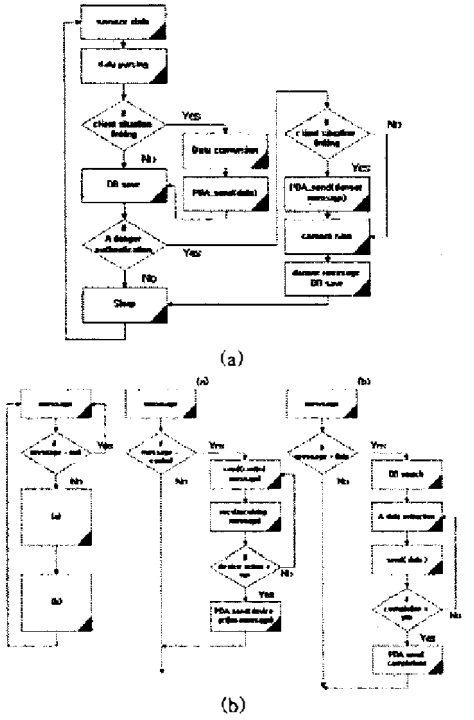


Fig. 5 Sensor data management server program flow sequence; (a) control board connection management, (b) PDA connection management.

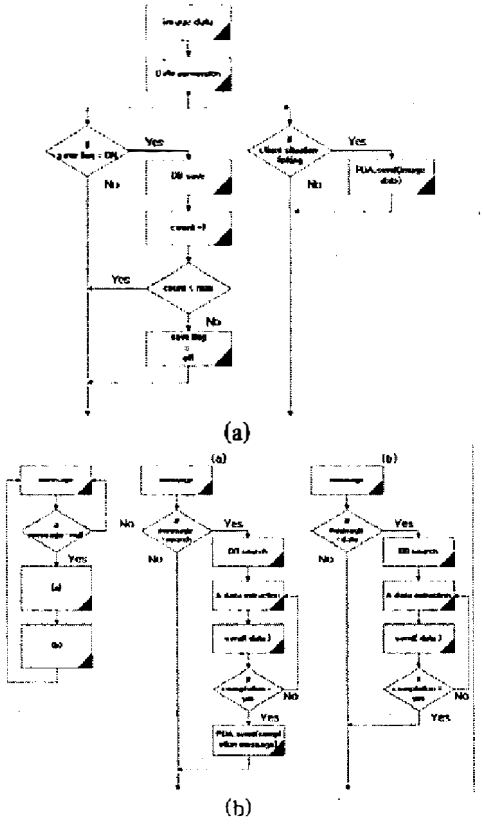


Fig. 6 Camera image data management server program flow sequence; (a) camera connection management, (b) PDA connection management.

Fig. 6 shows flow sequence of server program which gives a camera control signal and process image data from the camera. In server, image data from camera were processed and saved, and the image data were transmitted to client PC or PDA according to client program request in real time. Server program convert the image from CCD camera to the data which can be sown in PDA screen.

The converted image data were saved in a server PC with time data and the image during specific time can be displayed by the request of PC or PDA terminal program.

III. SYSTEM TEST

Figure 7 shows the screen-captured client PC application program. From client PC, installed surveillance camera, 8051 microcontroller board and a server computer can be connected. The server computer was used for saving image from camera and sensor data from several sensors. Sometimes the server computer send the image or sensor date to client PC in real time. The server computer used Oracle 8i as a database server.

In client PC program, the following 5 kinds of functions were included. The JPEG(Joint Photographic Experts Group) image was streamed by 3 frames for a second for moving image instead of MPEG(Moving Picture Experts Group) file.

(1) moving image monitoring
(2) Sensor data monitoring
(3) Web-camera control
(4) Power switches control for illuminators, electronic appliances etc.
(5) Connectivity monitoring to 8051 microcontroller board, web-camera and server computer.

Sensor data such as temperature, humidity, CO_2 concentration, flying dust density etc. from each sensor can be monitored from client PC or PDA. And power switches of illuminators, air conditioner and electronic appliances can be also turned on or turned off from client PC program.

The installed surveillance camera can be controlled to watch out special object from client PC program. The image data from surveillance camera can be monitored in

real time and the unattended intrusion can be checked and the warning signal can be sent to appointed person's cellular phone or PDA, for example. The image data and sensor data will be reserved in Web server computer and can be reproduced. Keypad console which was set up with 8051 microcontroller on the same board in Fig. 2(b) can be used as a terminal as the same way as at client PC application program in Fig. 7.

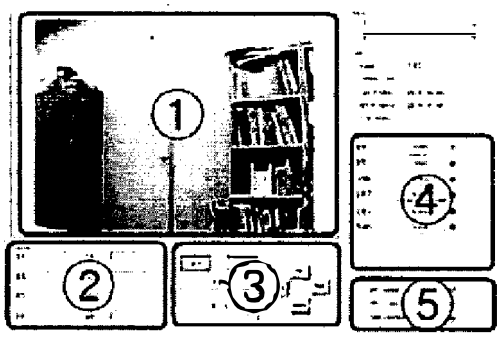


Fig. 7 Screen captured monitoring and controlling screen at terminal client PC.

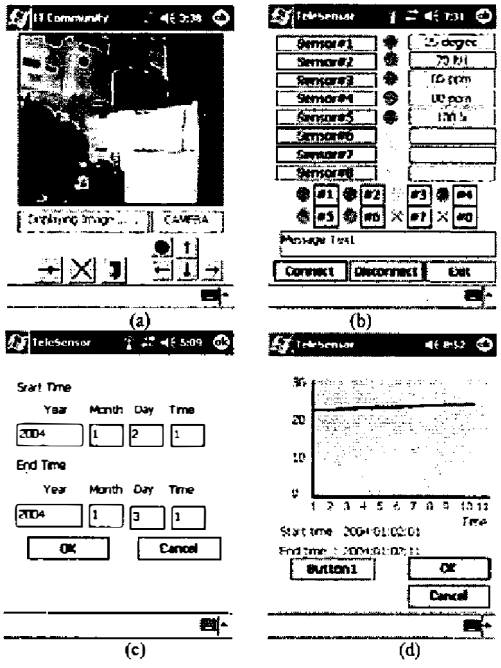


Fig. 8 Visualization in a PDA terminal of (a) camera view, (b) sensor outputs and electronic appliances switch status, (c) duration search engine and (d) searched sensor data for specific period.

PDA(personal digital assistant) was also used as a client terminal. Figure 8 shows the client program image on PDA screen. Installed web-camera image can be monitored and controlled(Fig. 8(a), and the sensor data can be checked and the power switch status can also be monitored well in the same way as PC client program(Fig. 8(b)). From the saved sensor data, we can search the data of assigned time duration as shown in Fig. 8(c and d).

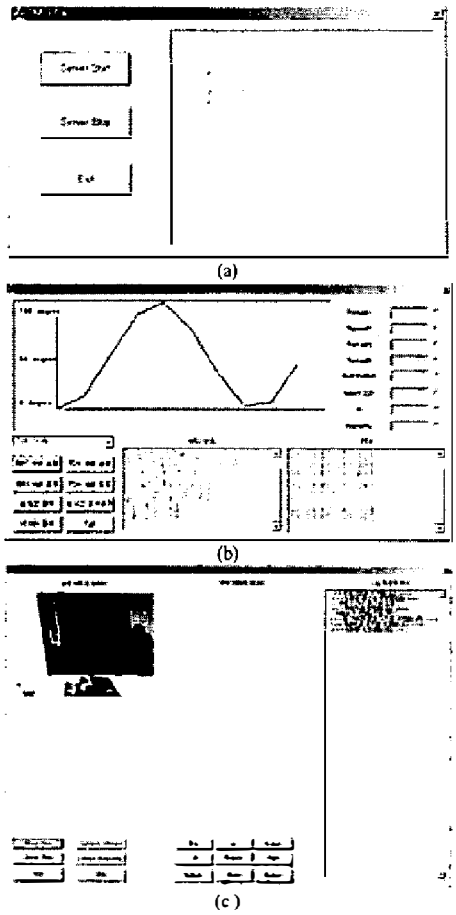


Fig. 9 Sensor data and camera image data management program in web server including (a) PDA connection management program, (b) Control board connection management program and (c) camera image data management program in server.

Figure 9 shows sensor and camera image data management program in web server including PDA connection management program(a), Control board connection program(b) and Camera image data management program in server.

IV. Experimental Results

Wireless sensor module was added to normal home networking system that include surveillance camera and power switches control function for room illumination and switching consumer electronics.

The wireless sensor module have only one transmitter and receiver, however many sensors, 8 sensors in our test, can be attached to the module. To system simplification, transmitter and receiver parts of sensor module were designed and fabricated using CPLD chip separately. In this transmitter sensor module part, most of analogue sensors can be put, so normal commercialized sensor can be used conveniently. The sensor module have very simple structure that include a CPLD chip, a UHF long range RF transmitter commercial chip and several normal analogue or digital sensors. So we can easily attach the transmitter module on the wall of room or at convenient place.

The RF sensor signal form the transmitter is filtered to recover the original sensor input and translated through RS 232 serial communication to other device. The receiver part is composed a CPLD chip which include receiver module, filter, RS 232 UART, and a VHF long range RF receiver commercial chip.

In former days, only toxic gases should be checked for safety of human body, however nowadays room atmosphere aim at comfortable life. The comfortableness can be obtained from complex monitoring and controlling of many parameters, such as temperature, humidity, CO_2 concentration, O_2 concentration, density of fine particle dust etc. So the wireless multi-sensor module for the monitoring indoor is very important technology in near future home networking technology.

A surveillance camera can be in control of direction and zoom in/out, and the resolution of camera image also can be controlled from terminal PC. Moreover unintended intrusion can be detected by image processing and alarm message can be sent to pre-appointed person.

In this study, most of system components were designed by ourselves and fabricated for system optimization. And the separated components work together well.

REFERENCES

[1] Francesco Calvino, Maria La Gennusa, Gianfranco Rizzo and Gianluca Scaccianoce, The control of indoor thermal comfort conditions: introducing a fuzzy adaptive controller, Energy and Buildings, Vol.36(2), pp.97-102.

[2] Zhongping Lin and Shiming Deng, The outdoor air ventilation rate in high-rise residences employing room air conditioners, Buildings and Environment 38 (2003) 1389-1399.

[3] Wan-Young Chung and Jun-Woo Lim, Patterning of Thin Tin Oxide Films with Nano-Size Particle for 2-Dimensional Micro Gas Sensor Array, Current Applied Physics 3(2003)413-416.

[4] Wan-Young Chung and Duk-Dong Lee, Real Time Multi-Channel Gas Leakage Monitoring System Using CPLD Chip, Sensors and Actuators B, 77(1-2), pp.186-189, 2001.7.