An Embedded Lab Security Monitoring System

P. Nataraju[1] and A. Sushmaja[2]
Department of Electronics and Communication Engineering Tenali Engineering College
Tenali, India

V. Srikanth[3] and V.B. Sundheep[4]
Department of Electronics and Communication Engineering Vignan's Lara Institute of Technology and Science, Vadlamudi, India

Abstract—*This paper presents the design and implementation of an Embedded Laboratory Security Monitoring System (ELSMS).The system includes a web server which acquires video information through camera, and Wireless Sensor Network (WSN) which gets environmental parameters through sensors and sends them to the web server. Users can access the Monitoring Server (MS) through PCs or Wireless Mobile Terminals(WMT) which are developed using Qt, to watch video and check environmental parameters in real-time. When an exception occurs, the MS sends Short Message Service (SMS) through GSM Modem, displays alarm information on web and gives sound and light alarm, etc. SQLite database stores historical information related to environmental parameters for users' query. The system proposed in this paper is a kind of new monitoring system that is applicable to the lab and other fields that store valuables.*

Keywords-Security Monitoring System; Video Transmission; Wireless Sensor Network

I. INTRODUCTION

Currently it already has Video Monitoring System (VMS), Intelligent Monitoring System (IMS), and Sensor Monitoring System[3-4], etc, on the market. VMS can be real-time video transmission and playback, but the cost is too high; IMS is difficult to be widely used because of its technological difficulties; Sensor Monitoring System can monitor a wide range of environmental parameters, but it is not intuitive, and generally it needs to install specific software on the monitor. In this paper, we designed an Embedded Laboratory Security Monitoring System (ELSMS). Combined with the advantages of VMS and SMS, functions as real-time video transmission, centralized monitoring of environmental parameters, and alarming in real-time are realized. Users can also query information directly on the web site through browser or Wireless Mobile Terminals at any time.

II. SYSTEM SCHEME DESIGN

In this paper, the design of ELSMS is on the background of laboratory security monitoring. It can be divided into three parts such as MS, WSN and Terminals; the structure is shown in Figure 1.MS is the core of the system. As a Web server, it can capture video information through the camera, receive environmental parameters from wireless sensor nodes, and

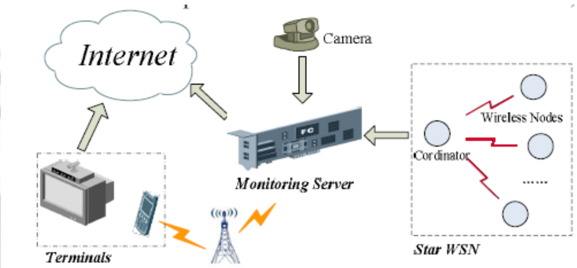


Fig. 1. System functional diagram

then upload them to the Internet; In addition, the MS analyses the environmental parameters, determines whether the laboratory is in security state. When an exception occurs, it gives real-time alarm on web-site, sends SMS to users, and gives sound and light alarming on the field, etc. Users can visit this MS to view the current video and environmental parameters of the laboratory; lastly, by creating a database in the MS, historical information of environmental parameters will be saved.

Terminals are set into PC terminals and WMT. PC terminals are personal computers; and WMT are terminal devices, which can be small and wireless, specifically designed for security persons. User interface of WMT is designed using Qt and through which users can access the MS within the coverage of a wireless LAN, get all the information and achieve the purpose of mobile monitoring.

The bottom layer of the system is a star WSN which is made up of wireless sensor nodes, and every wireless sensor node has different sensors which collect different environmental parameters of the lab and send them to the MS. The WSN can be expanded by mounting multiple sensors or wireless nodes.

III. HARDWARE DESIGN

Hardware design of the system is divided into design of MS, Remote Terminal (RT) and WSN. MS, as the core of the system, collects information through the USB camera and CC1100 wireless sensor nodes and feedbacks the collected information to users by the form of GSM SMS and Internet pages, etc. System hardware design is shown in Figure 2.

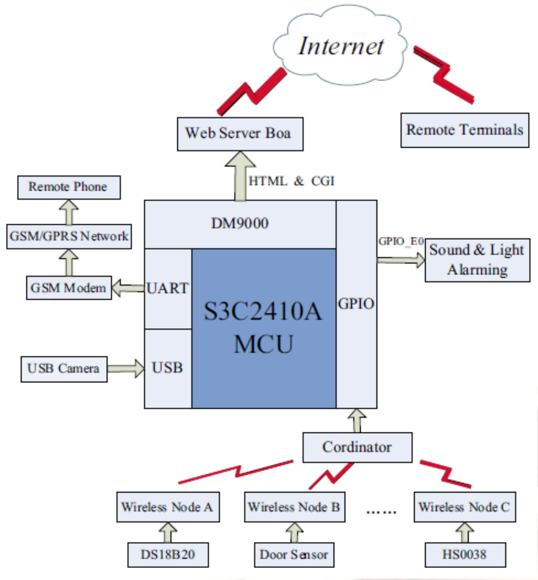


Fig. 2. Overall system hardware diagram

A. Monitoring Server Design

We use Samsung's S3C2410A chip as the MCU of MS. Its main frequency is up to 202 MHz; it has 3-channel UART, 4-channel DMA, 5-channel timer with PWM functions and USB interfaces, etc. The S3C2410 development board that we have chosen has expanded 64M SDRAM and 64M NAND FLASH externally, 2M NOR FLASH reserved, a 100M DM9000 Ethernet card, two standard RS232 serial ports, a USB host interface and a USB slave port, etc. The development board use DC 5V power supply with RESET and RTC circuit.

We use S3C2410 development board's USB slave port to connect with camera and to get video of the laboratory; use UART2 to connect with GSM Modem and send SMS; use its general I/O ports: GPIO_B6, GPIO_G3, GPIO_D14, GPIO_E13, GPIO_E11 and GPIO_E12 to connect with CC1100 RF module, so S3C2410 development board is used as the coordinator of the star WSN, which controls and receives wireless nodes' environmental parameters; use general I/O port GPIO_E0 to connect with relay to control high-power lamps and obtain sound and light alarming.

B. Remote Terminal Design

RT, as is said, is composed with PC Terminal and WMT. Using PC Terminal, users can login the MS through the browser. WMT are designed on another ARM development board that has a LCD screens. With a wireless LAN card, users can visit the MS and view related information within the coverage of any wireless LAN at any time. S3C2410 internal ADC is used for building control and conversion circuits of LCD.

C. WSN Design

The nodes of the WSN are made up of CC1100 RF module and MCU C8051F330, CC1100 RF module which is connected with S3C2410 development board is used as the coordinator of the star WSN. CC1100 chip is low-cost, and is especially designed for low power wireless applications. Its frequency can be set to 315MHz, 433MHz, 868MHz and 915MHz, its transceiver integrates a highly configurable modem, its data transfer rate can be up to 500kbps. Using CC1100 can not only take full advantage of its low cost, low power consumption, but also can expand system easily by increasing the number of sensors, or the number of wireless nodes. The MCU C8051F330 is fully compatible with MCS-51 core instructions, it has many analog and digital peripherals required by control systems, UART and SPI bus interface on chip, etc. It can work between 2.7V ~ 3.6V, in the industrial temperature range (-45^{0}C ~ 85^{0}C), and mostly, it is also low power consumption.

IV. SOFTWARE DESIGN

Software design of the system is divided into design of MS, WMT and Wireless Sensor Nodes. Software design of MS mainly includes building Web server, acquiring and transmitting video data, accessing and analyzing the wireless nodes' environmental parameters, etc. Software design of WMT mainly transplants the wireless network card driver, configures it, and designs user interfaces, etc. Software design of Wireless Sensor Nodes mainly solves problems of collecting and sending the sensor information.

A. Setting up Web server

We embedded Linux 2.4.18 kernel Operating System (OS) on the S3C2410 development board, transplanted software named Boa to set up Web server directly. It requires to modify three parts of the source code when transplants Boa-0.94.13, which are: (1) modify CC = gcc and CPP = gcc-E to CC = arm-linux-gcc and CPP = arm-linux-gcc-E in Makefile, select cross compile tool chain version 3.4.1; (2) modify #define TIMEZONE_OFFSET(foo) foo##->tm_gftoff to #define TIMEZONE_OFFSET(foo) (foo) - >tm_gftoff in file src/compat.h; (3) To allow users to login as root to perform the script, it is required to comment the following lines in file src/boa.c.

```
// If (setuid(0) != -1){
//      DIE (“icky Linux kernel bug!”);
// }
```

When the above codes were modified, an ARM architecture binary executable file boa can be generated, then copy it to the target board, a new folder named boa in the target board's directory /etc will be created. Then copy boa.conf, which is the Web server's configuration file and located in the source package and memi. types in Linux host to the target board's directory /etc/boa. We configure “User nobody” to “User root” (or “User 0”) in file boa.conf to start the server by user root; and configure “Document Root” contents to be “/var/www” to set the server's root directory path. Then run the command in the target board terminal to start the server.

[/mnt/yaffs]./boa &

By command “ps” can we view the status of the server process, and we can also modify file /etc/boa/boa.conf to configure the Web server’s other functions.

Server Boa supports CGI scripts programming. In this paper, we use C to program, we write CGI scripts using a series of API functions provided by CGIC library. CGI scripts use cgiMain as its main and entrance function. When designing CGIC scripts, should include cgic.h to call its API functions:

```
#include"cgic.h"
int cgiMain(void){
cgiHeaderContentType("text/html\n\n");
cgiFormStringNoNewlines("username",username, 2
5);
…...}
```

In the above codes, function CgiFormStringNoNewlines gets the username from textbox of web pages, it removes return symbol and the length of the contents was limited to not more than 25 bytes.

B. Video data acquisition and transmission

Video data are accessed through the USB interface; program should be load in kernel to support Video4Linux. Video data’s acquisition and transmission can be realized by some API functions in Video4Linux, or by transplanting mature server software servfox client software spcaview directly.

As a server program, servfox transmits video data on the basis of Boa Web server. Through modifying CC = gcc to CC = arm-linux-gcc in file Makefile, and compiling it using cross compile tool chain which version is 3.4.1, an ARM architecture binary executable file servfox will be generated. On the other hand, we get binary executable file spcaview by compiling it directly. The next step is to copy the folder http-java-appletwe in directory spcaview to the target board server root path (/var/www), and change its permission to be executable. Then by running the next commands in the target board terminal can we start the video monitoring server.

[/mnt/yaffs]./boa &

[/mnt/yaffs]ln–s/dev/v4l/video0/dev/video0

[/mnt/yaffs]servfox–d /dev/video0 –s 320x240–w 7070

One of real-time video monitoring diagrams is shown in Fig. 3.

Fig. 3. Real-time video monitoring diagram

C. Wireless network card driver’s transplantation and configuration

As we have adopted Linux 2.4.18 as OS of the mobile terminal, we have to patch it and add the wireless part support in kernel because of its poor support to the wireless peripherals.

It requires to modify three parts of the source code when users transplant the wireless network card driver: (1) select file Makefile.4 as its Makefile; (2) modify CC = gcc and LD = ld to CC = arm-linux-gcc and LD = arm-linux-ld in file Makefile, and select cross compile tool chain which version is 2.95.3; (3) comment the following union in file rtmp.h.

```
typedef struct __TX_BUFFER{…..
//union {
……
// };
} TX_BUFFER, *PTX_BUFFER;
```

By Compiling it and three files (rt73.o, rt73sta.dat and rt73.bin) can be generated. Then copy them to the right directory on the target board. Using command “insmod rt73.o” in target board terminal, users can load the wireless network card driver. A series of commands provided by wireless tools in Linux can help to configure wireless network. For example, users can enter command shown below to choose wireless router named TP-LINK_5DF61C as its router.

[/mnt/yaffs]iwconfig rausb0 essid "TP-LINK_5DF61C"

D. Collection and analysis of environmental parameters

Collection and analysis of environmental parameters contain device initialization, access and analysis of environmental parameters of wireless nodes, reading Monitoring Server’s surrounding environment parameters, determining alarm, controlling GSM modem to send SMS, reading system time and inserting relevant data into a database, etc. In this paper, we take multi-thread mechanism to achieve the above functions. The process is shown in Figure 4.

In the star WSN, coordinator controls multi-nodes communication. Each wireless node is set into receiving statues in general. When the coordinators’ request frame is accepted, the sensor node replies to the coordinator immediately by sending the environmental parameters. In order to reduce power consumption, we set every sensor node to be interrupt mode. Schematic diagram of sensor monitoring and historical information query are shown in Figure 5.

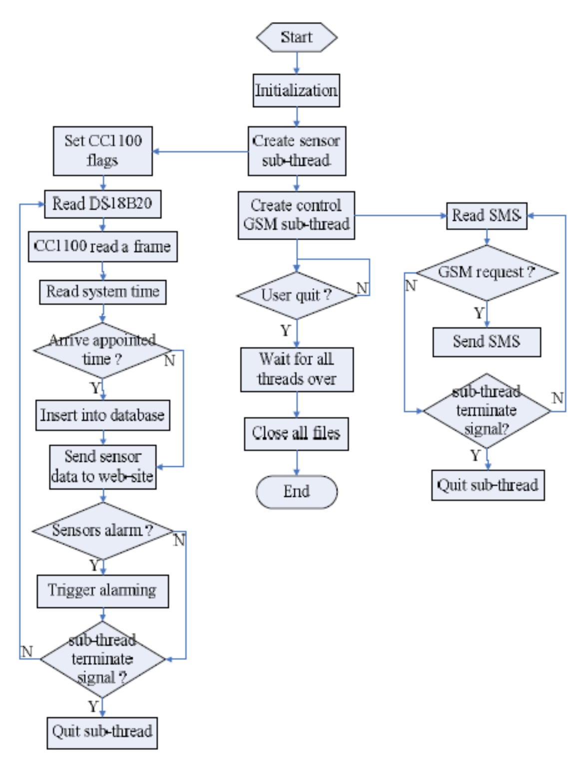
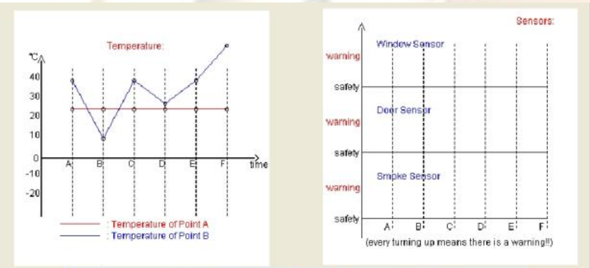


Fig. 4. Flow chart of environmental parameters collection and analysis



A:	10:36:49	B:	10:37:00
C:	10:41:46	D:	10:45:12
E:	10:45:40	F:	10:48:28

History Data In SQlite3

Date And Time:	Atemperature:	S3C2410:	Window:	Door:	Smoke:
2010-05-03 10:48:28	58	25	0	0	0
2010-05-03 10:45:40	40	25	0	0	0

Fig. 5. Schematic diagram of historical information query

V. CONCLUSION

We designed an Embedded Laboratory Security Monitoring System, and implemented its hardware and software functions. In this system, Boa is used to build Web server, camera collects video information through USB interface, star WSN acquires and transmits environmental parameters, and a database is created in the MS to save historical environmental parameters. The system has advantages such as real-time video data transmission, extensive monitoring of environmental parameters and convenience of operation and management. The system can be widely used in universities, intelligent buildings and other places that need to be distributed monitored or distributed controlled. Moreover, with the rapid spread of Wi-Fi Mesh technology, users will be able to login the MS through mobile phones that support Wi-Fi and realize the target of remote monitoring through mobile phones.

REFERENCES

[1] Yao Kun. "Research and Implementation of Mobile Terminal Based on ARM Linux". Xi Dian University, Xi'an, 2009. (in Chinese)
[2] ZHAO Xiao-jun, SU Hai-xia, REN Ming-wei, etc."Remote Monitor and Control System Based on ARM9 and CAN Bus". Computer Engineering, 2010, 36(3):231-233. (in Chinese)
[3] HOU Jun, WU Cheng-dong, YUAN Zhong-jia, etc."Research of intelligent home security surveillance system based on ZigBee" . Mechanical & Electrical Engineering Magazine, 2009, 26(1):67-70. (in Chinese)
[4] Wu Wei, Yanan Zhang, Fuxing Zhang, etc".Research on Navigation Marks-Monitored Network System Based on WSN", Asia-Pacific Conference on Information Processing, 2009(2): 521-524.
[5] Weixing Zhu, Fangkui Zhong, Xiangping Li".Automated Monitoring System of Pig Behavior Based On RFID and ARM-LINUX" .Third International Symposium on Intelligent Information Technology and Security Informatics, 2010:431– 434.
[6] Jian Huang, Peilei Rao, Xiaoguang Hu, etc. "Research of On-line Monitoring System of the Condition of Circuit Breaker Based on ARM and FPGA". 2009 IEEE International Conference on Control and Automation, Christchurch, New Zealand, 2009:201-205.