EMBEDDED INTELLIGENT HOME CONTROL SYSTEM BASED ON ARM-LINUX

I.Mahendar[1],K.Srinivasa Reddy[2],D.Rupa Kumar[3],E.Geetha Reddy[4]

Abstract— **the main objective of the system is to design "Linux Web-Served Distributed Home-Monitoring Using Internet Based Geographical Information System".**

In the existing system the Home monitoring system is design and controlled by using RF technology which can monitor and control the system inside the lab only in places where network availability is more. They are bit more costly because cost of components is increased. Not so easy to implement as you have to take great care of noise, Because of antennas it is bulkier.

To overcome the drawback present in existing system, our Embedded project designs a low cost feature which is based on embedded platform for monitoring the home appliances. This project uses temperature sensor and gas sensor to detect the temperature of the house and any gas leakage from the house respectively. The project uses ARM micro controller which is 32-bit controller to process the information.

The embedded project is to monitor status of the sensors on remote PC through a web page. Here temperature sensor and gas sensor can be monitored on web page through micro controller.

The web-server is connected to LAN or Internet. The house owner on the PC is also connected to same LAN or Internet. By typing the IP-address of LAN on the web browser, the owner gets a web page on screen. This page contains all the information about the status of the sensors or else the owner can also monitor the results through mobile if the mobile has internet facility.

Index Terms—**HTTP, TCP/IP, ARM, RISC, GCC, LINUX, WWW, QT, LAN.**

I. INTRODUCTION

An embedded system is a device which can be used to control, monitor, or auxiliary operate machinery and equipment as well as a combination of software and hardware. In general, the embedded system is a dedicated computer system which emphasizes applications and is based on computer technology. It allows customization and clipping of the software and hardware and has a strict require to functionality, reliability, cost, size, and power consumption as well as can be applied to some specific occasions. It generally consists of the embedded microprocessor, peripheral hardware, and embedded operating system and user applications to realize the control of other devices, monitoring or management functions and so on.

Monitoring and controlling systems from remote locations has been increasing in day to day life which makes easy to control and monitor condition from any place at any time. The embedded systems which use micro-controller such as 8-bit microcontroller as the main controller has been widely used in various Fields, but most of these applications are still in the low-level stag1e of stand-alone use of the embedded system. It is feasible and forward-looking to apply the high-performance 32-bit microprocessors such as Broadcom BCM2835 SoC (ARM1176JZFS), embedded Linux system and Qt / embedded GUI application to practical industrial Control in certain occasion. Nowadays the management of the Domestic laboratories in the research institute and Universities has issues of poor real time, high cost and low precision. It is difficult to determine the quality of the environment of the laboratory. So the Laboratory Intelligent Monitoring System should be developed to implement early warning, remote control, real time monitoring and other functions. This paper focuses on the process and difficult points in the application of embedded GUI based on Qt / Embedded and Linux device driver in the laboratory environment intelligent monitoring system.

Typically, programming, digital logic design and often a computer architecture course are prerequisites for the more advanced embedded systems or microprocessor design course that is the focus of this paper. For software development in the embedded systems industry, the C/C++ family of languages is still used in the large majority of new designs, according to annual industry surveys. Many embedded systems, microcontroller, or microprocessor design courses started out with low-cost 8-bit processors with limited capabilities, but most of the development effort in industry has moved on to modern System on-a-Chip (SOC) 32-bit devices that contain a reduced instruction set computer (RISC) processor with volatile memory, nonvolatile flash memory, and a wide assortment of standard I/O interfaces, all on a single chip. According to annual industry surveys of embedded designers, 70% of new designs now utilize an operating system (OS), and 59% include networking. The wide spread development of these new embedded devices with networking. Now that a single-chip microcontroller already contains the processor, memory, and numerous I/O interfaces with built in hardware controllers, it is appropriate to use a higher level of abstraction in such a course. An increased focus can be placed on robotics, networking, and the use of existing C/C++ application programming interface (API) libraries to enhance productivity, basic operating

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system concepts, and rapid prototyping of devices. Less time can be spent on assembly language and lower-level hardware topics. This paper describes the experience gained developing a laboratory to support development of these devices; it will primarily focus on the new technologies used in the student instructional laboratories during the first three offerings of the new course.

II. SYSTEM TOPOLOGY

The general framework of the Laboratory Intelligent Monitoring System is divided into two parts which are the local ARM Intelligent Monitoring Center and its peripheral equipments and all kinds of remote monitoring terminals.

III. over all System Plan

The total system plan is showed in figure1.

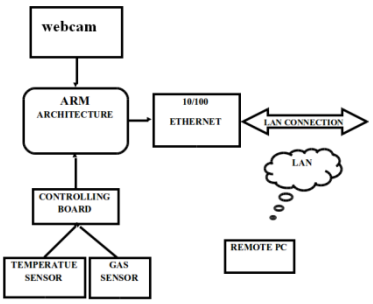

Fig.1 Block Diagram of the Total System

In this section, we give an overview on the proposed system architecture. The system makes use embedded board which makes use of less power consumptive and advanced micro controller like Broadcom BCM2835 SoC (ARM1176JZFS). BCM2835 is a Raspberry Pi company's microcontroller which is designed based on the structure of ARM11 family. This microcontroller works for a voltage of +3.3V DC and at an operating frequency of 700 MHz.

Our ARM board comes with integrated peripherals like Ethernet and Serial etc. On this board we are installing Linux operating system with necessary drivers for all peripheral devices and user level software stack which includes a light weight GUI based on XServer, TCP/IP stack to communicate with network devices and some standard system libraries for system level general IO operations. In this Home monitoring geographical information system we are using serial network for monitoring the environmental conditions in the home and sensors like temperature, gas are connected. Sensors are connected to sensor board. Sensor board with ARM controller connection is established via serial network which is connected to any one of the UART port avail in arm board.

After connecting all the devices power up the device. When the device starts booting from flash, it first loads the Linux to the device and initializes all the drivers and the core kernel. After initialization of the kernel it first checks whether all the devices are working properly or not. After that it loads the file system and starts the startup scripts for running necessary processes and daemons. Finally it starts the main application.

When our application starts running it first check all the devices and resources which it needs are available or not. After that it checks the connection with the devices and gives control to the user. The GUI for the user has the following options.

Status boxes for representing the monitored sensor values like temperature, gas Sensor.

From the sensor board we are sending monitored values to controller (ARM board) through RS232 serial cable. Home-Monitoring system monitors the conditions by Temperature, Humidity sensors also whenever environmental conditions are differed automatically sensor data will be modified and send it to controller. Monitored status of the sensors can be viewed on remote PC through a web page.

The web-server is connected to LAN or Internet. The house owner on the PC is also connected to same LAN or Internet. By typing the IP-address of LAN on the web browser, the owner gets a web page on screen. This page contains all the information about the status of the sensors or else the owner can also monitor the results through mobile if the mobile has internet facility. In this way we are implementing the monitoring system and displaying on Remote PC.

IV. Software design of ARM host controller

A. Transplantation of Linux Operating System

The transplant of Linux operating system is related with the hardware. Its essence is making the essential modification to the Linux operating system according to the concrete hardware platform to make it running on this hardware platform very well. The system's kernel edition is 2.6.12. The Linux operating system's transplant needs to complete three works: boot loader transplant, Linux kernel transplant and filing system transplant. Boot loader is running before the operating system kernel, the mainly role is initializing hardware equipment(including I/O, the special function register), establishing the memory space map and bringing the environment of the system's hardware and software to an appropriate state. The Linux operating system's kernel can provide good support to the ARM processor and manage most of components which connect to the periphery of the processor. The transplanted Linux kernel only needs to provide support to the hardware which will be used; therefore we may cut the kernel according to the practical application.

B. Application design

The overall software structure of the ARM main controller is shown in Figure 2. The system adopts Linux as the operating system of the ARM's main controller. The work needed to be done is: the cutting and transplantation of Linux 2.6.32, the programming of the serial driver, the programming of touch screen driver, the implementation of Web server and the migration of SQ Lite database, the system also adopts of the graphical user interface based on QT/E and establishes a QT user interface to optimize the human-computer interaction environment.

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C. Local Data Management & SQLite and Embedded GUI

The local data management for sensor networks includes three parts which are data storage, data analysis and data display. Storage of Sensor Data the ARM Intelligent Monitoring Center acquires sensor data via the sensor expansion board. Sensor expansion board with ATMELS controller as its master chip is used for sensor and communicating with intelligence monitoring center. SCM software is in charge of the local polling to obtain the status of each sensor and monitoring data. It can send out an interrupt request signal. ARM intelligent monitoring center send control commands to SCM according to the definition of serial communication protocol, the latter returns the state or data of specified sensors according to the commands. The sensor data is acquired and updated in a fixed time interval managed by SQLite database. But when the frequency of data acquisition is high, the data in the embedded database will be drastically increased and there is a need to clear the historical data, or the access performance of the database will gradually decline.

V. The Design of GUI and Device Driver of the Home Intelligent Monitoring System

The design of GUI for embedded systems is different from that of traditional data computing class software, which often handles mouse or keyboard events to complete a specific calculation, while the former mostly handle events caused by touch screen and other kinds of external devices. Because the embedded systems is resource-constrained, the design mode of the GUI of the traditional PC ,the memory consumption of which is relatively large and take up more CPU time, is not suitable for embedded systems. The lab intelligent monitoring system studied in this paper uses Qt/Embedded under embedded Linux as its GUI development platform, which can fully satisfy the restriction of embedded system resources. As QT uses C + + as its programming language, it can implement hybrid programming with Linux C. The header files include both QT-API library and Linux system calls libraries. Write the Linux system calls as parts of the slots functions which can respond to specific signals in order to achieve the combination of Qt / Embedded and Linux-C. Of course, to achieve reading and writing of a specific device file, there must be device drivers which provide reading and writing operation interface functions. Therefore, we need to complete the preparing, configuring and modifying of the drivers of sensors, cameras and other external expansion device of Broadcom BCM2835 SoC (ARM1176JZFS) microprocessor. The Laboratory Intelligent Monitoring System uses QT to complete GUI on the ARM head-end machine to achieve the graphical display of data collected by a variety of sensors. This article focuses on elaborating the design of the Linux drivers of various types of sensors and qtopia application in the system.

With the help of QT designer ,the programmer can quickly develop relevant GUI components and adjust the size and position, including functions such as displaying the current temperature, Light intensity concentrations of carbon dioxide and harmful gases concentration in the laboratory environment and showing whether the infrared sensors open or not. And then define the signals and slots functions, save it as Ui file.

VI. EXPERIMENTAL RESULTS

We compile the project as x86 version and make it runs on PC as a simulation with the help of qvfb. Then replace the compiler with arm-linux-g++ and recompile the program to generate a version that is suitable for Broadcom BCM2835 SoC (ARM1176JZFS) ARM development board. The final result that running on the embedded front-end machine is shown in Fig 2 and Fig 3.

In the Fig 2, shows the output on web browser. If we enter in the particular IP address in browser it shows the live video streaming and sensor values as shown in Fig 2.

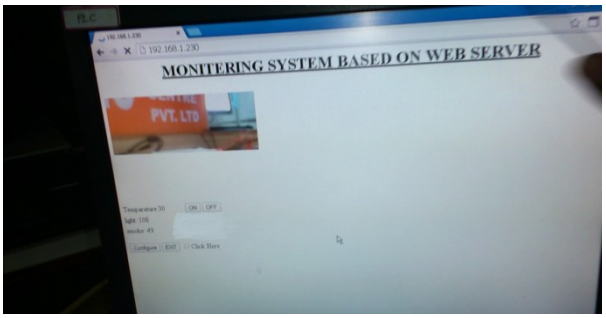

Fig.2 Output on web browser

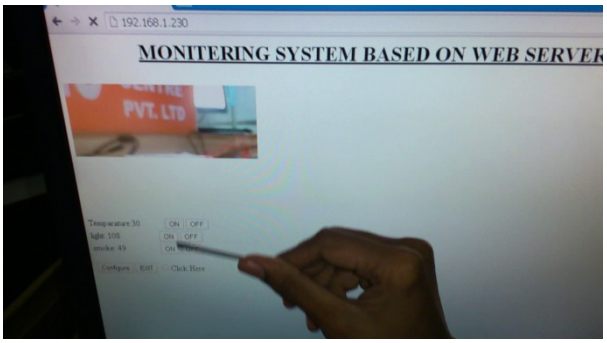

Fig.3 controlling through web browser

In the Fig 3 shows the controlling through web browser. We want control the any equipments in home by using this we browser as shown in Fig 2.

VII. CONCLUSION

In the post-PC era, the embedded system technology develops rapidly and the design of embedded GUI and the linux device drivers are important and indispensable components of it. This paper focuses on solving the issues of poor real time, high cost, low precision and incapability of determining whether the lab environment is in line with the body's health indicators in the laboratory management of domestic institutions of higher learning. It develops a laboratory intelligent monitoring system with Broadcom BCM2835 SoC (ARM1176JZFS) microprocessor as its main controller, elaborating the difficult points of the development of the GUI applications based on Qt / Embedded and Linux drivers for various types of sensors in the project. With a

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perfect support of the embedded system technology, we believe that the intelligent monitoring system will have better performance and broader market prospect.

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