

On-Line Remote Data Acquisition and Control System for Embedded Real Time Applications

Sheetal K. Mahadik*, Prof.P.G.Chilveri**

(Dept. of ECE,Pune University,VLSI and Embedded Systems. SKNCOE, Pune, India)

ABSTRACT

A typical Data Acquisition System (DAS) consists of individual sensors with the necessary signal conditioning, data conversion, data processing, multiplexing, data handling and associated transmission, storage and display data. This paper describes the DAS that is very useful in keeping track of data from sensors recording values from the environment in real time. The data collected from the sensor may be transmitted over long distances from the test center to the controlling authority. Analog data is acquired and converted into digital form for the purpose of processing, transmission, display and storage. A data can be transmitted transparently through Ethernet interface unit to the remote end desktop computer. While becoming the dominant LAN technology, Ethernet has proven to be a very effective and very economical PC networking solution. With 10 Mbps and 100 Mbps Ethernet components widely available at a relatively low cost, This design has the advantage of cost-effective, easily realized, stable and reliable transmission and so on.

Keywords - ARM9, Linux system, Qtopia, TCP/IP, LAN.

I. INTRODUCTION

Embedded systems is a computer system designed for specific control functions within a larger system often with real time computing constraints. Embedded systems control many devices that are used commonly today and are usually build dedicated to perform a specific task. Embedded systems are especially suited for use in transportation, fire safety, military, security, medical applications in form of alarm system monitoring abnormal activity or Data acquisition system. The DAS described here provides remote monitoring based on Ethernet. The Ethernet (IEEE 802.3) is the most mature and widely used LAN technology, connecting the embedded device to the network device such as Hub, switch thus realizing a flexible real time control and monitoring has already become an inevitable development trend of embedded technology. In this paper, the design and implementation process of a monitoring system based on ARM9. ARM 9

S3C2440 development kit is connected with PC using a crossover Ethernet cable RJ 45 to provide LAN configuration.

II. GENERAL DESCRIPTION

The Primary goal of building a network connected Data Acquisition system is to build a DAS which would be able to acquire the necessary data from sensors at correct speed and at a correct time and upload and record the values up on an external world through Ethernet. So that system values can be monitored from anywhere without the need of special equipments to receive and display the information in condensed, understandable and legible manner. The information can easily be accessed and controlled by PC, which in turn can be connected to a local low cost local area network (LAN) to transfer sensor values directly to a data logger or computer. The accessibility of this information is significantly curtailed by this need for proximity. However, developments in the Internet protocol TCP/IP, which is the universal communication standard, looks set to change all of this. In order to allow communications to be directed, every physical location on the network (server or client) requires an IP address. Softwares have been designed to run on PC that passes messages received on an IP network to the logger hardware via a serial port or USB.

III. HARDWARE DESCRIPTION

Here we discuss about the design methodology of touch screen based data acquisition. The hardware design consists of S3C2440 ARM9 processor with touch screen, serial port. The touch screen is interfaced to mini2440 development board. The System consists of two nodes first is data acquisition and other is monitoring the sensor data that is acquired. Networked PC Measurement System simply provides a PC-based data acquisition or measurement system with the necessary network interface card and software to serve measurement data over Ethernet. Network communications can be accomplished using a number of different approaches. For example, the PC system could utilize standard networking software provided by Microsoft, such as TCP/IP protocol, remote procedure calls (RPC), distributed component

object model (DCOM) or OLE for process Control (OPC). Here we used TCP/IP protocol.

A. S3C2440 ARM PROCESSOR

Friendly ARM Mini 2440 SBC (Single-Board Computer) with 400 MHz Samsung S3C2440 ARM9 processor. It contains a memory management unit making it a suitable platform for standalone applications, embedded real time operating systems and complex operating systems such as Linux. The on board UART interfaces UART0 and UART1 to connect PC COM ports. UART0 is used to perform command line operation of the board on PC and UART1 is used to communicate with PC from board using touch screen.

B. ETHERNET TECHNOLOGY

Ethernet is the most common type of connection computers used in a local area network (LAN). An Ethernet port looks much like a regular phone jack, but it is slightly wider. This port can be used to connect your computer to another computer, a local network, or an external DSL or cable modem. Two widely-used forms of Ethernet are 10BaseT and 100BaseT. In a 10BaseT Ethernet connection, data transfer speeds can reach 10 mbps (megabits per second) through a copper cable. In a 100BaseT Ethernet connection, transfer speeds can get up to 100 mbps. There is also a new technology called "Gigabit" Ethernet, where data transfer rates peak at 1000 mbps. Now that's fast. An Ethernet port is an opening on computer network equipment that Ethernet cables plug into. These ports are alternatively called jacks or sockets. Ethernet ports accept cables with RJ-45 connectors. The term Ethernet refers to the family of local-area network (LAN) products covered by the IEEE 802.3 standard that defines what is commonly known as the CSMA/CD protocol.

C. LM 35 TEMPERATURE SENSOR

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in °Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^{\circ}\text{C}$ at room temperature and $\pm 3/4^{\circ}\text{C}$ over a full -55 to $+150^{\circ}\text{C}$ temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only $60\ \mu\text{A}$ from its supply, it has very low self-heating,

less than 0.1°C in still air. The LM35 is rated to operate over a -55° to $+150^{\circ}\text{C}$ temperature range.

D. RJ45 ETHERNET MAGJACK

MAGJACK is a RJ45 cable jack with an in built Ethernet transformer, Status LEDs and Shielding. The Yellow and the Green LEDs in the figure above indicates the Reception and Transmission of Packets respectively.



Fig 1: RJ45 Magjack

E. UART

The Universal Asynchronous Receiver Transmitter (UART) is a popular and widely-used device for data communication in the field of telecommunication. The Universal Asynchronous Receiver/Transmitter (UART) takes bytes of data and transmits the individual bits in a sequential fashion. At the destination, a second UART re-assembles the bits into complete bytes. Each UART contains a shift register, which is the fundamental method of conversion between serial and parallel forms. Serial transmission of digital information (bits) through a single wire or other medium is less costly than parallel transmission through multiple wires. A UART is usually an individual (or part of an) integrated circuit used for serial communications over a computer or peripheral device serial port. UARTs are now commonly included in microcontrollers. Transmitting and receiving UARTs must be set for the same bit speed, character length, parity, and stop bits for proper operation. The receiving UART may detect some mismatched settings and set a "framing error" flag bit for the host system; in exceptional cases the receiving UART will produce an erratic stream of mutilated characters and transfer them to the host system. Many modern ICs now come with a UART that can also communicate synchronously; these devices are called USARTs (universal synchronous/asynchronous receiver/transmitter).

IV. MEMORY MODULE

The Mini2440 has two external SDRAM chips with a total of 32M bytes each or 64M bytes each with a full 32-bit data bus width for maximum speed. The Mini2440 has two kinds of Flash memories 64M or 128M Nand Flash, 2M Nor Flash in which the BIOS is installed. 64M NAND Flash, of which the type is K9F1208U0M, serves as the flash memory of the system. As the hard disc of the system, Nand Flash is mainly used for storage of

system boot, OS Kernel, file system, graphical interfaces and application program.

V. SOFTWARE DESCRIPTION

Software design is the main key design of the system. Without the software design hardware will not have any meaning. Software design of this system includes following:

D. TOOLCHAINS AND CROSSCOMILING

We are probably working on an x86 machine. When we type 'gcc' we are using a compiler that generates machine level code for an x86 processor. This is referred to as a 'native' compiler, as it is generating code for the machine it is running on. We need to generate code for the ARM architecture, so we use a cross compiler, that runs on an x86 machine but generates code for the ARM machine. This is referred to as the target machine.

The boot loader is a piece of code that set up the board, finds the kernel, loads it and starts it. UBOOT is a very versatile option for this purpose, and provides many ways to boot up the board. It can boot from flash, SD card and the network. Mini2440 comes with SuperVivi bootloader preinstalled. Before loading uboot first check the size of the NAND memory to decide which version of the pre-built images has to be loaded. Check that the power switch **S1** switch is in **OFF** position; the power led near the switch will be **OFF** and the switch in the **RIGHT** position (near the display).As pictured below connect USB, RS232 and power to your board; obviously connect the other side of the cables to the host PC. Then perform the step by step procedure to load linux kernel and file system also.

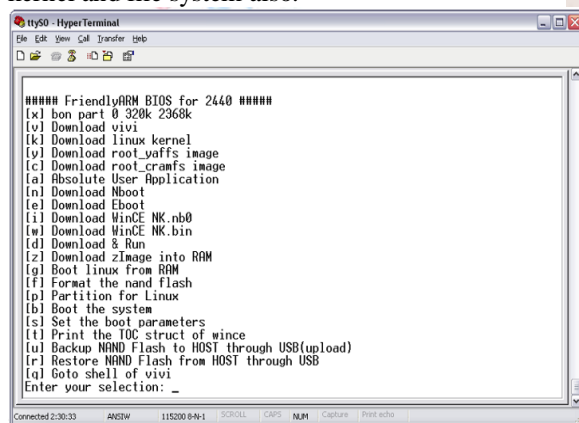


Fig 2: Hyperterminal Window.

The kernel is the operating system. Currently for this system the kernel provided by FriendlyARM, which can be downloaded from the FriendlyARM website is used. This provides much

better board support than other versions of mini2440 kernels. To use this one we will need to adjust the configuration somewhat. There are two tools to use for this 'menuconfig' which is a terminal style configuration utility and 'xconfig' which a GUI tool. While the GUI tool is by far the easiest, if there is a need to do a configuration over telnet, it is a good idea to be familiar with 'menuconfig'.

E. DEVELOPING APPLICATION USING QTOPIA

Qtopia provides a graphical environment for the embedded devices and we can develop Qtopia application on Linux. No hardware dependencies are required. It can support any processor and graphics card supported by Linux. Requires Linux kernel with linear frame buffer support (4,8,16 or 32 bit +VGA16 supported).when we create a new project in qt named Hello, we get some files automatically:

- HelloBase.ui
- main.cpp
- Hello.cpp
- Hello.pro

HelloBase.ui is used for user interface. main.cpp has the main function (entry point) from where your application starts execution. Hello.cpp file contains a class named "Hello". Hello class is derived from "HelloBase". Basically this class is generated from UI Compiler along with the .ui class and is derived from QWidget. QWidget is the class that works as a base class for all user interface elements. A Widget is the user interface that receives all types of events, like mouse event, keyboard event, paint event etc. Hello.pro file contains the components that are needed to build the project.

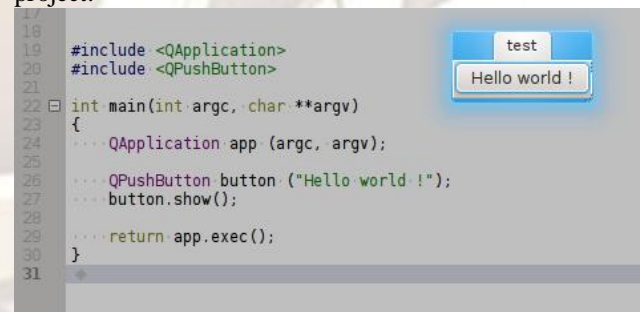


Fig 3: Hello World Application on QT.

F. NETWORK SETTINGS

In the sub-category "FriendlyARM" process, the point "Network Settings" icon to open the corresponding interface, shown in figure 3. Here, you can set up common network parameters:

- static IP address - the factory default to 192.168.1.230
- subnet mask - the factory default is 255.255.255.0
- gateways - the factory default to 192.168.1.1

- DNS server IP - the factory default is 192.168.1.1 and gateway address the same.
- Card MAC address - this address through the software by the driver settings can be modified, the development board MAC address of the factory are all the same in order to 08:90:90:90:90:90 Point "Save" button then above parameters can be saved and to come into effect immediately restart the development board.



Fig 4: IP Address Settings

G. PING TEST

To perform ping test connect a good development board attached to the network line, and set up an effective gateway, DNS and other parameters can be passed on graphics ping program interface to test the network connectivity. Sub-class in the process "FriendlyARM" midpoint "Ping Test" icon, hit open the corresponding interface, the following chart:

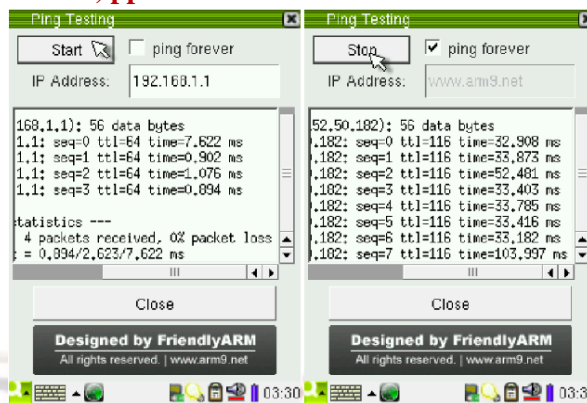


Fig 5: Ping test

Point "Start" button to start the ping, point of "Stop" button to stop ping, to close the "Ping Test" the interface will must stop the ping.

VI. RESULTS

Results have been tested firstly for the Potentiometer available on the board. The data have been captured in real time and got displayed on both the ends that is on client end (ARM 9) and server end (PC). If the value at sensor (LM35) goes beyond the predefined value then it is turned off through the GUI displayed on the PC screen. The software is designed using Qtopia language on ubuntu operating system. The LAN connection has to be carried out to transmit the data over the network connected devices.

VII. CONCLUSION

The embedded web server that has been designed can be used in educational institutions, offices and many other places. For web-based network element management provide an administrator with a simple but enhanced and more powerful user interface without additional hardware.

Poorly designed and configured software architectures might even generate high response time while the physical resources display low utilization. A remote user only requires a common Internet browser to carry out experiments on real hardware. The Embedded web server replaces the PC which is required for remote labs with special hard- and software.

REFERENCES

[1] S.Li, Jiarong, R. Luo, Yichun C.Wu, Guiming M. Li, Feng Wang, and Yong Wang. "Continuous and Real-Time Data Acquisition Embedded System for EAST", *IEEE Trans. Nuclear science*, Vol.57, No.2, pp. 696-699, April 2010.

- [2] Tran Nguyen, Bao Anh, Su-Lim Tan, "Real-Time Operating Systems for small microcontrollers", *IEEE Comp society*, pp. 31-45, September 2009.
- [3] F. Acernese, P. Amico, M. Alshourbagy, F. Antonucci, S. Aoudia, P. Astone, S. Avino, D. Babusci, G. Ballardin,"Data Acquisition System of the Virgo Gravitational Waves Interferometric detector" *IEEE Trans. Nuclear science* , Vol. 55, No. 1, pp.225-232, February 2008.
- [4] S. B. Silverstein, J. Rosenqvist, and C. Bohm, "A simple Linux-based platform for rapid prototyping of experimental control systems," *IEEE Trans. Nucl. Sci.*, vol. 53, no. 3, pp. 927–929, Jun. 2006.
- [5] Daogang Peng, Hao Zhang, Kai Zhang, Hui Li, Fei Xia,"Research of the Embedded Dynamic Web Monitoring System Based on EPA Protocol and ARM Linux," *IEEE Conf*, pp.640-644, 2009.
- [6] www.FriendlyArm.net.

