

Design of Linux based Web Server System for Soil Moisture Measurement using GSM and ARM9 Mini2440

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Abstract

This work has been designed for the efficient measurement of soil moisture. The remote monitoring of soil moisture is very important in rural India and useful for irrigation scheduling. The GSM has been extensively used in wireless communication. In our work we have designed embedded linux based web server system for remote monitoring of soil moisture. The ARM LPC2148 board has been used at the base station and ARM9 mini2440 board has been used at the server side for remote monitoring. We have also designed our own LPC2128 and SIM300 GSM module for the implementation of work.

Keywords— soil moisture, GSM, Web server, Wireless sensor network, mini2440.

I. INTRODUCTION

As Per the 2010 Food and Agriculture organization (FAO) world agriculture statistics, India is the world's largest producer of many fresh fruits and vegetables, milk, major spices, select fresh meats, select fibrous crops such as jute, several staples such as millets and castor oil seed. India is the second largest producer of wheat and rice, the world's major food staples. India is also the world's second or third largest producer of several dry fruits, agriculture-based textile raw materials roots and tuber crops, pulses, farmed fish, eggs, coconut, sugarcane and numerous vegetables. India ranked within the world's five largest producers of over 80% of agricultural produce items, including many cash crops such as coffee and cotton, in 2010. India is also one of the world's five largest producers of livestock and poultry meat, with one of the fastest growth rates, as of 2011.

Soil moisture is nothing but water content and could be available in the spaces between soil particles. Generally, soil moisture measured either 8 to 10 cm of upper soil or 75 to 100 cm of upper soil. The soil moisture quantity is very small compared to other quantities in the hydrological cycle. The measurement of soil moisture is very important for water quality management, reservoir management, geotechnical engineering, irrigation purpose, estimation of crop yield etc. The remote monitoring of soil moisture plays a vital role nowadays for various reasons and technological development in the last decade will motivate for the researchers to involve in the development of advance remote monitoring systems. With this system we can monitor soil moisture of remote places and helps us to avoid of visiting remote places frequently.

In this work we have mainly focussed to design a linux based web server system for soil moisture measurement using GSM and ARM9 mini2440. GSM is one of the latest mobile technologies using smart MODEM which can be easily interfaced to embedded microcontrollers. Now everything is going to be automated using this technology and we can access the devices remotely.

II. HARDWARE USED FOR THE IMPLEMENTATION

For the design of remote monitoring system to measure soil moisture, we have been used soil moisture sensor, ARM7 LPC2148 microcontroller, GSM modem and ARM9 mini2440 board

1) Soil Moisture sensor

Detects the amount of moisture content in the soil and outputs serial data at 9600 bps. The sensor measures the dielectric constant of the soil in order to find its volumetric water content (VWC). It obtains volumetric water content by measuring the dielectric constant of the media through the utilization of frequency

domain technology. The sensor has a low power requirement and very high resolution. This gives the ability to make many measurements (i.e. hourly) over a long period of time with minimal battery usage. This sensor could be used for various applications like, Irrigation scheduling, Plant-soil-water interaction studies and water quality etc. This sensor works with +5V power supply and reading outputs every 100ms with fast response time.

2) Design of ARM LPC2148 board

The LPC2148 microcontrollers are based on a 32bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combines the microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB [4][5]. Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement. It has serial communications interfaces ranging from a USB 2.0 Full Speed device, multiple UARTs, SPI, SSP to I2Cs, and on-chip SRAM of 8 kB up to 40 kB, various 32 bit timers, 10 bit ADCs, PWM channels, 10 bit DAC and GPIOs. The board required for our project has been designed by using KiCad software and the PCB tracks drawn is as shown in figure.1 and view of board is as shown in figure.2.

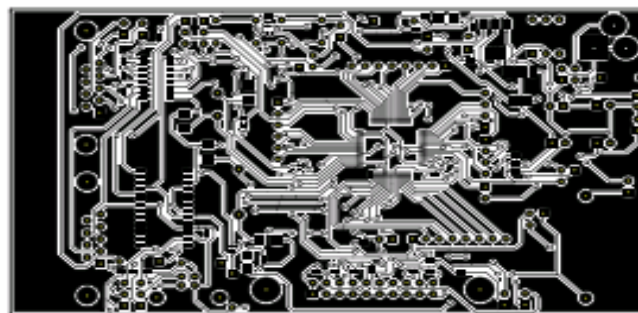


Fig.1 Tracks in PCB layout

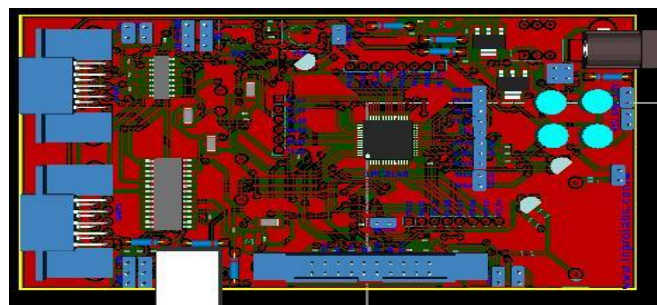
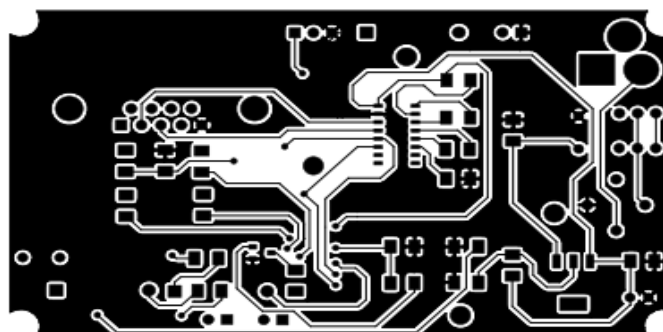


Fig.2 Complete ARM board

3) Design of GSM SIM300 board

Designed for global market, SIM300 [14] is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz. SIM300 provides GPRS multi-slot class 10 capabilities and support the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. SIM300 can fit almost all the WSN application. The Gerber files designed for the complete GSM board is as shown in figure.3



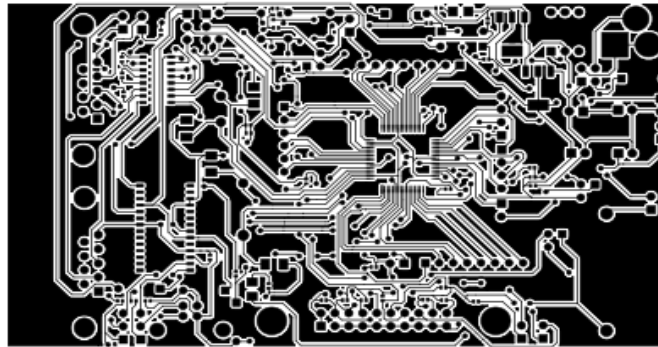


Fig.3 Gerber files of GSM board

4) ARM9 mini2440 board

In our implementation of remote monitoring of soil moisture system we have been used friendly ARM9 mini2440 board [11]. It is a low-cost ARM9 development board used widely for the development of embedded system as shown in figure.4. It has Samsung S3C2440 processor and On-board 64 MB SDRAM. This board will have provision of mapping either linux or wince operating system for the application development.

Some of the board features which includes:

- 100 Mbps Fast Ethernet RJ-45 interface (used network chips DM9000)
- Serial ports
- USB host
- USB slave (B-type interface)
- SD card storage interface
- Channel stereo audio output interface, all the way microphone interface
- 10-pin JTAG interface
- adjustable resistor, analog-to-digital converter for A/D test
- I2C-bus AT24C08 chip for I2C-bus test
- 2.0 mm pitch 20-pin camera interface
- On-board real-time clock battery



Fig.4 Friendly ARM9 mini2440 board

III. IMPLEMENTATION BLOCK DIAGRAM OF WSN FOR THE MEASUREMENT OF SOIL MOISTURE

The major components for the implementation of base station WSN consists of ARM LPC2148 board, SIM300 GSM module and soil moisture sensor. The block diagram is as shown in figure 5.

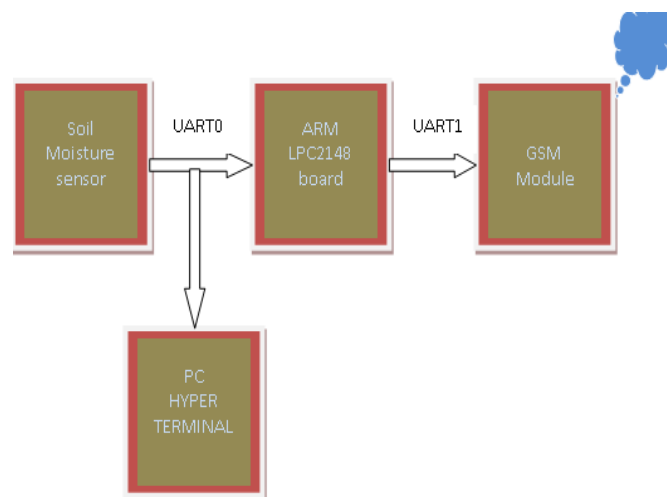


Fig.5: Block diagram of base station WSN

The soil moisture sensor gives serial data of baud rate 9600, connected to UART0 of LPC2148 board. The data can also be seen locally on hyper terminal of PC. The microcontroller sends data to the GSM by using AT commands AT+CMGS.

IV. IMPLEMENTATION BLOCK DIAGRAM AT THE SERVER SIDE

The measured value has been transmitted by GSM module which has been connected to the base station WSN. The server side another GSM module is connected which receives the SMS message which is nothing but the measured value and stores it in the SIM memory. The implementation block diagram at the server side is as shown in the figure 6.

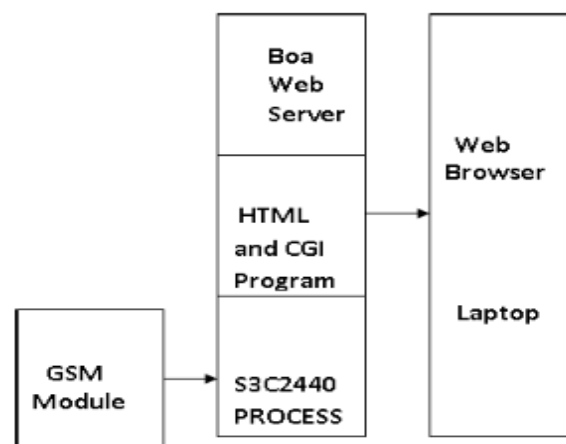


Fig.6 Server side set up

The server side set up has mainly contains GSM module, ARM9 mini2440 board and laptop. The processor in the board which reads the contents of SMS stored in the SIM memory by sending the AT command “AT + CMGR = 1”. This command which reads the content of first location and by sending the “AT + CMGD = 1” to delete the contents of first memory location. After successful reading, the values are stored and CGI C program has written to update the values in the web page. The simple web page has been designed by writing HTML program. The mini2440 board which contains factory installed Boa web server. We have been setup arm gcc tool chain for this board. By using DNW software, linux 2.6 kernel, necessary file systems for linux, super vivi image and bootloader has been downloaded to the board [10]. The two programs data_monitor.html and data_monitor.cgi have been written to display value dynamically on web page. With this setup it is possible for real time monitoring and we can see it anywhere by using internet.

V. RESULTS AND DISCUSSIONS

We have been tested sensor by mounting at different conditions like dry land, semi wet land and complete wet land. The sensor has been mounted on dry land and semi wet land is as shown in figure 7.



Fig.7 Sensor mounting on different conditions

The soil moisture sensor is connected to UART1 port and GSM connected to UART2 of designed ARM board. The complete set up for measuring system is as shown in figure 8.



Fig.8 set up for measuring soil moisture

The Serial communication data of soil moisture is displayed on hyper terminal of PC. The measured values for complete dry land are as shown in figure 9.

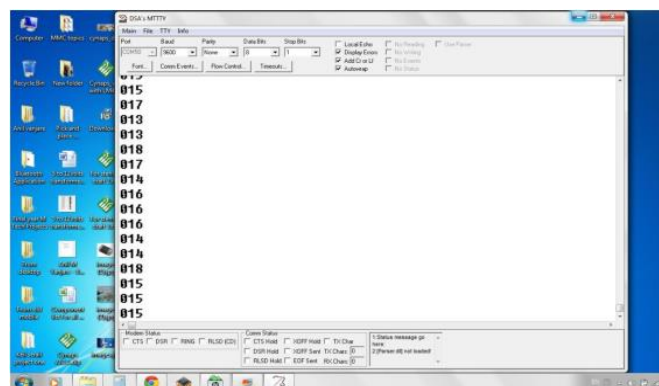


Fig.9 Measured values for dry land

The values measured under semi wet conditions are as shown in figure 10.

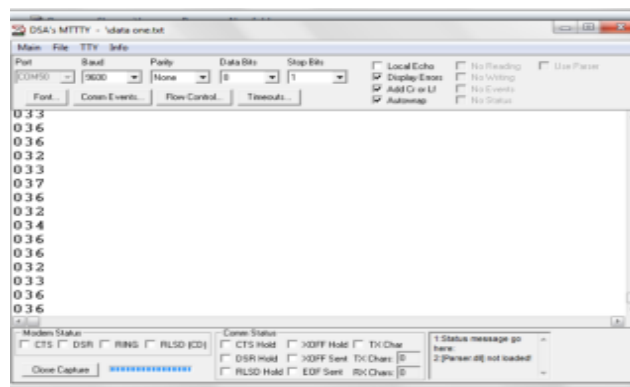


Fig.10 Measured values for semi wet land

The measured value of soil moisture from the WSN is transmitted to the server side and also registered mobile by GSM module. The receiver side GSM module is connected to the ARM MINI2440 board through UART port is as shown in figure 11.

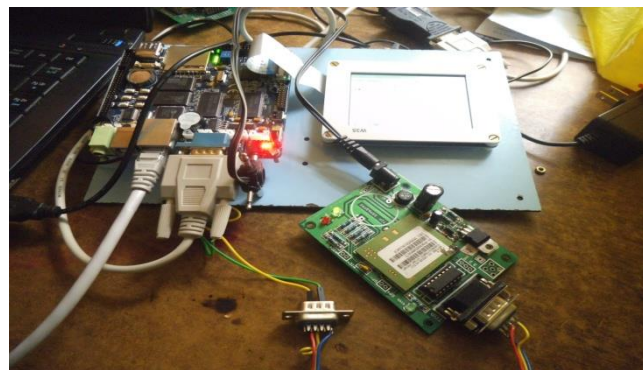


Fig.11 GSM module connected to mini2440 board

The Receiver side GSM module have been stores all the SMS messages in a SIM memory, which is usually referred as SM. Generally, it has capacity to store 20 or more SMS messages with starting index number 1. The command which is used to read content of SMS messages in any slot by using “AT + CMGR = n”. In our project we have read the content of first SMS message by sending command “AT + CMGR = 1” and deleting the message immediately by sending the command “AT + CMGD = 1” after reading successfully from the board.

The complete set up for the server side is as shown in figure 12, mainly contains the ARM mini2440 board, SIM300 GSM module and Laptop.



Fig.12. Server side includes mini2440, GSM module and Laptop

The mini2440 board which reads SMS messages and stored in database. The HTML program has been written to display the measured value in web page. The simple program has been written since we have not that much interested to design good colourful web page. The Boa web server is already installed in mini2440 board. The dynamic web page has been developed by writing CGI program with boa server. The two programs Data_monitor.html and Data_monitor.cgi have been written to display measured soil moisture value on web pages. We can access these values in the internet. The CGI program is written by using C language. The programs are stored in www directory of board is as shown in figure 13.

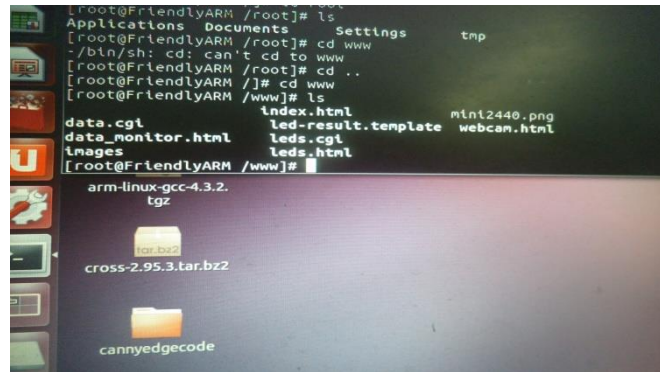


Fig.13 HTML and CGI programs

Finally the measured value has been displayed on our designed web page by boa web server using <http://<IP address of the mini2440 board>> as shown in figure 14. The value displayed on web page has tested for complete soil wet condition.

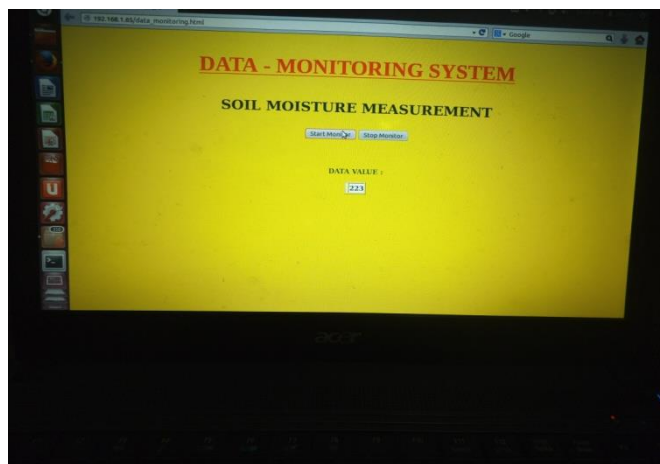


Fig.14 Displayed value on web page

VI. CONCLUSIONS

This design gives us a low cost solution for the measurement of soil moisture and monitored in remote places using our embedded web server system. The GSM has been used for wireless communication and Zigbee could have been used for wireless transmission of data. This can be suitable for water quality management in rural India. We can also write very good html program to make web page more attractive and colorful. The automated control system is also possible with the help of existing remote monitoring system.

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