An Approach to Develop Embedded System For Web Based Monitoring & Controlling of Renewable Energy Sources

[1]Akansha S. Fating, [2] T.H. Nagrare

[1] Research Scholar, G.H. Raisoni College of Engineering
Nagpur, India

[2]Assistant Professor, G.H. Raisoni College of Engineering
Nagpur, India

Abstract

The widespread application of Renewable Energy Sources (RES) requires centralized monitoring and controlling System. To make these operations control room independent, there is need to develop smart servers and web based applications. Cost is an essential factor of any embedded system design. This paper discusses a novel concept of designing of cost effective server/ client embedded system Renewable Energy sources. Here embedded server is developed with ARM9 controller loaded with windows CE operating system. Low cost client are designed using Atmega32 microcontroller with LAN connection. Server/ client are connected in LAN system and server based applications has been developed to monitor/ controlling the client operation. The server has web based applications that can be accessed via internet. Author has presented developed system and results.

Keywords: *Embedded System, Embeddded Web Server, ARM, Windows CE development.*

1. Introduction

In the past century, it has been seen that the consumption of non-renewable sources of energy has caused more environmental damage than any other human activity. Electricity generated from fossil fuels such as coal and crude oil has led to high concentrations of harmful gases in the atmosphere. This has in turn led to many problems being faced today such as ozone depletion and global warming.

Therefore, alternative sources of energy have become very important and relevant to today's world. These sources, such as the sun and wind, can never be exhausted and therefore are called renewable. The System that converts electrical energy from these sources is called Renewable Energy System.

Renewable energy is energy which comes from natural resources such as sunlight, wind, rain, Tides (Sea Waves) & geothermal heat (Heat Generated from Earth). All systems are remotely placed and generate power that stores in Battery. As generation and consumer systems are remotely placed, hence they need to monitor and have centralized control system. Development of an embedded system is need to today's word due to characteristics of embedded system like low cost, low power consumption, small size etc. Development of embedded system for the renewable energy source which is distributed at various locations is a challenging task for developer. Section 2 of this paper is focus on work done and published by researcher worldwide. Proposed system design and its implementation are presented in section 3 whereas testing and results of system is presented in section 4 of this paper.

2. Related Work

Several remote monitoring systems has developed in past by number of authors. The remote monitoring system for green house environment is set in spot itself. The data from client is gather with help of wireless module-GPRS &. CDMA. The dynamic WEB publishing can be realized by the ASP.NET technique in the remote server. Embedded operation system can be used for collection of data & for saving. This method could be significantly improve the system's Real-time, reliability and expansibility. The remote monitoring system can realize the real time publishing and the historical data request. The remote monitoring system can mitigate the bottle-neck phenomenon-so called "the last one kilometer access" to the remote agriculture spots and has the good prospects.[1]

Ethernet embedded system using ARM controller is presented by some authors. Here they discuss about designing of Ethernet system &their interfacing with ARM based controller. The author had presented an implementation of a platform independent embedded web server and its integration. Through introducing web into control network, that was possible to break through the spatio-temporal restriction of traditional control network and effectively achieve remote sensing, monitoring and real-time controlling for equipment[2]. Architecture of embedded remote monitoring system based on Internet has

some of the key problems. They suggested that use of Java Applet for dynamic page design improved response capability. The embedded web server was designed and built as an expansion module for one of the nodes in the wireless sensor network (WSN). That allows authorized Internet users to establish two-way communication with the sensor network. The server uses limited available hardware resources to implement an interface to the WSN node and to serve dynamic HTML pages to the remote user. That was allows the user to monitor the operation of the WSN remotely, to periodically download the sensed data, and to change the operation mode of the network [3].

Some author had discussed about how to design web server & for designing web server JAVA language is used. Also they had discuss of about problem related to renewable energy resources how the data related to renewable energy resources is monitor & how it is collected in centralized server. An internet based embedded network monitoring system is proposed for renewable energy systems. By using a low cost network communication module (RCM 3700) as a web server, one can achieve better network security, lower power consumption, compact size, and easier to use as compared with a PC based one. [4]

3. System Design

The proposed system is shown in figure 1. It consists of sub-systems as server and multiple clients. Client embedded system is directly connected to the individual renewable sources which driving certain applications. Server embedded system is central system connected to various clients through Local Area Network. This server system monitors & controls the operation of all clients. The server operation can be monitored & control through web from any internet based computer. This gives facility to administrator to control the operation of client from any corner of world & he need not required to be at control station were server is resided.

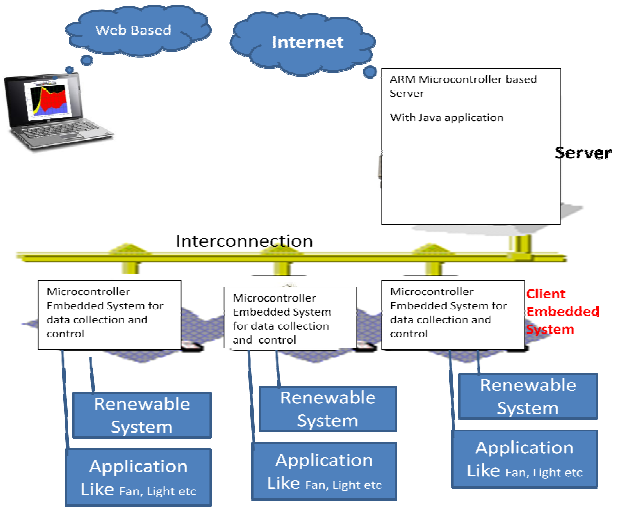


Figure 1. Proposed system for renewable energy system control

A. *Client Embedded System design*

Client embedded system has design for following applications.

- Monitoring status of battery which is charging through solar system.
- Monitor & control status of applications (Fan & Light)
- Monitor Surrounding temperature.
- Exchanging the information with server through Local Area Network.

The connection diagram of renewable energy sources is shown in figure 2. This block diagram clears that battery will be charge continuously through solar panel (one of the renewable energy source). Multiple applications like fan, light etc will be running on battery. The devices will be monitor and control by client embedded system, which is connected with the server.

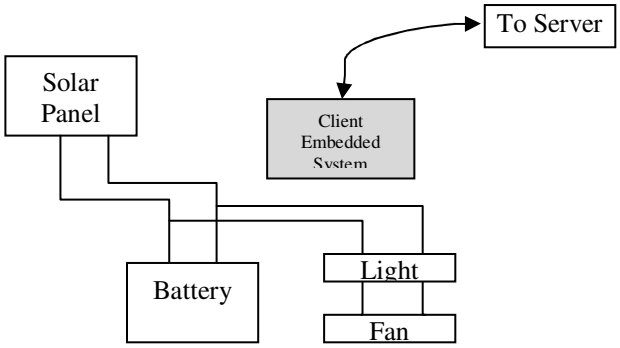


Figure 2. Connection diagram of client system

The embedded system is designed around Atmega 32 microcontroller as shown in figue3. It has four switch interface to selecting the program menu. Sensing temperature and battery voltage. 16X2 LCD display is interface to see the output of microcontroller. Multiple application are interfaced through relay to the circuits (like Fan and Light control). The system is designed with Ethernet interface with interfacing the chip ENC28J60,

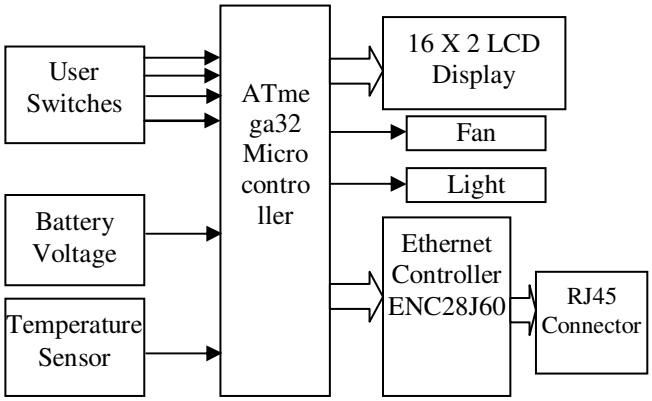


Figure 3. Block diagram of Client Embedded System

ATmega32 Microcontroller:

The Atmel® AVR®AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

Ethernet Controller:

Chip ENC28J60 is use as Ethernet controller for atmega 32 microcontroller. The operation of Ethernet controller IC is explain from figure4.

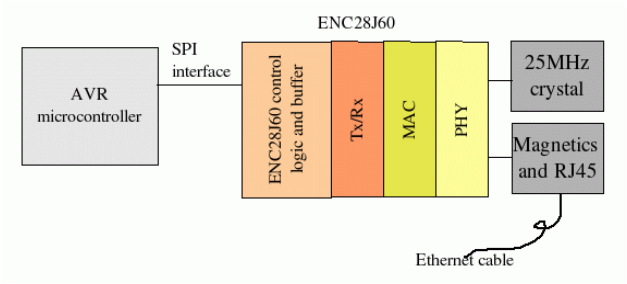


Figure 4. Operation of Ethernet controller ENC28J60

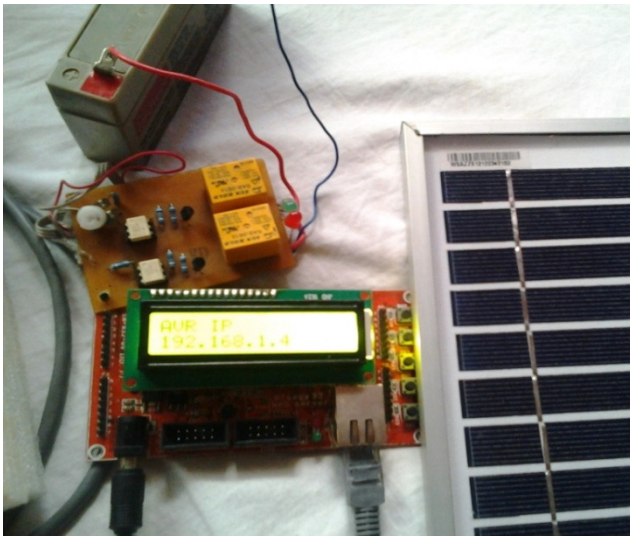


Figure 5. Photo of Single client embedded system attched with solar pannel

Software Design:

Software for the ATmega is designed in ANSI C language using AVR studio tool. UDP protocol is implemented for server client communication. Server should use certain commands to send information; the list of command is listed in table1.

TABLE I. COMMANDS USE FOR SERVER CLIENT COMMUNICATION

Command	Meaning
GA	Get all (send total status of client)
SL01 / SL10	Set on the Fan / Light
ST	Set time interval for Temperature sending to server
WL	Write message to client LCD

The server will initiate to connect the individual client. The client will have unique IP address. After connecting to the client server will send command 'GA' to client (this means send the current status of client. In response to this server command client will response in bit stream shown in figure 6, which consist of total information of client and its surrounding condition.

GAOKLLADCOTTEHHMMAAA.AAA.AAA.SSS.SSS.SSS;\r\n

Figure 6. Reponce string from client.

The response string shown in figure 5 can understand with meaning of their words as follows.

GA:-Get all command

LL:-application 1 &2

ADCO:- ADC value (4 digit value)

TT:-Temperature (2 digit value)

E:-enable/disable sending of Temperature value

HH:- Hours (Timer set to send Temp value)

MM:- minutes (Timer set to send Temp value)

AAA:-AVR IP (eg. 192.168.1.3)

SSS:- Server IP (eg. 192.168.1.22)

\r\n:-End of command

After receiving this bit string from server came to know necessary information. The software has designed to monitor the status and control the applications through these commands. Figure 7 shows snap shot of software developed for atmega based system using AVR studio tool

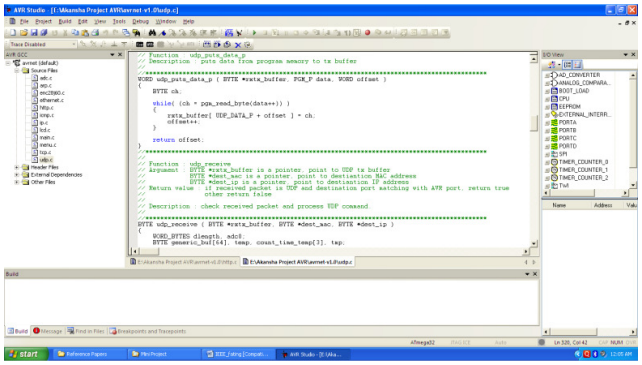


Figure 7. Snap shot of Software developmentt for atmega32 system

B. Server System design

The server has been design with Mini2440 ARM controller board loaded with windows CE 6.0 operating system on it.

Mini 2400

The MINI2440 Development Board is based on the Samsung S3C2440 ARM9 based microprocessor with 400 MHz clock. The board measures 100 x 100 mm, ideal for learning about ARM9 systems. On board 64M SDRAM and NAND Flash,2M NOR flash with preinstalled BIOS, 100M Ethernet RJ-45 port (powered by the DM9000 network chip), The MINI2440 development board currently supports Linux 2.6.29 and WinCE.NET 6.0. figure 8 shows the common resources available on mini2440 with ARM9 processor.

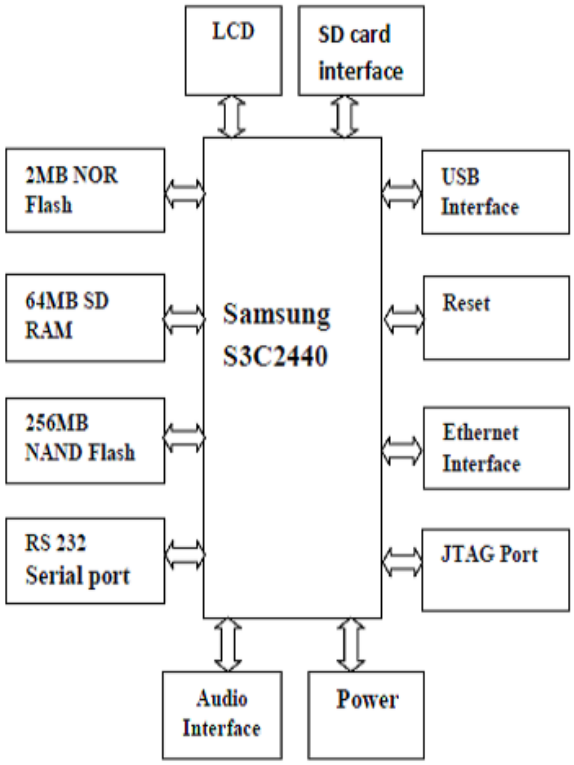


Figure 8. Block Diagram of Mini2440 board

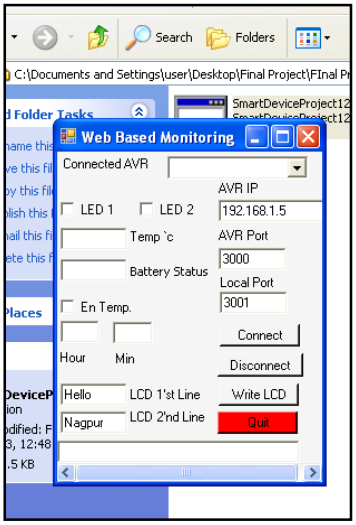
Software Development

The embedded server is loaded with windows CE operating system. Applications for winCE can be developed in visual studio with various languages like VB, C++, C# on dot net platform. Here visual studio is acting as cross builder, which build application for targeted winCE OS. Executable file of application, designed in Visual studio can be transferred to that target OS for execution.

The system software has been developed with C# language in visual studio 2008. The application is designed for following features.

- Use of UDP protocol through Ethernet connection
- Able to connect multiple client
- Popup menu will automatically update according to client connected.
- Individual pages for each clients, after selection of client from popup menu.
- Monitor the status of multiple clients.
- Able to control functions of multiple clients

Figure 8 shows application build in visual studio in PC and same application ported on ARM based embedded server loaded with winCE operating system.



(a)

(b)

Figure 9. Application softwre development (a)-development in PC, (b)-appliction deplyoid in Embedder Server

C. Interfacing embedded server and embedded client

ARM and wince based embedded server and ATmegra32 microcontroller based embedded client has connected with Ethernet connection with LAN cable. Figure 10 shows interfacing of embedded server and one embedded client with lan cable. In this connection server has IP address as 192.168.1.22 and client system has address as 192.168.1.4

Figure 10. Interfacing of Embedded Server and Embedded client through ethernet connection.

4. Testing

The designed server and three clients are connected with LAN switch. Server has IP address as 192.168.1.22 where as clients has IP address as

Client 1-192.168.1.3,

Client 2- 192.168.1.4

Client 3- 192.168.1.5

Block diagram of connection is shown in figure 11 and actual connection photo is given in figure 12. Server is able to monitor data of battery status, temperature, status of fan and light (as application connected to renewable energy resources). Server also able to control the operation of light and fan. Server is able to connect to multiple clients and shows their individual data.

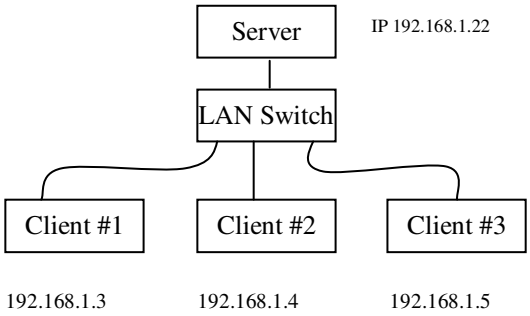


Figure 11. Block diagram of experimental setup for testing

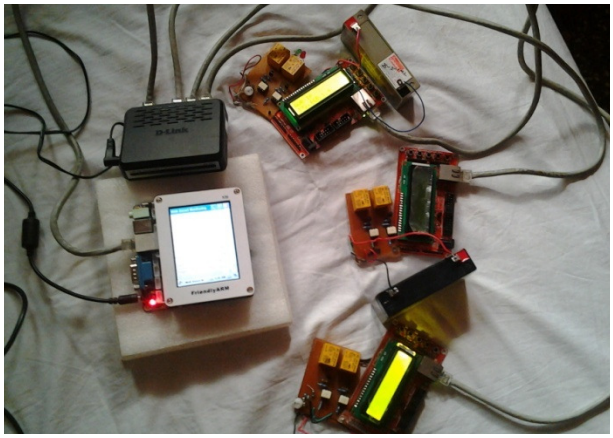


Figure 12. Photo of experimental setup for testing

5. Conclusion

Here author has presented concept of development of cost effective embedded system for web based renewable energy system that can monitor and control the functions. Author have presented the design of ARM processor and winCE operating system based Embedded server and ATmega microcontroller based embedded client. The system is tested through Ethernet connections and find satisfactory. This can be cost effective solution the renewable energy sector.

References

[1] Xiuhong Li1,"A Monitoring system for vegetable Greenhouse based on Wireless Sensor Network",IEEE 2006.

[2] B. Srinivas Raja and G. Srinivas Babu, "Design of Web based Remote Embedded Monitoring system", (CSEA) 2012.

[3] V L Varaprasad Nagula, M.Venkateswara Rao, T.Raghavendra Vishnu, "Embedded Ethernet Monitor And Controlling Using Web Browser" IJESAT, 2011.

[4] Se-Kang Ho ; Wei-Jen Lee ; Chia-Chi Chu ; Ching-Tsa Pan, "An internet based embedded network monitoring system for renewable energy systems", 2007. ICPE '07.

[5] Jian-ming Jiang," The Electrical Ethernet monitoring system based on embedded Web server" 2010 IEEE volume3.

[6] Fang Hongping," The Design of Remote Embedded Monitoring System based on Internet",2010 IEEE.

[7] Basanta Mahato," An Embedded Web controllable heater interface for Industry application",2010 IEEE (INDICON).

[8] Deepak C.Karia," Embedded Web Server Application Based automination & monitoring system",2011 IEEE.

[9] Basanta Mahato," An Embedded Web controllable heater interface for industry application",2011 IEEE.