NATIONAL CONFERENCE ON INNOVATIVE TRENDS IN ENGINEERING & TECHNOLOGY – NITET-19
15-16th March 2019
NOVATEUR PUBLICATIONS
International Journal Of Innovations in Engineering Research And Technology [IJIERT]
ISSN: 2394-3696

DESIGN AND IMPLEMENTATION OF ON-LINE INTERACTIVE INDUSTRAIL AUTOMATION SYSTEM USING BEAGLE BOARD

Prof. Sanjeev V Patil* and Prof. Swami P.S#

#Dept. Electronics and Telecommunication and Dept. Civil Engineering, A G. Patil Institute, Solapur, Maharashtra India

E-mail : 1sanjeev.vpatil@gmail.com, 2 s.prashant7474@gmail.com,

Abstract - Design of On-line Interactive Data Acquisition (IDACS) and its control System is a challenging part of any measurement, automation and development of on-line Interactive Data Acquisition and Control System applications. This system uses the standard Internet Protocol Suite (TCP/IP) to serve billions of users worldwide. This system uses Beagle Board portability with Real Time Linux operating system (RT LinuxOS) it makes the system more real time and handling various processes based on multitasking, and reliable scheduling mechanisms. This paper approached towards the design and development of on-line Interactive Data Acquisition and Control System (IDACS) using Beagle Board based embedded web server. Web server application is ported into a Beagle Board using embedded C'and JSP (JAVA) language. Web pages are written by Hypertext mark-up language (HTML).

Keywords-Beagle Board, Apache Tomcat Web Server, Ultrasonic Sensor, RTLinux Operating System, Interactive Data Acquisition System (IDACS), Camera etc.

I. INTRODUCTION

The Development of Embedded Technology, embedded data acquisition and remote monitoring technology in production data monitoring applications has become a new trend. On-line Interactive Data Acquisition and Control system plays the major role in the rapid development of the fast popularization and control in the field of measurement and control systems. It has been designed with the help of much electrical, electronic and high voltage equipment; it makes the system more complicated and not reliable. This paper approaches a new system that contains inbuilt Data Acquisition and Control system (DACS) within built ADC along with an on-line interaction. It makes the system more reliable and avoids more complication. It is great demand in consumer application and many industries. This system replaces various complex cables which are used for acquisition and it uses Beagle Board for data acquisition and digital diagnosis. A single worker can the machine and collect the various data from on-going work in a single work station and controlling of machine would be easier The simplest design of data acquisition system is detailed in [1].Which is Based on Linux Operating System [2], The design of flexible, reliable, data Acquisition architecture was approached in [3].Where the software resources are stored in local memory to avoid the level of resource usage and increases system's efficiency. This system process the client based on dynamic manner by server response and it maintains separate data base with DAC controller. Where the shared memory and internet protocols (TCP/IP) are used for data handling and process from remote users. This system we can also develop with global positioning system (GPS) and environmental monitoring system. It reduces the system complexity and effective for all kind of real time applications. Every real time embedded system should be run by real time operating systems. Even a small 8-bit microcontroller has the portability with RTOS is developed in [4]. In this paper Real time Linux Operating system is ported in Beagle Board. Generally all Beagle Board versions have portability with higher end RTOS. This RTLinux RTOS is very effective for many embedded application discussed in [5] & [6].

Here the embedded web server application is developed and ported into Beagle Board with this setup. This single Beagle Board has been act as data acquisition unit, control unit, embedded web server andself-diagnosis.All processes are allocated with essential resources and associated with reliable scheduling algorithms and internet protocols followed by Beagle Board. This miniaturized setup reduces the complexity & size of system and which gives the good performance as well.

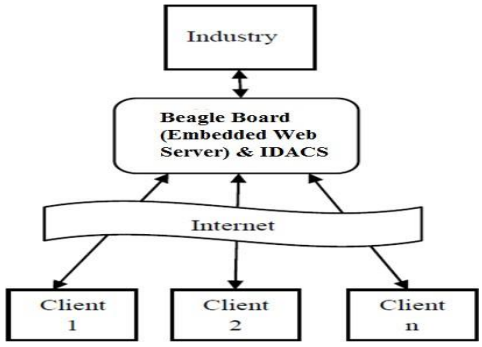

Fig.1 System overview

Fig 1 shows the overview of Interactive Data Acquisition and Control system. Every client can access the industry directly without any interaction with additional server and modules. This system contains single Beagle Board which is portable with Real Time Linux RTOS. BeagleBoard is the heart of this work. It handles two modes at same time, DAC and Web server. During DAC mode Processor can measure signals which are coming from various external sources and applications. And it can control the industry machineries by the control instruction sent by client via embedded web server, apart from that client can directly watch live video they can see what's happening at the industry side and going forward client can take appropriate action. This system uses RTLinux so it can handle many interrupts in an efficient manner because RTLinux has pre-emptive kernel with required privilege levels. Similarly during web server mode processor will handle client request and response to the particular client by sending web pages, client can interact the industry by giving instruction in web page on its own web browser. This setup can be suitable for inter communication with other nodes via Ethernet and higher end ports. Ethernet programming and execution is very easy and adaptable with various applications. Embedded web pages are designed by HTML language.

II. SYSTEM DESIGN

Hardware, Software Requirement, and Porting are the important steps in whole system design.

A. Hardware Design of the System

1) IDACS Design

Interactive data acquisition and control system design is the major part in hardware. Beagle board is a centre core of this system. The general hardware structure of the IDACS is shown in Fig 2. The on-line intelligent data acquisition and control system based on embedded Beagle Board platform has high universality, each acquisition and control device equipped with acquisition/control channels and isolated from each other. The measured data are stored in external memory (Micro-SD Card) in which the memory is act as a data base during web server mode. The Beagle Board directly supports the Ethernet service and RS232 communication. Hence the data has been stored and controlled by some other PCs or network via RS232& Ethernet. Beagle Board has internal I2C, I2S, and SPI module. So it has the ability to communicate with any other peripherals with very much good speed.

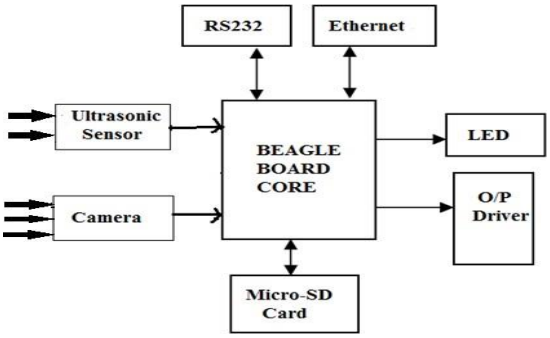

Fig. 2 General Structure of the IDACS (BB Core)

I2S is interface is provided on Board (integrated interchip sound) is an electrical serial bus interface standards used for connecting digital audio device together.I2C is the wired communication protocol to communicate with other processor or peripherals through two wired link, it is used to connect the low speed peripheral to embedded system. This system has uses LED's to display the information about status of the machine and we can also interface the LCD which makes the debugging and modification of the parameter easy. As the embedded Ethernet interface makes the remote data exchange between the applications become very easy. The Ethernet is one of the most popular packet-switched LAN technology with a bandwidth available of such as 10Mbps, 100Mbps, and 1Gbps and whereas bus has maximum length of 2500m (500m segments with 4 repeaters).

2) Camera and Ultrasonic Sensor

This system uses the camera where in which it keep on sending live update's to the client, client have a direct access of on-line records and in the mean client can see the live video sitting at the remote place's and later they can go ahead and control the machine and apart from this we can also connect the ultrasonic sensor, if anybody disturbs to the sensor(any obstacle) it sends an updated value to the remote client, based on the

sensor value retrieved by the client can take appropriate action.

Apart from this if we interface the temperature sensor means we can monitor room temperature also.

3) Beagle Board-xM

This system uses Beagle Board portability with Real Time Linux operating system.BeagleBoard-xM delivers extra ARM ® Cortex ™ -A8 MHz now at 1 GHz and extra memory with512MB of low-power DDR RAM, this board has an open hardware design improves upon the laptop-like performance and expandability and Direct connectivity is supported by the on-board four-port hub with 10/100 Ethernet, while maintaining a tiny 3.25" × 3.25" footprint.DM3730 processor is the heart of the Beagle Board-xM.

4) RS232 Communication

This RS232 DB-9 (usually called DB-9) port is very common and available at most of any Devices and many other computers, to allow compatibility among data communication equipment made by various manufactures, an interface standard called RS232 was set by the Electronics Industries Association (EIA)in 1960[7].today RS232 is most widely used serial I/O interfacing standard. This system serial port interface is single ended (connects only two devices with each other), the data rate is less than 20 kbps. .

B. Software Design of the System

1) Real Time Linux

RTLinux is a hard real-timeRTOSmicrokernel that runs the entire Linux operating as a fully pre-emptive process, It was developed by Victor Yodaiken.RTLinux provides the capability of running special real-time tasks and interrupt handlers on the same machine as standard Linux [8].RTCore is a POSIX 1003.13 PE51 type real-time kernel, something that looks like a multithreaded POSIX process with its own internal scheduler [9]. RTCore can run a secondary operating system as a thread, this is a peculiar model: a UNIX process with a UNIX operating system as a thread, but it provides a useful avenue to modularity. RTLinux is RTCore with Linux as the secondary kernel. Real-time applications run as real-time threads and signal handlers either within the address space of RTCore or within the address spaces of processes belonging to the secondary kernel. Real-time threads are scheduled by the RTCore scheduler without reference to the process scheduler in the secondary operating system. The secondary operating system is the idle thread for the real-time system. The virtual machine virtualizes the interrupt controller so the secondary kernel can preserve internal synchronization without interfering with real-time processing.

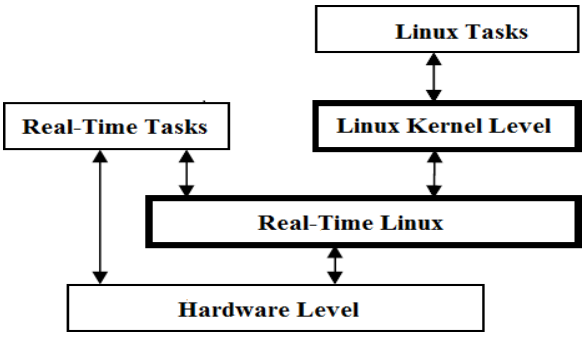

Fig .3 RTLinux Run Time Model

As unlike Linux, RTLinux provides hard real-time capability. It has a hybrid kernel architecture with a small real-time kernel coexists with the Linux kernel running as the lowest priority task. This combination allows RTLinux to provide highly optimized, time-shared services in parallel with the real-time, predictable, and low-latency execution. Besides this unique feature, RTLinux is freely available to the public. As more development tools are geared towards RTLinux, it will become a dominant player in the embedded market. RTLinux is a typical dual-kernel, one is Linux kernel, which provides various features of general purpose OS, other one is RTLinux kernel, which support hard real time capability. Fig 3 illustrates the RTLinux architecture.

2) System Design Flowchart

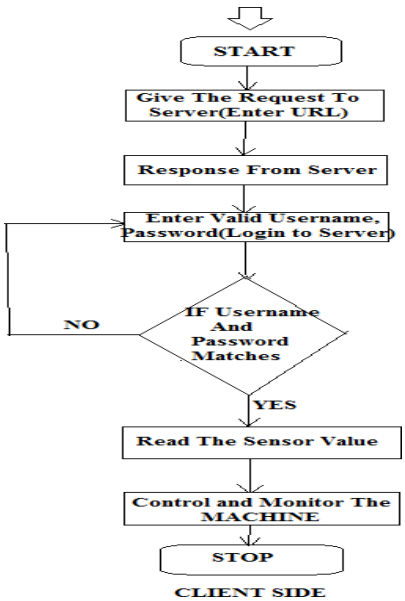

Fig. 4 Client side Program Flow

The Client can enter into the server by entering appropriate URL (with known IP address of Board), once the server responds it will ask for username and password, after giving valid username and password, client can access the industry by reading sensor value or based on video access, and client can take appropriate action on the machine.

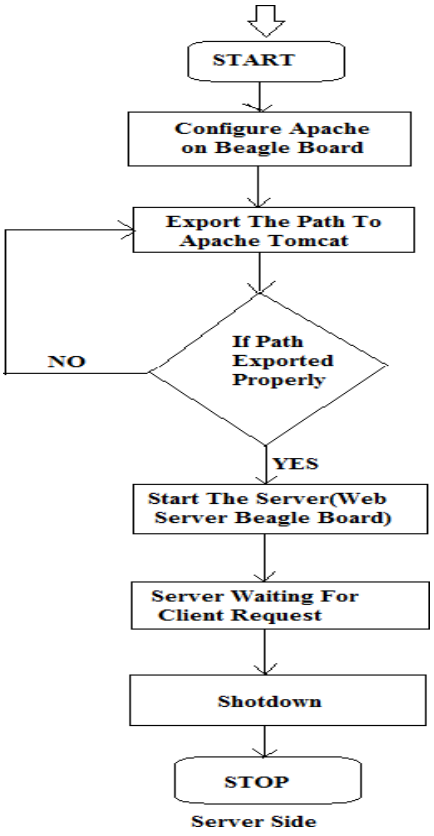

Fig.5 Server side Program flow

Configure Apache by exporting an appropriate path to Apache Tomcat, then it starts the server (now beagle board acting as web server), once server gets started, it will waits for the clients request.

3) Apache Tomcat (Web Server)

Apache Tomcat (or simply Tomcat, formerly also called Jakarta Tomcat) is a source web and servlet container developed by the (ASF) [10]. Tomcat implements the Java Servlet and the Java Server Pages (JSP) specifications from Oracle Corporation, and provides a "pure Java" HTTP web server environment for Java code to run. It provides a java virtual machine and also associates the elements to give a complete java runtime environment and it also provides web server software to make the environment accessible on Web.

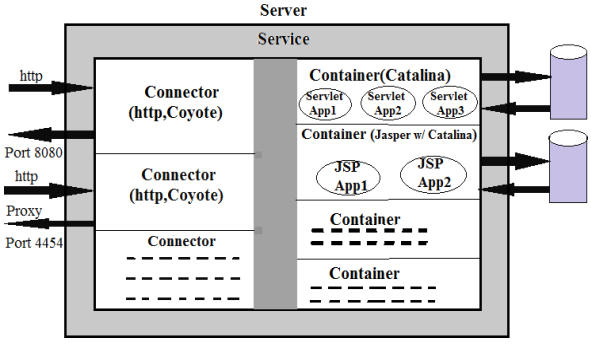

Fig.6 Structure of Apache Tomcat

The above figure shows the General Structure of Tomcat which mainly consists of Servlet/JSP Container, HTTP connector and JSP engine. Tomcat runs as a Windows service or Linux or Unix Daemon, awaiting connections (by default) on port 8080[11].A single instance of Tomcat can provide several service, through this is unusual. Each Tomcat service will be have at least one (and possibly more) connectors, and at least one in which an engine such as catalane provides a service's

4) TCP/IP (Internet Protocols)

Lightweight IP (LwIP) is a widely used open sourceTCP/IP stack designed for embedded systems, LwIP was originally developed by systems. Improvements achieved by LwIP in terms of processing speed and memory usage, Most TCP/IP implementations keep a strict division between the application layer and the lower protocol layers [12].As in many other TCP/IP implementations, the layered protocol design was used as a guide for the LwIP design and implementation [9].This protocol implements in order to improve performance both in terms of processing speed and memory usage. Hence RTLLwIP is more suitable for embedded systems.

III. RESULTS AND DISCUSSIONS

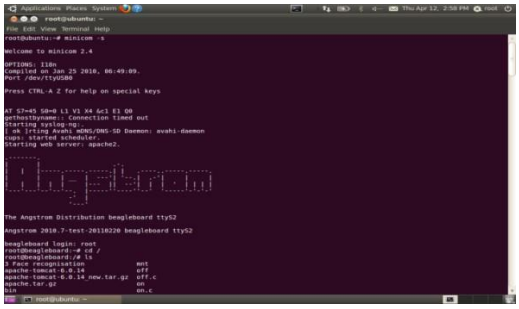

Fig.7 Booting Linux on the Beagle Board-xM

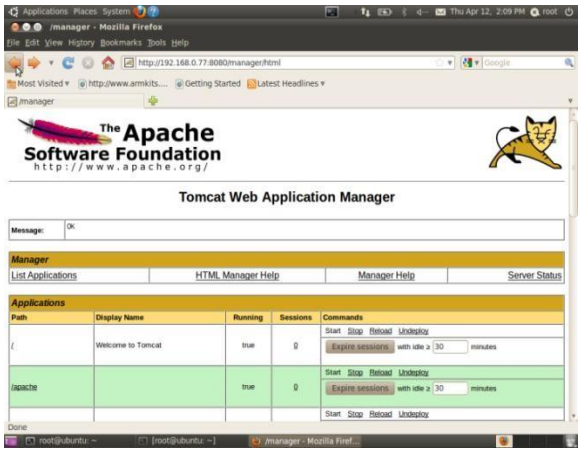

Fig.8 Apache Tomcat running at the Server side

The above Figure 7 shows for the Booting Linux on the Beagle Board, once the board is booted later we configure the Apache as shown in Figure 8, the remote client can enter the server by giving authorized username and the password, after entering in to the Apache Server the user has to access industry or they can control the machine.

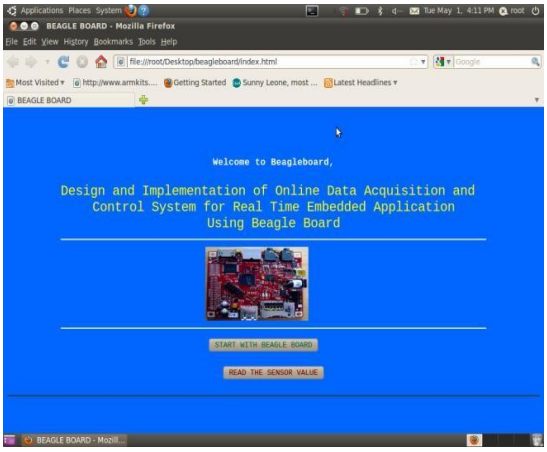

Fig.9 Web Page requested by Client

The above Figure shows a simple web page designed using HTML language. It is requested by the client to server. Then the internet processes these request and server response for client request with web page. Now the Client can know the status of industry machineries and can control the machines via its own browser from remote location along with this client can have video access over their own browser. It is showed in Fig.10, 11&12.

Fig. 10 Host System and the Target Board Hardware

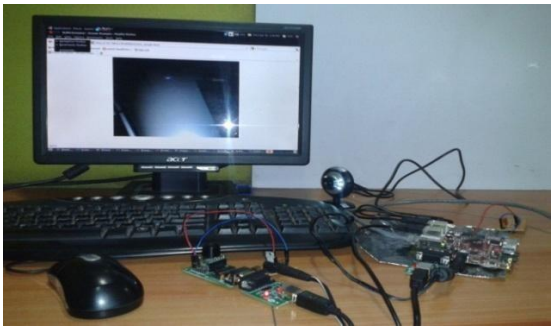

Fig. 11 Video accessible by the remote client

Fig. 12 Web page sent by Target board to the remote Client

. Hence, results show that the client can access the whole industry from any remote place via its own local browser. In industry the single Beagle Board acts as data acquisition and control system and as web server, so the system is compact with less complexity. This system replaces the traditional system for remote access and control by embedded web server with Real Time Linux operating system.

IV. MERIT OF THE SYSTEM

A) Existing System

The use of single chip Data acquisition system (DAS) method in Instrumentation and process control

application is not only limited in processing capacity, with limited memory and also the problem of poor real time and reliability. General web server requires more resources and huge amount of memories. This system can only measure the remote signals and it cannot be used to control the process and also which is having limited capacity and lack in performing a real time operation. This system uses ARM9 embedded processor which is of very limited memory and processing speed also low. To overcome this problem we gone for proposed system.

B) Proposed System

Because of the limited processing capacity, limited memory and the problem of poor real time and reliability of DAS system has been overcome by the substitution of embedded Beagle Board for single chip method to realize interactive data acquisition and control (IDACS). This IDACS system can able to measure the remote signals and can control the remote devices through reliable protocols and communication network (TCP/IP).

Advancement in technology is very well reflected and supported by changes in measurement and control instrumentation. This system uses the Camera and Ultrasonic Sensor which are helps in monitoring the machine and in mean while the client can also see the live video while accessing at on-line by seeing this video still they can have control and monitoring of the machine's. And also this system uses RTLinux Multi-tasking operating system to measure and control the whole process (fully pre-emptive). And the embedded web server mode requires less resource usage, high reliability, security, controllability and portability.

V. CONCLUSIONS

An advancement in technology is very well reflected and supported by changes in measurement and control instrumentation, with the rapid development of the field of industrial process control and the wide range of applications of network, intelligence, digital distributed control System, it is necessary to make a higher demand of the data accuracy and reliability of the control system This embedded Beagle Board system can adapt to the strict requirements of the data acquisition and control system such as the reliability, functionality, size, cost, power consumption, and remote access and so on. This system operated by DACS mode to acquire the signals and control the devices remotely. Embedded web server (Apache Tomcat) mode is used to share the data with clients in online. Both modes are efficiently carried out by real time multi-tasking operating system (RTLinux-os). This system can be Widely applied to petroleum, electric power, chemical, metallurgy, steel, transportation, Electronic & Electrical industries, Automobiles, Home security and so on.

REFERENCES

[1] K.JackerandJ.Mckinney,"TkDAS- A data acquisition system using RTLinux, COMEDI, And Tcl/Tk," inProc. Third Real Time Linux Workshop, 2001. [Online].Available: The Real Time Linux.

[2] Jerry Epplin: "Linux as an Embedded Operating System" , Embedded Systems Programming.

[3] Clyde C. W. Robson, Samuel Silverstein, and Christian Bohm, "AnOperation-Server Based Data Acquisition System Architecture," *IEEE Trans. Nuclear science*, Vol. 55, No. 1, February 2008.

[4] Tran Nguyen, Bao Anh, Su-Lim Tan, "Real-Time Operating Systems for small microcontrollers", IEEE Comp society, pp. 31-45, September 2009.

[5] Yodaiken, Victor (1996). "Cheap Operating systems Research" Published in the Proceedings of the First Conference on Freely Redistributable Systems, Cambridge MA, 1996.

[6] Barabanov, Michael (1996). "A Linux Based Real-Time Operating System.

[7] Electronics Industries Association, "EIA Standard RS-232-C Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Data Interchange", August 1969, reprinted in Telebyte Technology ***Data Communication Library***, Greenlawn NY, 1985, no ISBN.

[8] Yodaiken, Victor (1999). RTLinux, real-time linux, FMSLab, Soccoro, New Mexico, USA.

[9] IEEE Std 1003.1b-1993 IEEE Standard for Information Technology. Portable operating System interface (POSIX) part 1: System application Programming interface, amendment 1: Real-time extensions. Technical report, IEEE, New York, 1994.

[10] "The Apache Software Foundation Announces Apache TomEE Certified,as Java EE 6 Web Profile Compatible". MarketWatch. 4 Oct. 2011.

[11] "Building Complex VDK/LwIP Application Using Blackfin Processors"Kaushal Sanghai, Analog Devices Inc. September 2008.

[12] TCP/IP Illustrated, Volume 1 The Protocols, W. Richard Stevens. Published by Addison- Wesley. ISBN 0-20-163346-9. This book gives many useful low-level details About TCP/IP, UDP and ICMP.

[13] BeagleBoard-http:// www.beagleboard.org

[14] RTlinux-http://www.rtlinux.org

[15] Apache Tomcat-http://tomcat.apache.org

[16] www.opensourcelinux.org