

Design and Realization of Embedded Web Server based on Arm 11 and Raspbian Wheezy

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Abstract---As the World-Wide Web (WWW) continues to evolve, it is clear that its underlying technologies are useful for much more than just browsing the web. Web browsers have become the de facto standard user interface for a variety of applications including embedded real time applications. The embedded web server technology is the combination of embedded device and Internet technology. Through this embedded web server user can access their equipments remotely. The equipment mentioned here could be home appliances and factory devices. This paper is focused on implementation of ARM embedded web server based on Raspberry Pi. The embedded web server design includes a complete web server with TCP/IP support and Ethernet interface. In this paper, we present the design to implement medical monitoring system from a sensor unit. So our approach to develop this system initiated with the extensive study of ARM, medical monitoring systems and web servers with encryption.

Keywords: Raspberry Pi, Raspbian wheezy, python language, SSL encryption

I. INTRODUCTION

In this modern era of automation and advanced computing the social and commercial needs of mankind are changing very frequently. To keep up with these changes, we need to develop systems which are capable of performing different functions within some specified limits of time, accuracy and cost. Automation can be very effective to reduce human effort and involvement in different areas. This can be a boon for those fields which need a lot of skilled employees and also in areas where it is dangerous for lives of people involved in that job. Now-a-days in medical field there is a need of data monitoring and control, for this application embedded web server can prove to be a very good system which may be capable of reducing the need of skilled workers.

An embedded system is a device that has computer intelligence and is dedicated to performing a single task, or a group of related tasks. An embedded system often performs monitoring the medical parameters of a patient.

A web server is a system which hosts websites and provides services for any requesting clients. The general purpose web server composes of an operating system, web pages or web applications and a huge amount of memory and sometimes a special hardware.

The embedded web server is the combination of embedded device and Internet technology, which provides a flexible remote device monitoring and management function based on Internet browser and it has become an advanced development trend of embedded technology. An embedded web server is an ARM processor that contains an internet software suite as well as application code for monitoring and controlling machines/systems.

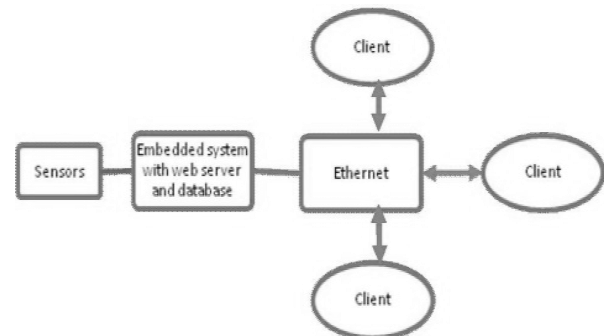


Fig. 1: Block Diagram of Embedded Web Server

II. BLOCK DIAGRAM

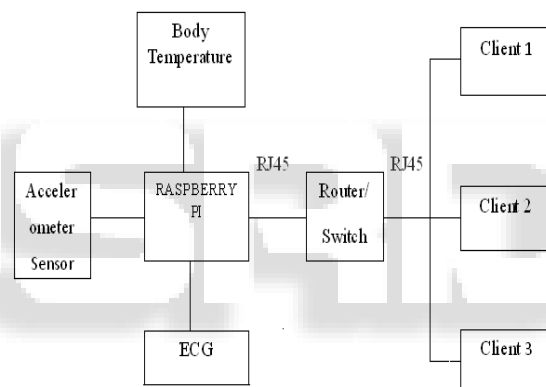


Fig. 2: Block diagram of web server with raspberry pi

The raspberry pi installed with Raspbian wheezy real time operating system (Flavour of Linux). An Embedded web server is developed in that Raspbian OS to monitor the medical parameter of every patient. Through the Embedded web server the medical parameters like ECG, Body temperature and accelerometer values are displayed in the embedded web server with encryption algorithm. The ECG sensor and body temperature shows the patient health conditions and the accelerometer shows the body movement of patients. The embedded web server is protected with encrypted password for security. The encryption technique used here is SSL Encryption method.

SSL Algorithm

SSL is the short form for Secure **S**ockets **L**ayer, a protocol developed by Netscape for transmitting private documents via the Internet. SSL uses a cryptographic system that uses two keys to encrypt data – a public key known to everyone and a private or secret key known only to the recipient of the message. Both Netscape navigator and Internet Explorer support SSL, and many web sites use the protocol to obtain confidential user information, such as

credit card numbers. By convention, URLs that require an SSL connection start with https: instead of http.

Another protocol for transmitting data securely over the World Wide Web is *Secure HTTP (S-HTTP)*. Whereas SSL creates a secure connection between a client and a server, over which any amount of data can be sent securely, S-HTTP is designed to transmit individual messages securely. SSL and S-HTTP, therefore, can be seen as complementary rather than competing technologies. Both protocols have been approved by the Internet Engineering Task Force (IETF) as a standard.

The Secure Sockets Layer protocol is a protocol layer which may be placed between a reliable connection-oriented network layer protocol (e.g. TCP/IP) and the application protocol layer (e.g. HTTP). SSL provides for secure communication between client and server by allowing mutual authentication, the use of digital signatures for integrity and encryption for privacy.

The protocol is designed to support a range of choices for specific algorithms used for cryptography, digests and signatures. This allows algorithm selection for specific servers to be made based on legal, export or other concerns and also enables the protocol to take advantage of new algorithms. Choices are negotiated between client and server when establishing a protocol session.

III. HARDWARE DESCRIPTION

To implement this embedded web server we used different hardware, which are described in this section.

A. Raspberry Pi

The Raspberry Pi is an inexpensive ARM processor based single board computer running the GNU/LINUX operating system. It is powered by BCM2835 System on chip from Broadcom that contains an ARM processor running at 700 MHz. It has many peripherals such as USB master port, 10/100 Ethernet, HDMI and composite video outputs, and SD card slot. It has 256 MB of RAM and a few general input/output pins (GPIO) are available for low level interfacing with external electronic circuitry. The Raspberry Pi has the microprocessor ARM1176JZF-S which is a member of ARM 11 family and has ARM v6 architecture.

B. Accelerometer sensor

The accelerometer sensor used here is ADXL335 which is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ± 3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.

C. Temperature sensor

The temperature sensor used here is LM35 series there 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 $\pm 3/4^\circ$ cover 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 μA 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, while the LM35C is rated for a -40° to $+110^\circ\text{C}$ range (-10° with improved accuracy).

D. ECG sensor

MOD-EKG is digital heart-rate monitor based on TI's MSP430FG439 microcontroller. The heartbeat rate per minute is displayed on the LCD. In addition, the application outputs a digital data stream via an RS232 serial port to allow EKG waveform display on a PC. The only way to do this is via board's UEXT connector, where RS232 signals are leaded. The connection between the PC and MOD-EKG can be made by using our adapter – MOD-USB-RS232 that converts the RS signals into USB signals, and vice versa.

An electrocardiogram (ECG), also called an EKG, is a graphic tracing of the voltage generated by the heart muscle during a heartbeat. In this application, the EKG waveform is used by the MCU to measure the heartbeat rate. Because heartbeat calculation is the major focus the electrodes are simplified to two connections, one to a right hand and the other to the left hand.

E. Embedded Web Server

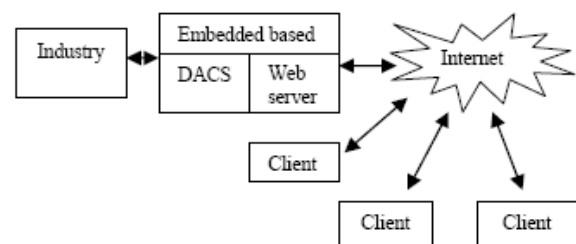


Fig. 3: Architecture of embedded web server

An embedded web server is an ARM processor that contains an internet software suite as well as application code for monitoring and controlling machines/systems. Embedded web servers are integral part of an embedded network Fig 5 shows the proposed concept of DACS with embedded web server on a single chip module. This is a single hardware it contains RTOS portable ARM processor. ARM processor is the responsible part for measuring signals and controlling the devices remotely. Measurements can be done by DACS mode and the data are shared with clients through embedded web server by embedded web server mode. The real time operating system manages all the tasks such as measuring signals, conversion of signals, data base up-dation, sending

HTML pages and connecting /communicating with new users etc., The RTOS manages all the required tasks in parallel and in small amounts of time. Web based management user interfaces using embedded web server have many advantages: ubiquity, user-friendly, low-development cost and high maintainability. Embedded web server has different requirements, such as low resource usage, high reliability, security, portability and controllability for which general web server technologies are unsuitable.

F. Ethernet

Ethernet is the networking technology used in many offices and homes to enable computers to communicate and share resources. Many Ethernet networks also connect to a router that provides access to the Internet. IEEE 802.3 supports a LAN standard originally developed by Xerox and later extended by a joint venture between Digital Equipment Corporation, Intel Corporation and Xerox. This was called Ethernet.

IV. SOFTWARE DESCRIPTION

A. RTOS

A real-time operating system (RTOS) is an operating system (OS) intended to serve real-time application requests. It must be able to process data as it comes in, typically without buffering delays. Processing time requirements (including any OS delay) are measured in tenths of seconds or shorter. A key characteristic of an RTOS is the level of its consistency concerning the amount of time it takes to accept and complete an application's task; the variability is jitter. A hard real-time operating system has less jitter than a soft real-time operating system. The chief design goal is not high throughput, but rather a guarantee of a soft or hard performance category. An RTOS that can usually or generally meet a deadline is a soft real-time OS, but if it can meet a deadline deterministically it is a hard real-time OS.

B. RTOS – RASPBIAN WHEEZY

Raspbian wheezy is an unofficial port of Debian Wheezy armhf with compilation settings adjusted to produce code that uses "hardware floating point", the "hard float" ABI and will run on the Raspberry Pi. The port is necessary because the official Debian Wheezy armhf release is compatible only with versions of the ARM architecture later than the one used on the Raspberry Pi (ARMv7-A CPUs and higher vs the Raspberry Pi's ARMv6 CPU).Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. An operating system is the set of basic programs and utilities that make your Raspberry Pi run. However, Raspbian provides more than a pure OS: it comes with over 35,000 packages; pre-compiled software bundled in a nice format for easy installation on your Raspberry Pi.

C. APACHE 2.2

The Apache HTTP Server, commonly referred to as Apache is a web server application notable for playing a key role in the initial growth of the World Wide Web. It is an open-source web server platform, which guarantees the online availability of the majority of the websites active

today.Apache is developed and maintained by an open community of developers under the auspices of the Apache Software Foundation. The server is aimed at serving a great deal of widely popular modern web platforms/operating systems such as Unix, Windows, Linux, Solaris, Novell NetWare, FreeBSD, Mac OS X, Microsoft Windows, OS/2, etc. Apache 2.2 came out in 2006 and offers new and more flexible modules for user authentication and proxy caching, support for files exceeding 2 GB, as well as SQL support. Apache 2.2 version was used for creating Web server for this project.

D. PHP

The PHP Hypertext Pre-processor (PHP) is a programming language that allows web developers to create dynamic content that interacts with databases. PHP is basically used for developing web based software applications. PHP is a recursive acronym for "PHP: Hypertext Preprocessor". PHP is a server side scripting language that is embedded in HTML. It is used to manage dynamic content, databases, session tracking, even build entire e-commerce sites. PHP Syntax is C-Like.

E. MySQL

It is the most popular Open Source Relational SQL database management system. MySQL is a small, compact database server ideal for small and not so small applications. In addition to supporting standard SQL (ANSI), it compiles on a number of platforms and has multithreading abilities on UNIX servers, which make for great performance. For non-Unix people, MySQL can be run as a service on Windows NT and as a normal process in Windows 95/98 machines.

F. Python Language

Python is a widely used general-purpose, high-level programming language. Its design philosophy emphasizes code readability, and its syntax allows programmers to express concepts in fewer lines of code than would be possible in languages such as C. The language provides constructs intended to enable clear programs on both a small and large scale. Python supports multiple programming paradigms, including object-oriented, imperative and functional programming or procedural styles. It features a dynamic type system and automatic memory management and has a large and comprehensive standard library.

V. SIMULATION RESULTS

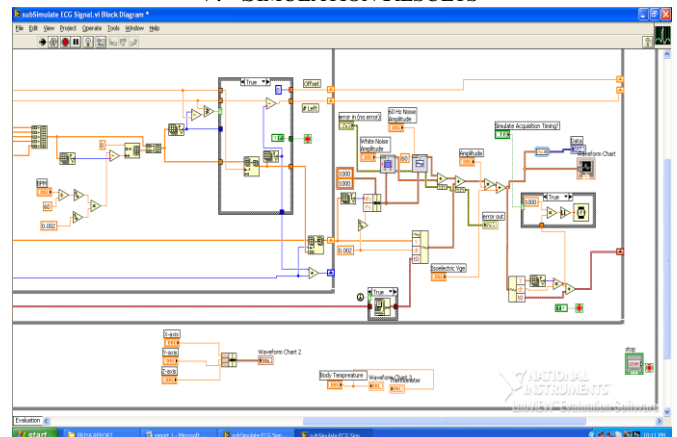


Fig. 4: Block diagram of the simulation

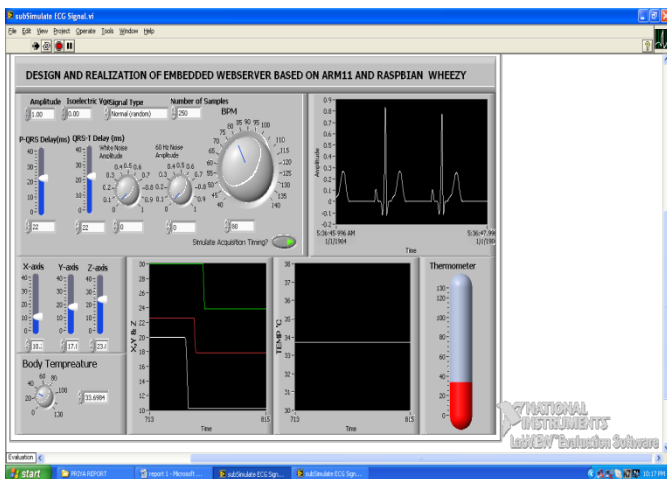


Fig. 5: Output of the simulation

VI. CONCLUSION

In this project our task is to acquire data from sensor and make it accessible over a network on which it could be accessed by any remote client. After completion of project we are able to receive data from a remote client using ARM embedded web server which we had implemented using Raspberry pi, here our data is temperature of the body, acceleration, and ECG. We can connect n number of sensor. This acquired data from the sensors was successfully displayed on the webpage when requested from the authorized person.

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