Embedded Web Server using Raspberry PI

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Abstract: - **The presented paper aims at designing embedded web server with ARM1176JZF-S 700 MHz Raspberry Pi processor and Ethernet module kit. The paper is focused on ARM-11 and Ethernet based design of an embedded web server using Apache server. The embedded web server data base includes a complete web server data with MySQL.**

Keywords:— **Raspberry Pi Processor, Ethernet, MySQL.**

I. INTRODUCTION

An Embedded web server is a computer based server system that processes requests via HTTP, the basic network protocol which is used to distribute the embedded hardware related data base information onto the World Wide Web. This term can be referred a choice of choosing either to the entire system, or to the software that accepts and supervises the HTTP requests [1]. The most common usage of web servers is to host the primary functions of a web server which is used to store, the process and deliver all the web pages to clients. All the communications between client and server takes place using the Hypertext Transfer Protocol (HTTP). The Pages delivered are most frequently used HTML documents, which may include images, style sheets and scripts in addition to text content. Web servers are not always used for serving the World Wide Web. They can also be found with embedded devices such as printers, routers, webcams and serving only at a local network and the web server may then be used as a part of a system for monitoring and administering the device in question. This commonly means that no additional software has to be installed on the client computer [3].
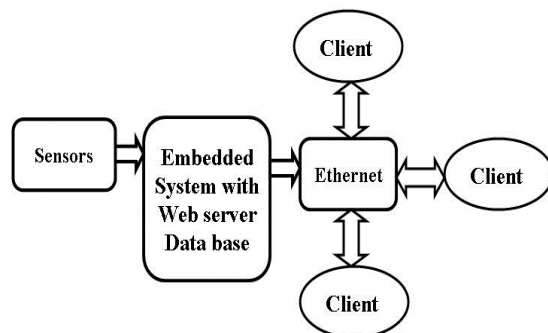

Fig.1: Block diagram of Embedded Web server

For web development we use PHP as a server-side scripting language it is also used as a general-purpose programming language. In the year 2013, PHP was installed on more than 240 million websites and 2.1 million web servers.

The PHP stores whole numbers in platform-dependent ranges, either a 64- bit or 32-bit signed an integer equivalent to the C-language. All the Unsigned integers are converted to signed values in certain situations and it is also different from other programming languages. These integer variables can be assigned using decimal, octal, hexadecimal and binary notations also. PHP is a general-purpose scripting language which is especially suited to the server-side web development program, and in this case PHP generally runs on a web server. Any PHP code in any requested file can be executed by the PHP runtime; usually it is used to create dynamic web page content or dynamic images which are used on websites [5].

This PHP language can also be used for command-line scripting and client-side graphical user interface (GUI) applications. PHP can be positioned on most web servers, many operating systems and platforms, can be used with more relational database management systems (RDBMS). Most web hosting provider's all support PHP for clients and as it is basically available free of charge, and PHP Group provides complete source code for users to build, customize and can also extend for their own use.

II. RELATED WORK

In this paper we introduced the ARM-11 Raspberry Pi processor which primarily uses Linux kernel-based operating systems. It is clear that this tiny computer

can show the Raspberry Pi based running of the games, with word processing, along with managing spread-sheets and playing high-definition videos. Along with access to the internet, through Ethernet or Wi-Fi (with a USB dongle), and also high definition output, the Raspberry Pi is an incredibly versatile piece of computing the kit. Most importantly the Raspberry Pi also gives at every child in the country a chance to own a personal computer which they can develop, learn from that, and play with it, at an incredibly low cost and an unbelievably small package.

The Raspberry Pi principally uses Linux kernel-based operating systems. The GPU hardware is accessed through a firmware image which is successfully loaded into the GPU at the boot time from SD-card. The firmware image is also known as the binary blob, which is associated to an ARM coded Linux drivers and were initially used for closed source. Using the present part of the driver code it was later released, and however much of the actual driver work is done using the closed source GPU code. This Application software uses calls to closed source run-time libraries (Open Max, OpenGL ES or open VG) which in turn also calls to an open source driver inside the Linux kernel, and then it calls the closed source as Videocore IV GPU driver code and the API of the kernel driver is unique for these closed libraries. All the Video applications used were OpenMAX, 3D applications use OpenGL ES and 2D applications we also use OpenVG both in turn use EGL. The OpenMAX and EGL were used at the open source kernel driver in turn.
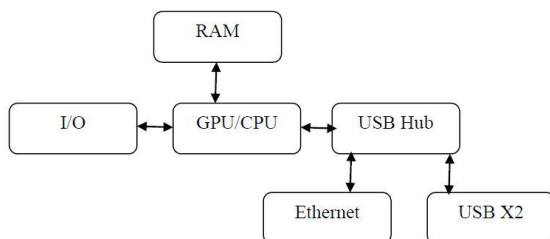
Location on the PCB of connectors and major ICs:

Fig.2: Block diagram of Model-B Raspberry Pi Processor

1. Raspbian

The system after cycling through these several recommendations, since once before the hardware was first made available in market, the Raspberry Pi Foundation have created the New out Of Box System (NOOBS) installer, and as of July 2013 it suggests using to install the Debian-derived Raspbian. This Foundation intends to create an application which is stored at website for people to exchange the programs[10].

Raspbian is a Debian-based free operating system which is optimized for the Raspberry Pi hardware. It is a current recommended system, which was officially released in July 2012, although it is still in development process. It is a free software and maintained independently by the Raspberry Pi Foundation. It is based on ARM hard-float (armhf)-Debian 7 'Wheezy' architecture port with the LXDE desktop environment, but optimized for the ARMv6 instruction set of the Raspberry Pi. It provides some available deb software packages, and also pre-compiled software bundles. The Raspberry Pi processor system requires a minimum size of 2 GB SD card for Raspbian, also a 4 GB SD card or above is recommended and downloaded to the Raspbian "wheezy" image file and which firstly it has to be unzipped and then only written to a suitable SD card, and formatting it before usage[12].

SQL stands for Structured Query Language which is a database computer language and is used for the retrieval and management of data in relational database. A database is defined as a separate application that stores as a collection of data. For each database it has one or more distinct APIs for all creating, accessing, managing, searching and also replicating the data using which it holds. Other kinds of data stores can also be used, such as files on the file system, or large hash tables in memory, but also a data fetching and writing it would not be so fast and easy with those types of systems. [8], [11].

So now these days, we use relational database management systems (RDBMS) to store and also manage huge volumes of data and this is called relational database because all the data which is stored into different tables and relations are established using primary keys or other types of keys also known as foreign keys. A Relational Data Base Management System (RDBMS) is software that enables you to implement a database with tables, columns and indexes which Guarantees the Referential Integrity between rows of various tables, Updates the indexes automatically and also interprets as an SQL query and

combines this information from various tables. MySQL database is a fast, easy-to-use RDBMS being used for many small and big businesses also. MySQL is developed, marketed, and supported by MySQL AB, developed by Swedish company. MySQL is a very powerful program in its own right. It handles with a large subset of the functionality of the most expensive and powerful database packages. It works on many operating systems and with many languages including all PHP, PERL, C, C++, JAVA, etc. SQL is a language of database which includes database creation, deletion, fetching rows and also modifying rows etc. It is an ANSI (American National Standards Institute) standard, but there are many different versions of SQL language which allows the users to access and describe the data in presented relational database management systems. The system used to define the data in database and manipulate it and also to embed within other languages using SQL modules, libraries & pre-compilers which is used to create and drop databases and tables.

III. HARDWARE DESCRIPTION

1. *Raspberry Pi processor:*

In the presented paper on Embedded Web server we used the Raspberry Pi, which is a small, powerful and lightweight ARM based computer which can do many of the things a desktop PC can do. The Raspberry Pi is built using ARM11 processor. It is based on a Broadcom BCM2835 chip. It is a credit card sized computer that runs the freely available Linux Operating System.

The Raspberry pi comes with following features:
Power consumption - The Pi consumes about five to seven watts of electricity and this is about one tenth of what a comparable full-size box can be used. As the servers are running constantly night and day, these electrical savings can really add up and is very affordable with good quality.

Fig.3: Raspberry pi processor

No moving parts - The Pi uses an SD card for storage, which is fast and also has no moving parts. There are no fans or other things to worry about working of it. A Class 10 SD card is commonly used for the best performing and it is also compared to lower class cards, but will mainly only affects the boot time.

Small form factor - The Pi is a credit card sized and can be held in your hand easily. And it can be integrated inside of devices, too.

No noise - The Pi is completely silent.

Status lights - There are several status lights on Pi's motherboard and with a clear case you can see NIC activity, its disk I/O, and power status, etc.

Expansion capabilities - There are numerous devices that are available for Pi, which at very affordable prices and are everything from an I/O board (GPIO) to a camera, the Pi has two USB ports, by hooking up a powered USB hub, and more devices can also be added.

Built-in HDMI capable graphics - The display port on the Pi is HDMI which can handle resolutions up to 1920×1200, which is nice for making the Pi in to a video player box as an example. There are some different converters that can convert to a VGA for backwards compatibility. A list of HDMI to VGA converters can be found here usually. I ended up using the Sanoxy HDMI to VGA cable (ASIN # B0088K7QUQ) which has worked well so far.

Affordable – Comparing with other similar alternatives, the Pi (revision B) offers the very best specs for the price, and it is one of the few devices in which its class that offers 512 MB of RAM. The Pi has come down in price since it has been first arrived, and it is finally affordable as a hobby, business usage.

Huge community support - The Pi has phenomenal community support and it can be obtained quite easily for the hardware and GNU/Linux software which runs on the Pi and is commonly used in user forums, and it is depending on the GNU/Linux distribution used. A

good list of distributions can be found.

Over clocking capability - The Pi can be over clocked if there is any performance problems with the applications used.

Multiple uses - Having the storage on an SD card it is very easy to swap with other SD cards running at other GNU/Linux distributions which is used quickly and easily change the functionality of the Pi. Using the "dd" command on a GNU/Linux computer, a backup of the SD card can be created and later can be restored.

2. Ethernet

A local-area network (LAN) architecture for Ethernet was developed in year 1976 by Xerox with DEC which is used as a bus or star topology with the speed that supports is of 10Mbps. An Ethernet LAN specification is mainly served as the basis for the IEEE 802.3 standard, which specifies either physical or lower software layers [17].

It uses the CSMA/CD access method to handle many simultaneous demands and it is one of the most widely implemented LAN standards. An Ethernet cable which is mainly called as *100Base-T, which* supports the data transfer rate of 100Mbps and this version, *Gigabit Ethernet* supports the data rates of 1 gigabit (1,000 megabits) per second.
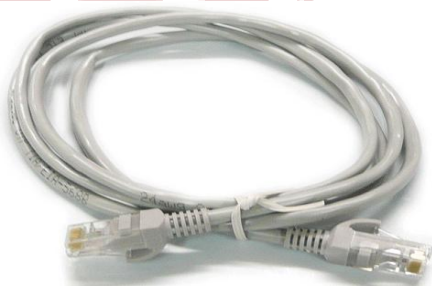

Fig.4: Ethernet LAN cable

The Fast Ethernet supports three main wiring schemes, which are mentioned below. All of these systems uses hubs or switches to connect the network and there was no shared medium scheme like coaxial cable of 10Base5. It was mainly because of the decrease in maximum cable length, which is made it impractical

to connect a network with a single cable [8].

100Base-T4 - This uses category 3 twisted pairs, which is normally present in offices for the telephone networks. These wires can handle clock rates up to 25 MHz, and so to achieve 100 MHz with four twisted pairs. Out of these four twisted pairs, one it is always to the hub, from the hub, and other two are switches that are able to connect the current transmission direction. 100Base-TX - This uses category 5 twisted pairs that are more expensive than category 3 cables and this designing is easier, because of the wires that can handle clock rates up to 125 MHz and beyond level. Only two twisted pairs per station is used, one to the hub and another one from it. This scheme allows full duplex communication at the stations that can transmit at 100 Mbps and receives at 100 Mbps simultaneously. 100Base-FX - This uses two strands of multimode fibre, one for each direction, it is full duplex with 100 Mbps in every direction. In addition, the distance between a station and a hub can be up to 2 km.

IV. SOFTWARE DESCRIPTION

1. Raspbian OS:

Raspbian 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.

2. PuTTY:

PuTTY is a free and open-source terminal emulator; serial console and network file transfer application. It supports several network protocols, including SCP, SSH, Telnet, rlogin, and raw socket connection. It can also connect to a serial port(since version 0.59). The name "PuTTY" has no definitive meaning. PuTTY was originally written for Microsoft Windows, but it has been ported to various other operating systems. Official ports are available for some Unix-like platforms, with work-in-progress ports to Classic Mac OS and Mac OS X, and unofficial ports have been contributed to platforms such as Symbian and Windows Mobile. PuTTY was written and is

maintained primarily by Simon Tatham and is currently beta software.

3. *Apache Web Server:*

Apache, otherwise known as "Apache HTTP Server", is an established standard in the online distribution of website services, which gave the initial boost for the expansion 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. 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.

4. *MySQL:*

SQL stands for Structured Query Language which is a database computer language and is used for the retrieval and management of data in relational database. A database is defined as a separate application that stores as a collection of data. For each database it has one or more distinct APIs for all creating, accessing, managing, searching and also replicating the data using which it holds. Other kinds of data stores can also be used, such as files on the file system, or large hash tables in memory, but also a data fetching and writing it would not be so fast and easy with those types of systems[8], [11].

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marketed, and supported by MySQL AB, developed by Swedish company. MySQL is a very powerful program in its own right. It handles with a large subset of the functionality of the most expensive and powerful database packages. It works on many operating systems and with many languages including all PHP, PERL, C, C++, JAVA, etc. SQL is a language of database which includes database creation, deletion, fetching rows and also modifying rows etc. It is an ANSI (American National Standards Institute) standard, but there are many different versions of SQL language which allows the users to access and describe the data in presented relational database management systems. The system used to define the data in database and manipulate it and also to embed within other languages using SQL modules, libraries & pre-compilers which is used to create and drop databases and tables.

V. RESULTS

Raspberry Pi is capable of doing multiple tasks at a time like a computer. If anyone wants to build a complex project like an advanced robot where things need to be controlled from a web page over internet then Pi is the best choice. Pi can be converted into a web server, VPN server, print server, database server etc. Arduino is good if you just want to blink a LED but if you have hundreds of LEDs needs to be controlled over web page, then Pi is the best suited.

Raspberry Pi is 40 times faster than Arduino, with PI, you can send mails, listen music, play videos, run internet etc. Also as we have stated earlier that it has memory, processor, USB ports, Ethernet port etc. and it doesn't require external hardware's for most of the functions. It can be accessed via SSH and file can be easily transferred over FTP.

VI. CONCLUSION

The presented paper based on embedded web server which is an Integrating feature of all the hardware and software components that are studied and detailed explanation was presented in it with Arm-11 Raspberry pi processor. The presence of each and every module has been reasoned out. Hence the contributing to the best working unit for new techniques related to embedded web server using raspberry pi has been surveyed perfectly.

Secondly, using highly advanced IC's and processors like ARM1176JZF-S 700 MHz processor, Linux operating system technology with the help of growing technology, the paper has been successfully explained with an unique idea. The paper describes embedded web server which is accessible over a network on which it could be accessed by any embedded client. The data can be monitored on the webpage when requested from any other system connected to the web server.

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