Low cost web server for ICU Applications

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Abstract: The Healthcare industry is rapidly increasing with the growing technology in Sensors & SOC. These technologies are increasingly important in healthcare as a result of the aging population and the tendency to acquire chronic disease such as heart attack, high blood pressure amongst the elderly. 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 data acquisition & monitoring system using sensors which monitors Blood Pressure, Heart Beat, Temperature & Humidity, which are mostly used in ICU Application.

Keywords*:* Web Server, Raspberry Pi, healthcare, wearable devise, body sensor, Heart Beat, SPO2.

1. 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 industries which need a lot of skilled employees and also in areas where it is dangerous for lives of people involved in that job.

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.

Data Acquisition System (DAS) is meant for acquiring data from sensors and as most of the physical sensors available provide analog data, these systems also perform analog to digital conversion.

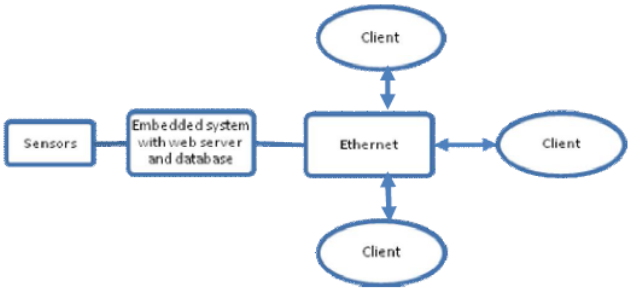


Fig.1: Block Diagram of Embedded Web server

This proposed system will reduce the cost of health-care and enlarge the worth of life of the patient while decreasing the trouble of the professional's healthcare

2. OBJECTIVE

In this project the main task was to design an embedded system which would be able to serve the

purpose of data acquisition and also act as a web server for monitoring different health parameters like temperature, heartbeat, & blood pressure. So our approach to develop this system initiated with the extensive study of ARM, data acquisition systems and web servers. This provided us with the necessities for the desired system. According to these requirements from all available resources, most appropriate set of elements were chosen and the final design was created and to implement this design various hardware and software tools were used.

This paper describes the hardware implementation to detect the saturation of oxygen in the blood, blood Pressure, pulse rate, temperature & Humidity in real time

3. SYSTEM DESCRIPTION

A) Hardware Description:

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

1. Raspberry Pi: The Raspberry Pi is an inexpensive ARM processor based credit card sized 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

We used Raspberry Pi to implement web server.

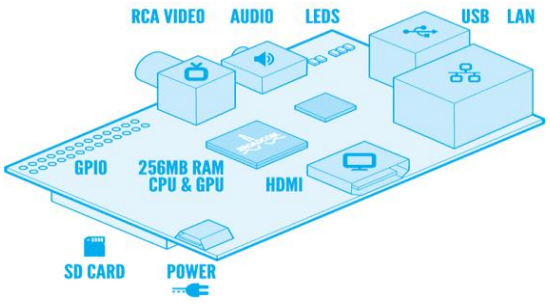


Fig 2 : Block Diagram of Raspberry Pi

2. Heart Beat sensor: A custom heart rate sensor was designed to read the patient's beats per minute (bpm). The designed sensor is very small and inexpensive. The technique used to measure the heart rate is based on near-infrared spectroscopy (NIR). NIR involves using light in the wavelength of 700–900 nm to measure blood volume. At these wavelengths most tissues do not absorb light other than haemoglobin (which is what we are interested in).This allowed for designing non invasive and low cost method of measuring the pulse. A silicon phototransistor, moulded into a flat side-facing package, and a GaAs Infrared Emitting Diode were used in the sensor. The sensor consists of a super bright red LED and light detector. The LED needs to be super bright as the maximum light must pass spread in finger and detected by detector. Now, when the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse. This signal is amplified and triggered through an amplifier which outputs +5V logic level signal. The output signal is also indicated by a LED which blinks on each heart beat.

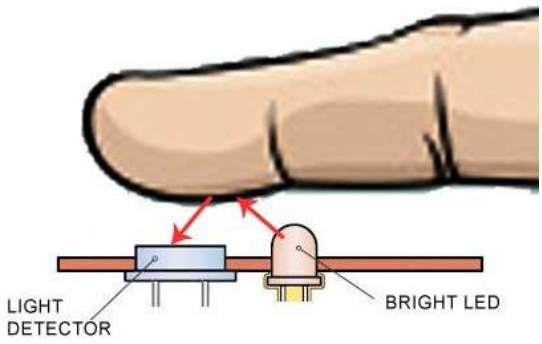


Fig 3: Heart Pulse sensor Principle

The pulse signal is applied to the P1.0 input of PIC 12F675 which is monitored by the program whenever this input goes high. Internally to U2, there is a counter which counts how many 1ms intervals there are between two high going heart beat pulses. This number is then divided by 60,000, since the time period is 10micro second and the result is the pulse rate. For example, if the pulse rate is 60 BPM beats per minute) there will be a pulse every second. The duration of one heart beat will be one seconds or 1000 x 1ms. Dividing 60,000 by 1000 will give the correct result of 60

which is shown on the display. If there is invalid result (BPM>200) it is invalid and waits for next cycle.

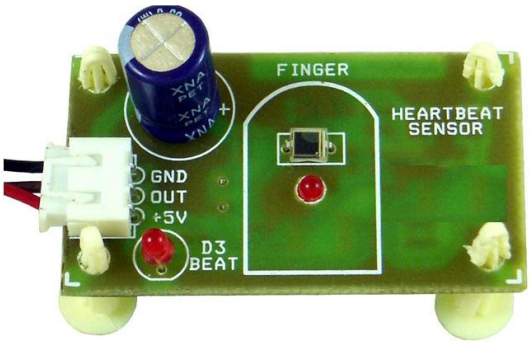


Fig 4 : Heart Beat Module

3. Temperature & Humidity sensor: The skin temperature measurement is done using an integrated circuit, the LM 35 temperature sensor produced by Texas Instruments The Sensor gives an analog output depending on the measured temperature. This voltage has to be measured by the microcontroller using a 10 bit Analog-to-Digital converter (ADC). PIC 12F675 was used to as Microcontroller .With a rough estimation usually the body temperature is 5.1 C higher than skin temperature . Humidity Sensor used id SI 168 from silicon labs & was interfaced to 12F 675 on 10 bit ADC Channel .

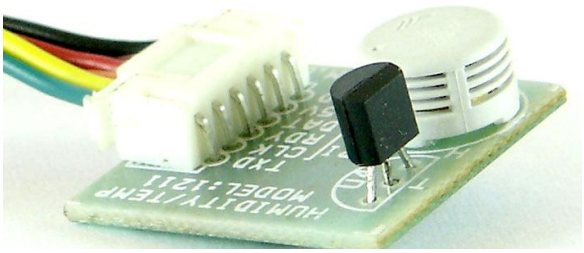


Fig 5: Temperature & Humidity Module

4. Blood Pressure Sensor: The Blood pressure measurement was done was a readymade blood pressure instrument which had inbuilt system for measuring Systolic, Diastolic and Pulse Reading .The system was altered to get the digital output on serial port as Serial Data at 9600 baud rate(8 bits data, No parity, 1 stop bits). Outputs three parameters in ASCII.

Fig 6:- Blood Pressure Module

B) Software Description

Various software resources were used to implement the project, these are described below:

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 arm hf 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).

2. Apache 2.2: 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.

3. 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 Pre-processor". 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.

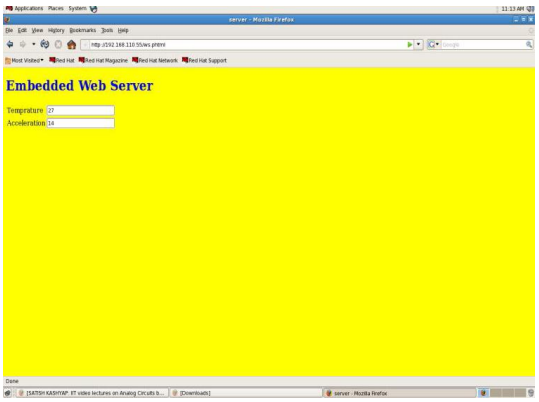
4. MySQL: It is the most popular Open Source Relational SQL database management system. MySQL is a small, compact database server ideal for small and not so small applications. In addition to supporting standard SQL (ANSI), it compiles on a number of platforms and has multithreading abilities on Unix 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

4. IMPLEMENTATION

For implementation of this project, we interfaced Temperature & humidity sensor, Blood pressure module & Heart Beat sensor module on GPIO pins of Raspberry Pi . The data from the sensors were acquired through GPIO pins and, Raspberry Pi as web server. And to make Raspberry Pi a web server we had used following software- Apache 2.2 as the web server, MySQL for building database and PHP to create web pages and retrieve values from database.

5. TESTING AND RESULTS

After individual testing of different modules of this project, the final setup was made arranging all devices in proper manner. After this final arrangement the whole system was tested. This setup is shown in the figure below



Now when a remote computer requests for this data to the server it serves the data through a webpage as displayed in the following figure.

6. 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, Humidity, skin temperature, Heart Rate, Blood pressure. This acquired data from the sensors was successfully displayed on the webpage when requested from any other system connected to the server.

7. DISCUSSIONS AND FUTURE DEVELOPMENTS

In this paper, we have presented the research, of applied nature, done to monitor physiological parameters such as skin temperature, heart rate, and blood Pressure. A prototype was and tested to establish the proof of concept. The system were tested and compared with commercial system and it was found to be accurate and reliable at this developed/development stage. The novel aspect of the design is its low cost web server & sensors .This is an enormous improvement over existing commercial products. A panic button can also been provided in the developed system which can be used under an emergency situation

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