Embedded Web server for Industrial Applications using Raspberry-Pi

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Abstract:
Nowadays web server based monitoring systems are widely used in many industries, and they setup a PC-based server which consumes a large place and power also. The idea of this project is to provide the same web server based monitoring service with a very less space and low power consumption. The objective of this paper is to design remote data acquisition system that is controlled by ARM processor and a web server application. This system not only provides monitoring of the devices but also controlling of them.

Keywords: ARM, Embedded Web Server, Raspberry Pi

I. INTRODUCTION

Role of the web server is to provide data to the clients when it is requested through HTTP (Hypertext Transfer Protocol), it can also have the capability to store and process the data. Traditional methods make use of workstations with operating systems such as windows, Linux and UNIX. These workstations are capable of storing large amount of data occupying large area and setup cost.

The purpose of this paper is to overcome the area, cost and power constraints which can be cut down and the system can be made more efficient. The embedded web server can provide services with minimum computing resources.

The embedded devices are hardly evolved in past years. Embedded devices are gaining popularity because they are getting smart enough to be able to connect them to network. The embedded web server has to be relatively small in size and should be easily integration with many device and Raspberry pi is the perfect choice for that. Although they have limited storage and hardware capabilities, these drawbacks hardly matter and it is still capable of performing vital tasks with these limitations.

Internet is getting into day to day life everyone one becoming an integral part of life. Users across the globe, is it home or industry they want to access their devices remotely by making use of internet technology. The embedded web server is expected to able to replace the personal computers and give way to enhancements in all the parameters which can boost the overall efficiency of the system, some of the parameters are listed in Table 1.

The data available on embedded web server must be secured in the sense that only authorized persons should be able to access the data.

This module is able to collect the data and display it on web pages. Whenever any user types IP address in the web browser address bar, he is intend to access the data collected by the server. The embedded server is able to provide dynamic data whenever requested by the client.

II. SYSTEM DESIGN

A. Embedded Web Server

Raspberry pi provides the platform for the embedded web server, data acquisition and control unit. Figure 1 shows a typical implementation of embedded web server. A temperature sensor (DS1820) is connected to raspberry pi. Raspberry pi continuously monitors the temperature values from the sensor and places them on the server. A control action is provided for the client if he intended to do so. The system is designed such that raspberry pi continuously monitors the temperature and if the temperature exceeds a predefined value then raspberry pi will turn off the control device. An alert mail or SMS can be sent to the user. The embedded web pages are designed by using HTML and CSS. The pages are designed in a simple user friendly fashion to avoid unnecessary complexities. However the client can control the devices remotely by using embedded web server, the client has to do is to logon to the webpage using login credentials and can access all the data.

B. Hardware Design

1) Raspberry Pi:

The Raspberry Pi is a series of credit card-sized System-on-Chip computer developed in the United Kingdom by the Raspberry Pi Foundation. This project is implemented using Raspberry pi 2 Model B. It has 1GB capacity of RAM which...
makes its and ideal for handling embedded application. This raspberry version capable of working at high clock frequency of 900Mhz, there are many ways of using raspberry pi from controlling an LED to basic understanding of operating system. It has good number of in-built compilers to supports many languages, and it provides best support for python programming language. The price of the raspberry pi is quite affordable. There are many operating systems available for raspberry pi but the RASPBIAN is dedicated to raspberry pi. Raspberry pi foundation and Debian collaboratively designed the RASPBIAN. It has HDMI port for digital and analog output, Ethernet port for network connectivity, 4 USB ports.

2) Digital Temperature sensor
DS1820 is a temperature sensor used in this project which is capable of providing 9bit – 12bit temperature readings. With the resolution of 0.5°C it can measure temperatures in the range of -55 to +125°C. DS1820 comes with the capability of sending data over 1-wire interface. Thus it avoids unnecessary wirings.

C. Software Design

1) SQLite and Apache:
SQLite is a database management system in the public domain software packages. It is a lightweight database management system when it is compared on platforms like administrative, complexity, amount of resource usage and overhead involved. SQLite’s conservative resource use and small code size makes it best choice for embedded systems. The Apache Server software is an application running on operating system for providing web services and capable of multi-tasking. The Apache Web server provides complete range of web server features, including SS, CGI and virtual domains. 

![Block diagram of the proposed embedded web server](image)

Figure. 1. Block diagram of the proposed embedded web server

2) Cron Tab:
Cron in as software utility for scheduling time based jobs in UNIX like computer operating systems. It schedules commands or shell scripts to run periodically at certain fixed time intervals. It can start the execution after recovering from a power failure.

III. METHODOLOGY

The system should be able to acquire data, store and reproduce whenever demanded by the client. DS1820 is a thermal sensor used for acquiring temperature. The system is provisioned such that it can control an electronic component from the client; here for demonstration purpose we used an LED. In this methodology temperature sensors and LED are connected to Raspberry Pi. Raspberry pi will continuously monitor the sensors and stores the data acquired from sensors into SQL database. SQLite database management system is used for storing the data. Since the raspberry operates at high frequency (900 MHz), lot of unnecessary data is stored. To avoid such undesired events Cron Job is used. By using this we can schedule updating of data in the database at some predefined time intervals.

![ operational Flow char of embedded web server](image)

Figure.2. operational Flow char of embedded web server

Once the data is acquired from the sensor, it will be compared with that of predefined threshold value and if the acquired values are not within the threshold values then the control device will be turned off and vice-versa. However the control device can be operated from the client end also, to do that the client needs to get authorized by providing login credential. Figure 2 depicts the flow of operation. Bidirectional connectivity is provided in the system to make it user friendly, whereas existing systems used only one direction connectivity. Thus it gives user with multiple options for controlling a device from remote areas. The authorized client can access the current as well as previous data. The stored data is displayed as a graph in figure 3.

IV. EXPERIMENTAL RESULTS

Figure 3 shows the data collected by raspberry pi at different time intervals. The SQLite manages the data in the database. To avoid memory overflow SQLite regularly flushes out the unnecessary data. Figure 5 shows the login page that is used to authenticate the user. The page dynamically validates the credentials submitted by the user so that only authenticated users only can get information from the web server. However users can be created with different roles such as guest and administrator.
Figure 3. Temperature Chart.

Figure 6 shows the user interface for the client to control the devices from remote areas. The control action can be from controlling an LED to controlling a motor.

V. SYSTEM MERITS

A. Existing Work
The existing method employs single chip data acquisition method, which has the limitation in processing capability and lags in producing reactive output. Conventional web servers need large amount of area and memories which leads to increase in cost. The proposed method is compared with that of existing conventional method and some of the findings are listed in table 1

B. Proposed Work
The Raspberry pi module eliminates the problem of size, cost and power consumption. It performs well in most of the domains where conventional systems fail. When raspberry pi used as a web server it not only able to serve the data to the clients but also it can control devices connected to it in remote areas through proper authentication.

VI. CONCLUSION

The rapid development in industrial sectors is demanding efficient methods for implementation of web servers. The raspberry pi provides an effective solution for acquiring data from the sensors and reproducing it to the user in an on demand manner with the current and previous values. The proposed system plays a vital role in cutting down the area and the cost requirement. The module has the capability to continue its operation even after the reboot without any human intervention.

VII. REFERENCES


