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Implementation of Remote Lab on Embedded Web Server

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ABSTRACT: This paper presents the implementation of Remote Lab on Embedded Web Server. Remote lab architecture is set of experiment and uses case scenarios. Proposed approach improves the current state of the art in the area of embedded systems design. Architecture of Remote Lab System consists of a computer server, one experiment module microcontroller system and embedded web server for controlling lab modules. The hex files or c codes generated with the help of various client machine, Integrated Development Environment (IDE) can be transferred to the server through the Transmission Control Protocol (TCP) which in turn programs the microcontroller attached to Raspberry pi with the help of various software tools like avrdude.

KEYWORDS: ARM, AVR, Embedded server, PHP, Raspberry pi.

I. INTRODUCTION

This paper discusses the remote programming of microcontroller, where a prototype of remote lab is setup with the help of beagle bone black which can program any microcontrollers attached to it, If specified and setup properly. This paper also comes up with a design solution of an embedded web-based remote monitoring system for the environment in the laboratories, which realizes the local management and remote publishing applications for large scale dynamic data of sensor networks. The remote labs find much application in industrial and educational institutions. Its advantages over conventional PC servers are explained below.

- Implementation on Embedded Web Server for the remote lab will provide advantages like cost effectiveness because the required hardware is cheaper when compared to using a PC server. Software is built on open source utilities and API's. The power required is very optimum since the system is running on minimum requirements and the dimension of equipment are also smaller providing easy installation and maintenance.
- Because the Embedded Web Server working with pure HTML and PHP instructions that opened the port is port 8080 only, so that the firewall is safe.
- Remote labs can be multiuser, so that at any instant multiple users can log onto to the system and through proper context switching all can access the system resources depending on processing speed of processor and the number of experimental modules installed.
- Other telemetric activities like remote programming or re-programming based on the environment conditions pertaining to the remote location became challenging. This paper discusses and designs on such issues of remotely programming microcontrollers.

II. LITERATURE REVIEW

In comparison with PC, the embedded system is greatly improved in stability, reliability and safety etc. The embedded system transplanted web server can be called embedded web server. Through web page released by embedded web server, remote users can obtain the real-time status information and control remote equipments without time

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restriction. This type of Embedded Web Server has many advantages, such as small size, low power consumption, low cost and flexible designed. It's easy to implement, and it is an effective way of leading Internet into embedded system.

A. Internet of Things[IOT][1]

1. The Internet of Things (IOT) is defined as an integrated part of the future Internet, which ensures that 'things' with identities can communicate with each other.
2. IOT will be applied in different areas eg. smart cities ,agriculture .

B. GSM-Bluetooth based remote monitoring system [2]

1. But it is not efficient in situations which have strong real time requirements.
2. Also in GSM-Bluetooth monitoring system there is no stability also it's not a real time system .

C. PC based monitoring system [3]

Pc based remote monitoring system has drawback high cost ,unsatisfactory stability and reliability. Moreover in the Client/Server architecture, the maintenance burden on the server would be heavy because some particular monitor software should be installed on each remote monitor terminal. In various Internet applications based on client server architecture, it is better to use embedded WEB server other than PC server for decreasing volume, cost and power consumption.

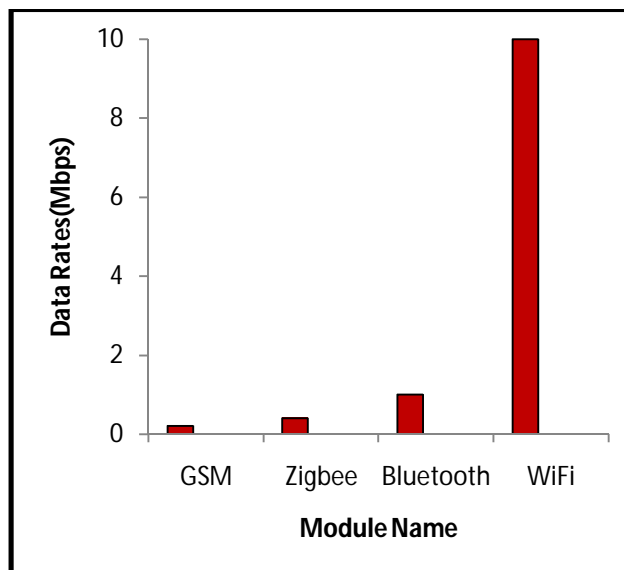


Figure 1. Data rates of different modules

Figure 1 shows the data rates of different module. The wifi has highest data rates as compared to GSM, zigbee and Bluetooth. So Embedded based remote lab implementation require less execution time .So it is fast as compared to other Remote lab implementation.

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III. GENERAL ARCHITECTURE

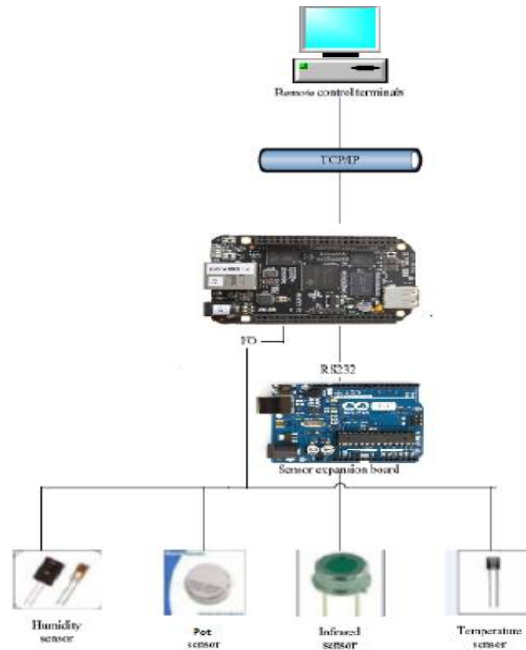


Figure 2. General architecture of Remote Lab Implementation

The central processing unit is a Raspberry pi board consisting of ARM cortex A-8 processor. The general framework of remote lab can be classified into two. The remote monitoring system consisting of various sensors whose calibrated values can be displayed on LCD and the expansion board which can be programmed remotely which is the Arduino uno in this design.

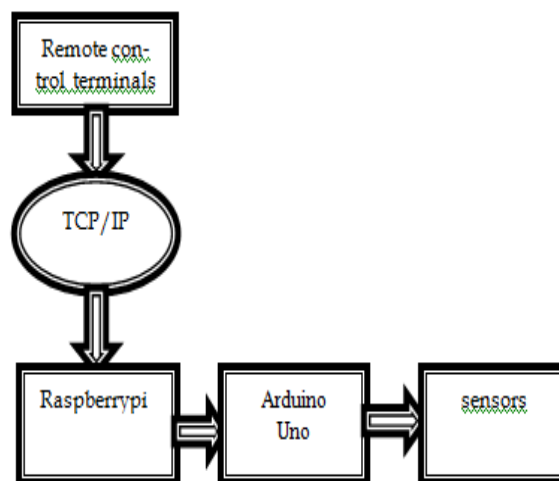


Figure 3. Block diagram of Remote Lab Implementation

A new design of remote laboratory is multiuser based embedded web server. Architecture of Remote Lab System consists of a computer server, experiment module microcontroller system and embedded web server for controlling lab modules.



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IV. DESIGN OF SYSTEM HARDWARE

A. Raspberry pi

The Raspberry Pi is a single-board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science. The original Raspberry Pi is based on the Broadcom BCM2835 system on a chip (SOC), which includes an ARM1176JZF 700 MHz processor, Video Core IV GPU, 512Mb of RAM. The Foundation provides Debian and Arch Linux ARM distributions for downloads. Tools are available for Python as the main programming language.

B. Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328 microcontroller. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller by simply connecting it to a computer with a USB cable or powering it with a AC-to-DC adapter or battery, the bootloader will call to the starting location of the flash memory where the program is residing and the program gets executed.

C. Sensors

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. Humidity is the presence of water in air. The amount of water vapour in air can affect human comfort as well as many manufacturing processes in industries. The presence of water vapour also influences various physical, chemical, and biological processes. A position sensor is any device that permits position measurement. It can either be an absolute position sensor or a relative one (displacement sensor). Position sensors can be linear, angular, or multi-axis. An infrared sensor is an electronic instrument which is used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion.

V. DESIGN OF SYSTEM SOFTWARE

Raspberry PI is configured as server which has the capability to program the Arduino using AVRDUDE installed on it. Raspberry PI is ported with raspbian jessie OS based on Linux Kernel, Firmware of Raspberry PI controller is written in python. On the Client side a software application created using LabVIEW which connects to the server and capable of transferring hex file to the server and Communication commands for certain actions of the server through TCP/IP Protocol.

LabVIEW is an integrated development environment designed specifically for engineers and scientists. LabVIEW is a graphical programming language (G) that uses a dataflow model instead of sequential lines of text code, empowering you to write functional code using a visual layout that resembles your thought process.

VI. ADVANTAGES

- 1.Low cost
- 2.Minimum power required
- 3.Easy to installation
- 4.Easy to maintain
- 5.Safe
- 6.Remote lab can be multiuser

VII. APPLICATION

- 1.For industrial application
- 2.Educational institutions
- 3.Home automations



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VIII. CONCLUSION

An embedded web server thereby reducing the implementation cost, power consumption, boot-up and runtime. Also show that the system designed realizes safe and convenient remote monitoring and local management of the environment in laboratories and has high availability, reliability and popularization.

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