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Web-controlled Embedded System using Mobile

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Abstract

The wireless communication is widely used in embedded system. The automation required for long distance control of the system enables to make application based on wireless communication. In this paper, an application of wireless communication is done for a long distance control of electrical appliances via a mobile phone by Web-controlled (Internet). The Web-controlled embedded system using mobile has application for the control of home appliances (lights, fans, ACs, heater etc), medical equipments, industrial controls

Currently available techniques for controlling the devices in embedded system are using mobile phones with the DTMF feature or by sending messages in the form of SMS. In this paper, a novel approach for controlling the devices using the mobile phone by accessing the internet through GPRS/3G technology have been proposed. The major advantage of using this technique provides flexibility in monitoring and controlling the devices world-wide.

Keywords: Embedded system; Microcontroller; Mobile phone; Internet; GPRS; 3G.

Introduction

Embedded systems show up in all kinds of applications from medical instruments, office equipments and traffic signals to room temperature controls and industrial machines. Internet [1,2,3,8] access improves many of these applications even further

because users located far away from the system can see them operating from a distance .

Some embedded systems uses are more vital to monitor than others. Embedded systems that control car cabin humidity, for example, are typical of "blind" controllers. If the humidity feels right, they must be working; as a result, they go unnoticed probably unappreciated. In modern car have dozens of these embedded systems [4,9].

On the other hand, thousands of applications exist where the embedded systems functions are vital to company operations. One example is the controller in a manufacturing machine. Operators and managers need to see the controller functions without having to walk up to the machine to inspect its read-outs.

When the information contained in these controllers need to be available to a wider group of people, the addition of an Internet (www world-wide web) interface becomes a useful function. This is the reason why this research topic chosen; World-Wide Web Controlled Embedded Systems - being able to access system data over the web [3].

There are three requirements for effective web access in an embedded system:

- The information needs to be accessed over a network. The information contained inside the device must be available to users of the internet locally and perhaps world wide.
- The device to be web enabled must have some types of data for monitoring. Typical sensor inputs in a system can have electrical, physical, chemical or mechanical types. These inputs can be used to measure voltage, current, watts, temperature, humidity, pressure, speed, altitude, GPS location, pH value, mass flow, color, RPM, vibration, open /closed position etc.
- The utility of the web interface expands greatly when we need to control some functions of the embedded systems. For example, to measure the temperature and humidity of a room where critical equipments are running. At any moment, any of such room whose air conditioners are not working properly can create problem to the equipments.

While managing a single room in a factory doesn't seem like a formidable challenge, imagine if we had to manage 50 rooms in six towns. Having web access to each one would greatly simplify the task of knowing if the room conditions are well maintained or not.

Description of System

The major components of a world-wide web controlled embedded systems are:

A microcontroller/microprocessor, interface to Ethernet (MAC/PHY) and jack (RJ 45). Along with these major components, a list of supporting electronic components and a power supply form the structure of web-enabled device [5].

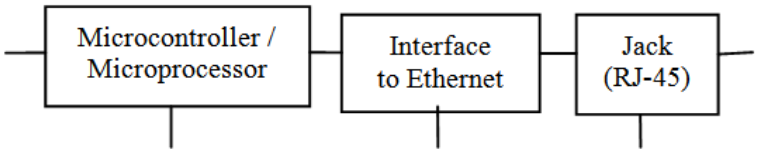

Figure 1: Embedded system for web control.

The microcontroller/microprocessor receives and transmits serial or parallel data to the device being web enabled. It can use internal or external memory for code as well as data .The Ethernet is an integrated circuit dedicated to receive the internet data packets. The chip is commonly called the "MAC-PHY" circuit. The RJ-45 jack is the familiar network jack that the Ethernet cable plugs into. This miniature silver box also contains magnetic transformers also called as a MagJack.

The first way humans want to interact with any device is through web pages. This has become the standard way of accessing everything from printers to power strips. Hyper Text Transfer Protocol (HTTP) [3,4] and its secure counter parts HTTPS are the protocol standards for all browsers. It's critical that the web server be fast, efficient and simple. The first impression of the embedded system comes from its web page, so everything depends on getting it right. If it takes 20 seconds to load, the device feels sluggish, unresponsive and perhaps untrustworthy.

An embedded web server [3,4] performs many operations throughout its lifetime. Besides presenting a web interface, some of its other functions might include sending email, synchronizing its clock, querying a variety of sensors, managing user preferences, responding to various network requests and even updating its own firmware code.

Each of these tasks is distinct. However, there is one major component in common with all of them- the hardware. All the tasks execute on the same Central Processing Unit (CPU), memory and Input/ Output devices (I/O) .While it is possible for a skilled programmer to design each task so that it allocates its own processing time and memory space along with interfacing directly to peripheral devices, this method introduces complexity, redundancy and is prone to error.

The software that facilitates managing these resources is termed the operating system (OS). Operating systems are available in a wide range of capabilities and features, but in general they are all geared toward the same goal- allowing applications to define how to use the system resources in order to solve a particular problem. A system designed with an OS should at the very least obtain two basic benefits: efficiency and convenience.

The World Wide Web (www) controlled embedded system is going to offer a new way of accessing our requirements even being away from the systems. This could help greatly for monitoring and controlling devices world wide. Many techniques have been evolved and yet left to come new ways to access world wide.

Block Diagram

The below block diagram represents the interface of electrical devices to be controlled

with the embedded system which have many sensors & transducers to read the status of each device. The embedded system has feature to transfer the status of devices on website.

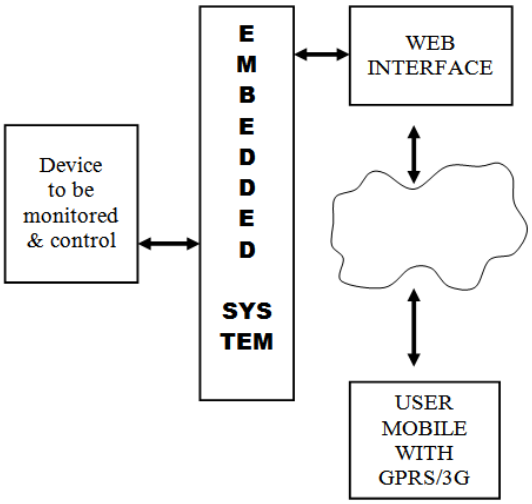

Figure 2: Embedded system with devices &mobile interface.

Controlling the devices through website accessed on PC or laptops may cause handling uncomfortable during movements. Thus a mobile phone may be utilized for such application having feature of accessing internet/GPRS. A mobile phone with GPRS allows accessing any website like www.embedded.com. Through website a user can enter in authorized area by providing passwords & can locate the device to be controlled. User can access the status of the device & control according to his requirements.

As a simple application, this Web-controlled Embedded System using mobile can be used for controlling an air-conditioner. A person may see the status of the room temperature in his/her house before leaving the office. He/she may start the air-conditioner as he/she leaves the office & when he/she reaches the house may get appropriate temperature of the room. This way the system is going to offer a great feature in electrical appliances to be controlled away from home.

Major Subsystems

Controlling Devices using Relays

Relays are used to connect electrical appliances, which are working with ac 220V. The microcontroller is working at +5v dc & it send control bit in the form of 1/0. So a relay will provide the interface between a dc & an ac device. When microcontroller needs to switch on a device, it sends 1 on to the corresponding relay & that device will switched ON. And when it needs to switch off a device, it sends 0 to corresponding relay & device will be OFF.

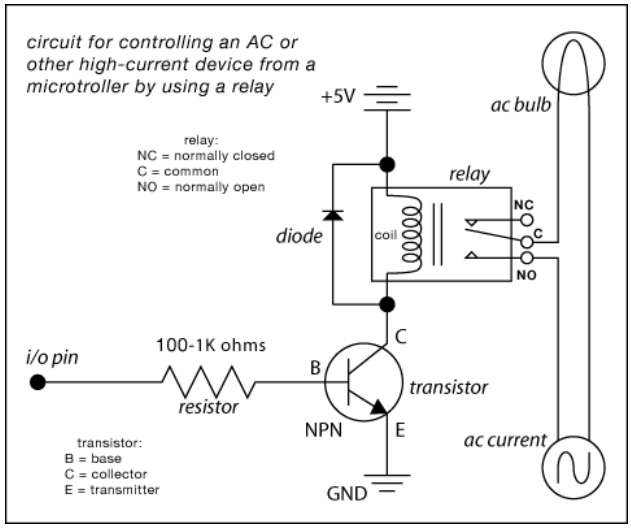

Figure 3: Relay circuit interface to embedded system.

Embedded system

The embedded system contains a microcontroller, which is the heart of the system. The microcontroller is connected to Ethernet controller which is responsible for the sending & receiving the messages through the internet. The RJ-45 jack connector connects the embedded system with the internet line.

Different types of sensors/transducers may be incorporated in the system to read the physical parameters like temperature, pressure, humidity, or any type of signal which need to be read. The sensors/transducers may provide analog or digital outputs. The analog signals have to be converted in digital signal using Analog-to–Digital Converters which is interfaced with microcontroller. The microcontroller read-out these digital signals & compare with the user set values. According to the need of system to be controlled, the microcontroller needs signal which is sent through the website.

Mobile phone

The mobile phone provides the means to access the internet using GPRS [2,6,7,10,] or 3G Technology[11]. In mobile phones, GPRS is the easy way to access websites. General Packet Radio Service (GPRS) is a 2.5 generation packet based network technology for GSM networks. GPRS supports data transfer rates in the order of 40-60 Kbps. However, it should support data speeds reach theoretically up to 171.2 Kbps. Data transfer rate is based on optimal conditions in terms of available cell/sector capacity, available time slots, maximum coding scheme etc.

The major feature of GPRS & other packet based mobile data technologies is the “always on” capability. Being packet based, GPRS allows for the use of infrastructure & facilities only when a transaction is required, rather than maintaining facilities in a session-like manner. This provides very good infrastructure efficiency & service delivery improvements.

The WAP protocol is used to show internet contents on wireless system, like mobile phones. Using GPRS as a bearer for WAP, will allow for the use of WAP on a per- transaction rather than a per-minute-of-use basis. GPRS will allow for autonomous service realization through the always-on capability. For example, a GPRS customer could receive content or services without actually manually invoking a service or transaction. This has significant impact for mobile commerce & location based services.

The high speed network for variety of data intensive applications enables to use 3G [11]. Third generation (3G) networks were conceived from the Universal Mobile Telecommunications Service (UMTS). 3G systems consist of the two main standards, CDMA2000 & W-CDMA, as well as other 3G variants such as NTT DoCoMo's Freedom of mobile Multimedia Access (FOMA) & Time Division Synchronous Code Division Multiple Access (TD-SCDMA).

The data speed of 3G is based on many factors including the chip rate, channel structure, power control & synchronization. The Actual data speed may vary in accordance with number of users in cell/sector; distance of user from cell; user is moving or stationary; network operator capacity & network optimization requirements.

Thus depending upon the feature, GPRS/3G, available in the mobile phone, we can access internet & accordingly control the devices remotely.

Flow Chart

Mobile user

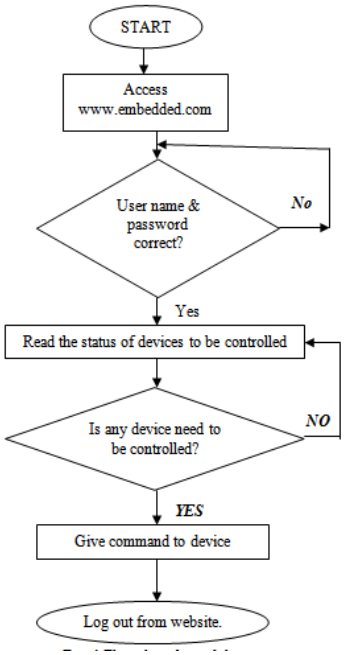

Figure 4: Flow chart for mobile user.

The mobile user can access the website to control the electrical appliances. The user has to enter in the authorized area by entering user name & password in website like www.embedded .com. An authorized user can only see the status of devices on web pages. The status of each of the devices through the sensor/transducers is available to see & control according to the need of user. He may give command to devices for the control operation accordingly.

Web controlled embedded system

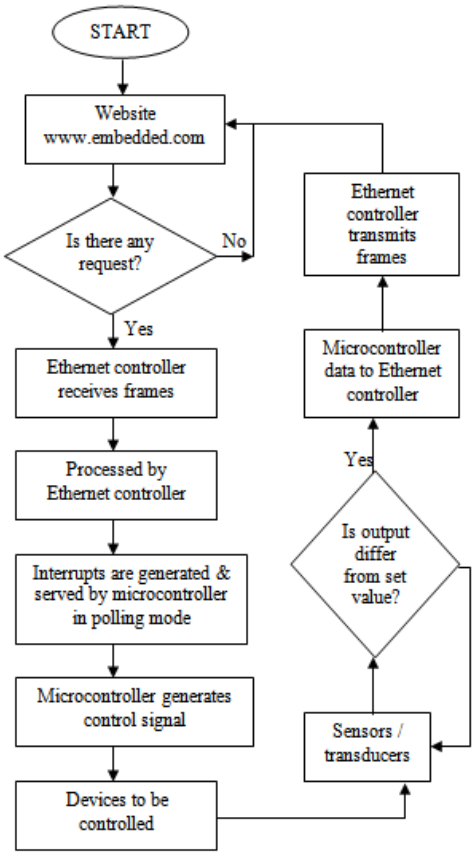

Figure 5: Flow chart for Web controlled embedded system.

The web-controlled embedded system continuously monitors any changes on the website. Any user when changes any of the value, the web page sends packets to Ethernet controller. The Ethernet controller decodes the packet & process the data. Ethernet generates interrupt signals & send to microcontroller for the processing of data & required control to be given to electrical appliances [7].

The sensors/transducers continuously read the status of the devices & microcontroller compare these values with set values/reference values. Any changes in the status of the devices will be updated by Ethernet, transmitting a packet to the web servers. The web servers then update the web pages accordingly.

The pseudo code for the web controlled embedded system is as follows:

```
Main ()
{
        Webpage: www.embedded.com
        User name: XXXXXX
        Password: XXXX
        If correct
        {
           Device need to be controlled?
           {
                AC: ON/OFF
                Fan: ON/OFF
                Bulb: ON/OFF
                Tube light: ON/OFF
            }
        }
}
```

Figure 6: Pseudo code for web controlled embedded system.

Conclusion

By wireless control of electrical appliances used in home/office, we have flexibility to make our living hood a comfortable. The web-controlled embedded system using mobile phone gives tremendous freedom to control devices during movements or away from site. The internet access using 3G technology gives a faster processing than GPRS. Therefore, most of the currently available mobile phones have 3G features.

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