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Remote Control of Home Appliances

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ABSTRACT
The paper entitled "Remote Control of Home Appliances" aims at providing access to home appliances from a far-off location over the Internet. The paper is designed and implemented to achieve control on the appliances such as light bulbs, fans, serial lights and a dot-matrix display over the internet. The paper is deployed by dividing it into three major modules namely Input, Computation and Output where the modules interact with each other to bring out the overall functionality the paper desires to. The significance of implementing the paper is, the remote control of home appliances over the internet. The other important advantages are: It eliminates re-programming the microcontroller of the dot-matrix display and also it eliminates the need for a person to be present to operate and control any of the home appliances, thus reducing the labor.

Keywords **-** Embedded system, Home appliances, IP addresses, Internet of things, Remote Control

I. Introduction

The Internet of Things (IoT) refers to uniquely identifiable objects and their virtual representations in an Internet-like structure. It is a scenario in which objects, animals or people are provided with unique identifiers and the ability to automatically transfer data over a network without requiring human-to-human or human-to-computer interaction. According to Gartner there will be nearly 26 billion devices on the Internet of Things by 2020. According to ABI Research more than 30 billion devices will be wirelessly connected to the Internet of Things (Internet of Everything) by 2020!

Imagine an end-user who has decorated his house for Christmas with serial lights and that he wants to control the lights from a distant location, say, his office. If the end-user has a dot-matrix display then, the user would like to display any new pop-up messages on the fly. This could be brought into existence in real-time by providing unique IP Addresses to both the devices. The Internet of Things allows these systems to be connected and controlled over the internet using their IP Addresses, similarly to how a computer is connected to internet. Now, imagine that you happen to forget to turn off the fan and a light bulb of your room when you leave for work. You wouldn't know this until you return home or you wouldn't have enough time to return home and switch them off. Hence, to avoid such wastage of electricity, the user is given access to the light bulb and the fan over the internet, so that he/she can turn them off sitting in his/her workplace.

The paper entitled "Remote Control of Home Appliances" is an application of the concepts under the plethora of "Internet of Things". This paper aims at providing access to a light bulb, a fan, a serial lights controller and also a dot matrix display from a far-off location over the Internet.

Thus, Internet of Things (IoT) is quite possibly the biggest change that will impact engineers over the next decade as they evolve the standalone embedded systems into massive and powerful networks of devices that deliver unprecedented amounts of data over the Internet.

II. Problem Statement

The light bulbs and fans that we use in our daily life are switched on and off via a switch manually. Such light bulbs usually do not have intensity control. The speed of the fan is controlled by the user manually using the regulator's nob. Thus, in their busy life, users tend to forget switching off the light bulbs and fans while leaving home for their workplace. The user wouldn't know this until he/she returns home or wouldn't have enough time to return home and switch them off. Thus resulting in a huge wastage of electricity, emptying the pockets paying bills.

The currently existing Serial Lights Controller is a manually operated Embedded System. The end-users have to operate the controller only via the keys/ button present on the device. To choose a particular light sequence, the end-user will have to go to the controller device and select the required sequence by pressing the relevant buttons on the device. Also, the device usually doesn't support changing the color of the serial light bulbs. Thus, manual monitoring and controlling of the device is required.

The existing Dot Matrix Display allows the characters to be displayed, pre-programmed into the microcontroller as a constant array. To allow a new character to be displayed, the character must be pre-

programmed into the constant array manually. Such pre-programming requires turning off the entire display system, which could lead to a bad user experience.

Such manual controlling and pre-programming can be over-ruled using the following proposed system on the concepts of Internet of Things.

III. Related Work

In this section we present the related works carried out by several authors. Authors of [1] concentrate on describing how to connect a micro-controller to LAN or Internet and use it as a web server. This paper offers a new approach to control home appliances from a remote terminal, with an option from a local server, using the Internet. The system for the Home Automation Network has a vast scope and almost limitless application in today's technology driven market. In the paper [2] authors have proposed a small power saving embedded Web server for home appliances. The operation of remote controlling the server through a PC connected with a LAN was also confirmed to be stable. Therefore, the proposed Web server could be easily implemented into home appliances, which require space saving, power saving and low price. Authors of [3] have proposed a paper that describes how to implement embedded Internet access technology based on microcontroller. It designs a hardware architecture and software programming for embedded web application. Instead of full-featured TCP/IP, it makes use of simplified TCP/IP protocol because of limited storage space in the microcontroller and unnecessary function based on embedded Internet. The flow of data processing on web server is described in detail. The partial program code for embedded web server is written out in the last part of thesis. The authors of [4] have proposed a system that combines the mature technology of Web with the embedded and fully utilize the advantages of both. Applied the embedded Web technology in the field of equipment condition monitoring, the equipment remote monitoring system is designed based on embedded Web. Firstly, the function and structure of the system are designed. Secondly, based on the commonly Web design technology, the embedded Web server is designed by integrating embedded CGI (common gateway interface), ActiveX and Java Applet technology. Finally, the problem of communication security is considered. The system can complete the remote access, monitoring and maintenance operations of equipment through the network and Web browser. Practical operations show that the system can decrease system running cost and improve maintaining efficiency. It has wide application prospect and great popularization value. The Article [5] emphasizes that the Internet of Things is not just science fiction; it has already arrived. Some of the things currently networked together send data over the public Internet, and some communicate over secure private networks, but all share common protocols that allow them to interoperate to help solve profound problems.

Buildings account for three-quarters of all electricity use in the United States, and, of that, about one-third is wasted. Lights stay on when there is natural light available, and air is cooled even when the weather outside is more comfortable or a room is unoccupied. Sometimes fans move air in the wrong direction or heating and cooling systems are operated simultaneously. This enormous amount of waste persists because the behavior of thermostats and light bulbs are set when buildings are constructed; the wiring is fixed and the controllers are inaccessible. Only when the infrastructure itself becomes intelligent, with networked sensors and actuators, can the efficiency of a building be improved over the course of its lifetime.

IV. Proposed Model

The light bulbs and fans are made to operate automatically over the internet without requiring a user to control its switches manually. Such automation can be achieved using the vast concepts of Internet of Things. The proposed system allows the user to control the intensity of the light bulb and also allows the user to regulate the speed of the fan over the internet. Thus, making both the light bulb and the fan as objects in the network of things.

To eliminate the manual control of the serial lights, the controller is automated. This can be achieved using the concept of Internet of Things. The end-user, far-off from the controller, can control the serial lights over the internet, its sequencing and also the color of the lights. Thus, the serial lights controller can be connected as an object to the web of objects.

The dot matrix display can also be automated using the internet of things. The message to be displayed on the matrix can be given to the display on the fly, instead of it being pre-programmed into the microcontroller. Thus making the dot matrix display also an object in the web of objects.

All the objects expressed here are integrated as a single system that has a unique IP Address assigned to it. The IP Address of the system allow the objects/devices to be connected to the internet and also allows the objects to be accessible over the internet.

Thus, the applications of the proposed system could be in: Home automation, lights show, decorating a building for a special occasion, displaying just-in pop-up messages, and so on.

1.1 System Architecture

A system architecture or systems architecture is the conceptual model that defines the structure, behavior and more views of a system.

This paper is implemented in three main modules, namely:

- Input
- Computation
- Output

The interaction between the three modules is shown in the Fig. 1 below:

The Input module: It provides user interface to remotely access the system where, one can use the application and give inputs to the system to control its components. A power supply is used to supply electric power to the microcontroller. A user at a remote place uses the application to give inputs to the system to access the various components. Once

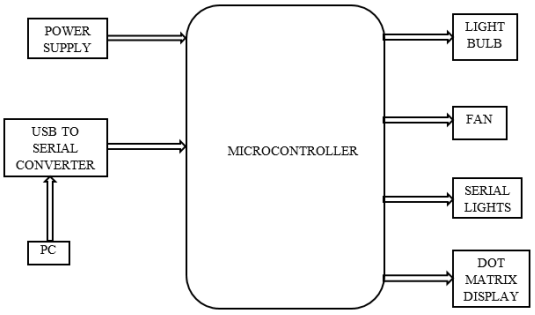

Fig. 1: System Architecture

the input data is available, it is transmitted over the internet to the local PC which is connected to the proposed system. It is the job of the local PC to transfer this input data to the USB to Serial Converter of the system.

The Computation module: Once the remote user gives input to the application in the Input module, the USB to Serial Converter forwards these inputs to the microcontroller in a serial fashion. The USB to Serial converter unwraps the received data, converts them into serial data bits and finally forward them to the microcontroller. Based on the outcome of the computation, one of the components, such as the light bulb, the fan, the serial lights and the dot-matrix display, will respond to the input data. For instance, if the remote user inputs a request to change the color of the serial lights to green, then the microcontroller produces suitable signals and forwards it to the serial lights. As a result the serial lights glow green in color.

The Output module: The light bulb, fan, serial lights and dot matrix display form the Output Module. With the valid set of inputs given, the control signals generated and forwarded by the microcontroller invokes one of these output components to show the result of the computation. For instance, if the remote user inputs a request to decrease the intensity of a light bulb, then the microcontroller processes the inputs, produces suitable signals and forwards it to the light bulb, thus decreasing its intensity to the requested level.

Consider, for instance, that the user wants to change the message displayed on the Dot-matrix Display. The user at a distant location, uses the application to enter the new message to be displayed on the dot matrix. Once the message is input, the local PC receives the data and passes it onto the USB to Serial Converter of the proposed system. The USB to Serial Converters unwraps the data, converts it into serial data bits and transmits them to the microcontroller. It is the job of the microcontroller to update the currently displayed message on the dot matrix to the newly received message.

V. Algorithm

Algorithm for the Data flow of the proposed system is written below:

Input: Form Data.

Output: Appliances perform the input operations.

Steps:

1. User inputs in the Web Application at a remote machine.
2. Input data are processed at the Local Server.
3. Local Server forwards the data to the Microcontroller.
4. Switching Action takes place with the appliances.

Algorithm above shows the dataflow of the proposed model. A graphical user interface is designed as a web based application. The user will access this interface to control the home appliances. The data from this application will be passed to the local server, that is, the home PC. The local server will then pass on the signals to the microcontroller via the USB to Serial Converter. The USB to Serial Converter unwraps these signals into serial data bits. The microcontroller will be programmed in an appropriate way to understand and convert these data bits into the required electrical signals. These analog signals will be transmitted to the corresponding switch controlling the home appliance. The end result will be a simple action like: switching on a light bulb or fan and also it can vary the intensity of light and fan using PWM technic. The end result also includes changing the color of the serial lights and also controlling the speed of the serial lights. Also, when the user types a message at the remote PC via a keyboard, that data is sent to the local server and the message will be displayed on the dot matrix display without requiring to re-program the microcontroller.

VI. Results and Discussion

In this section the results obtained after implementing the proposed system are discussed.

The proposed system was developed with the successful implementation of every feature specified during the requirements specification documentation. The following are the snapshots of the results obtained.

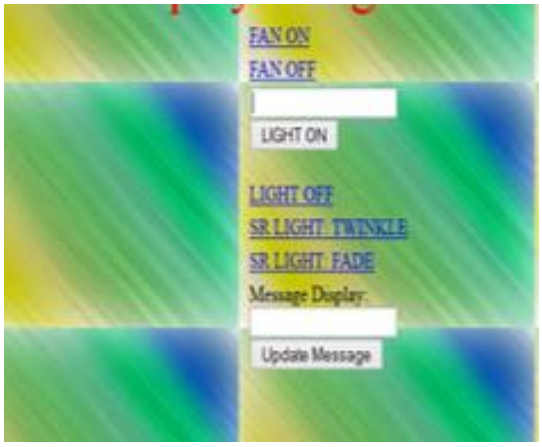

Fig. 2 Snapshot of the Web Application

After the server is started at the local system the user at the local PC or at a remote location types in the IP Address of the server system after which the above web page Fig. 2 is displayed. This web page consists of the options to operate on the appliances. Two text boxes are given to enter values. The first box accepts the light intensity value in a certain format and the second text box accepts the new message to be updated on the dot matrix display. The various options are provided to turn on the fan and to turn it off, turn on the light bulb and turn it off, to twinkle the serial lights, for the fading off the serial lights and to submit the new message to server.

When the remote users choose the FAN ON option of the web application, then the fan is turned on (Fig. 3) at the users home location.

Fig. 3 Fan turned ON

Also, when the users choose the FAN OFF option of the web application the fan is accordingly turned off.

The Fig. 4 shows that the light is turned on when the "LIGHT ON" option of the web application is chosen. The light intensity value is entered in the text box provided for it on the web application. Once the value is set the light bulb glows to the given intensity.

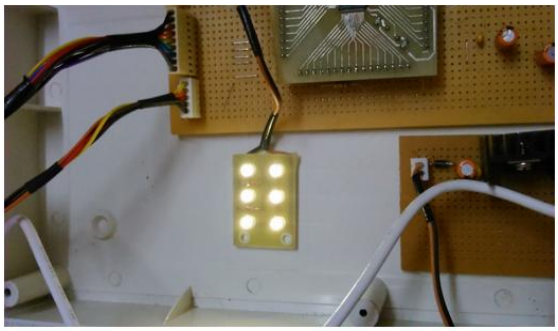

Fig. 4 Light turned ON

When the option chosen is on the serial lights, then there are two possible choices; one being twinkling of the serial lights and other to fade them off. In Fig. 5, the top snapshot shows the twinkling serial lights whereas the bottom snaps show the three notable colors when the serial lights fade off. These variations in RGB colors are due to change in the duty cycles of the voltage intensity by the pulse width modulation technique.

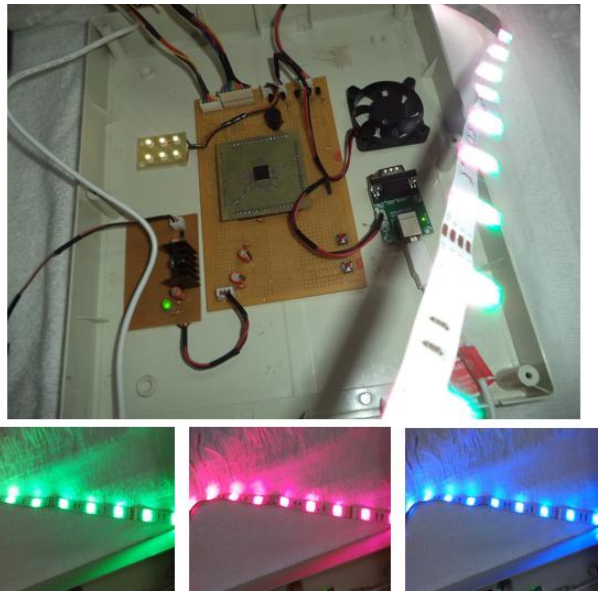

Fig. 5 Serial lights twinkling (top) and fading off (below)

Finally, if the user at a remote location wishes to change the message displayed on the Dot-matrix display at his office, then he can enter that new message in the text box provided on the web application. Once the new message is submitted by clicking of the 'Update Message' Button on the web application, the message is updated in the dot-matrix display board. The Fig. 6 below is the result when the

message is updated to "WELCOME TO PESCE MANDYA". Before this update, the dot matrix was displaying "MERRY CHRISTMAS".

Fig. 6 Dot-matrix display before updating (top) and after updating (below)

VII. Conclusion

The paper "Remote Control of Home Appliances" was developed keeping in mind the users who tend to forget switching off the lights bulbs and fans while leaving home for their workplace. The user wouldn't know this until he/she returns home or wouldn't have enough time to return home and switch them off. Thus resulting in a huge wastage of electricity, emptying the pockets paying bills. A serial lights controller always required an operator to control its operation; to change the message displayed on a dot matrix display, first it had to be switched off, connected to a PC and then re-programmed. With the implementation of the proposed system, all of these manual operations and controls mentioned above, along with the re-programming of the dot matrix display was eliminated.

The proposed system was developed with the successful implementation of every feature specified during the requirements specification documentation. The proposed system was given a unique IP Address as that of the local host through which the appliances such as the light bulb, fan, dot-matrix display unit and the serial lights were controlled over the internet using an application running at the local host. The following features were successfully implemented: turning on and turning off the light bulb, controlling its intensity, turning on and turning off the fan, controlling various operations on the serial lights and updating the message displayed on the dot-matrix without disconnecting it. Thus, all the four of the above mentioned appliances were successfully connected objects to the web of objects.

At the current phase of the Internet of Things, most applications are independent and deployed for specific users. In the near future the Internet and Wireless technologies will connect different sources of information such as sensors in smart homes turn off utilities, close windows, monitor security and report to homeowners in real times, mobile phones and cars in an ever tighter manner. With the development and maturity of distributed intelligent information processing technologies, Internet of Things systems will make intelligent sensing widely available through information sharing and collaboration.

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