Home Automation System using Raspberry Pi

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Abstract*— *Nowadays automation encompasses many vital elements, systems and job functions. To embed this term with controlling devices especially for electric devices at home will give a system which will turn to be highly beneficial to end user. Therefore we have presented the architecture and implementation of the home automation system for controlling electric devices using raspberry pi as the central (main) hardware. The proposed system is having two parts; the first part consist web server controlling user interface and the details of the devices are stored in the database. While second part consists hardware structure which provides appropriate interface to raspberry pi and electric devices. This part also consist a controller module as a bridge between raspberry pi and electric devices. Unlike most of other available home automation system we have used raspberry pi as the main hardware due to benefits like low cost, high performance and massively diverse range of uses and applications.

Keywords—Raspberry Pi, Automation

A. Overview

Automation is generally being seen as the occurrence of any process without any human interaction but formally it can be defined as it is the use of machines to do the things people would otherwise have to do. The reason for automation is that machines can work far more quickly, economically and consistently then people do. Especially these day when the amount of gadgets people use would just not get built if it was not machines doing them. The other issue which is being faced now days by entire world is some environmental problems like global warming, air pollution etc. To overcome these problems one of the solution is wastage of energy resources should be minimized. One way to minimize this wastage is to apply automation systems for electric devices. In our system we have emphasized on home automation for electric devices. [1] Describes home automation as the system to control the electricity wastage and involvement of technology within the home to enhance the quality of life of its occupants, through the provision of different services such as controlling of electric devices and energy conservation. Establishment of this system in a private home will increase the comfort while on the other hand system installed in commercial buildings will increase comfort and also allow centralized control of heating, ventilation, air condition and lighting. Hence this system can contribute to an overall cost reduction and also to energy saving which is one of the major issues for the world as mentioned earlier.

B. Features and benefits of proposed system Here the proposed system does have very simple architecture. Features supported by the system are mentioned below.

1) Interoperability: The beauty of an automation system is its ability to tie diverse electronic devices together so they can perform as one unified system. The proposed system will work very smoothly due to quite simple design. Depending on the openness of the system the devices get involved in communication with each other. Here proposed system is simpler and open in nature to put all the devices combine operated
2) Remote access: “Home Automation is all about being able to control things in your home, and part of that is being able to change the settings quickly and easily if your plans change. More often than not, plans change when you’re not at home, so being able to communicate those changes with your home automation system remotely is one of the most revered features of an automation system. Remote access capabilities allow you to monitor your home’s environment and alter the settings of the lights, thermostats and other gear if necessary all from your

laptop or cell phone. Remote access also allows your installer to tweak your system without having to make a house call, which is always cheaper and more convenient. Here the proposed system do provide the remote access to any user with authenticating the end user.

3) Expandability: The way you live in your home five years from now will probably be much different than the way you live in your home today. Moreover, technology will continue to evolve, introducing a completely new generation of products to the marketplace. In the future, you may also want to add new rooms—like a recently finished basement or an addition off the back—to your automation network. Or, you may simply want to start out with just a few features when you first put in your system then add new capabilities later as you have the money. For these reasons, it's important that a home automation system can be easily expanded both vertically to incorporate additional products and horizontally to support additional rooms. The proposed system can easily get into with more number of devices any time it is required by simply adding the additional controllers and piece of code in the program.

4) Variety of interfaces: There are a number of different ways you can control the electronic systems in your home. Depending on your family dynamic, budget and preferences end user might need different interface to control. Proposed system can easily switch design of the interface.

5) Commitment to energy saving: One of the hottest topics in the consumer media is energy conservation. Automation systems can help save energy by turning off electronics devices automatically. Various features like alarm system for a device which has been on for more than certain time, graphical analysis and history will increase the energy conservation mark very high for the proposed system.

II *SYSTEM ANALYSIS*

A. *Problem definition*

Home automation system faces major challenges like high installation cost, Lack of security, fix/rigid system or lack of scalability. The main objectives of that research is to design and to implement a Cheap and open source home automation system that is capable of controlling and automating most of the house appliance through an easy manageable web interface to run and maintain the home automation system. The proposed system supports a great feature of flexibility by using Wi-Fi technology to interconnect its distributed modules to home automation server. This will definitely decrease the initial installation cost and will provide the scope of upgrading, and system reconfiguration on some certain situations. System will make use of secure wireless LAN connections between distributed hardware modules and server, and secure communication protocols between users and server.

B. *System requirement*

The following are the most important requirement of the proposed system.

1) User Friendly Interface: User can manage system locally or remotely home automation system easily using simple web interface

2) Raspberry Pi (central hardware): The proposed system contains raspberry pi as main hardware which will control the devices using its general input output pin. Central server will provide the state of the devices to the raspberry pi connected to it and pi will operate the devices accordingly. Here are some of the features of the raspberry pi.

- Raspberry pi is a low cost device with wide range uses. It is having 512MB RAM in compare to 2KB of Arduino using which we can implement many complex programming applications at a time. Raspberry pi also have BCM7835 processor having speed of 700MHz while Arduino have ATMEGA328 processor with 16MHz speed. Raspberry Pi is designed to function on a much higher level. With already integrated hardware that takes care of things like Ethernet, video and audio processing, large quantities of RAM and an almost unlimited amount of storage space, they are really mini-computers.
- Raspberry pi is also able to run complete operating systems, like Linux and Android, and develop programs within those operating system that can control the systems functions and the IO that are made available.
- By combining raspberry pi with microcontroller, we will be able to make the system to a product level.

3) Large area coverage: Another challenge lies in the fact that devices of a home automation system are dispersed over large areas. Also, they may rely on an infrastructure of access points and a wired backbone network (or particularly sensitive receivers). Due to Wi-Fi modem available to raspberry pi it may directly connect to the web server through Internet by routers or any other medium which will make remote access available for the end user. 4) Other hardware:
Raspberry pi model B provides3.3V to the input output pin which is not sufficient to operate heavy devices like air conditioner or any other heavy devices. Therefore relay and transmitters are required to operate high voltage devices. As they will act as

switching for the devices which are installed for controlling.

III SYSTEM ARCHITECTURE DESIGN

A. *Home automation system layout*

As mentioned the proposed home automation system does contains three major components, The server, hardware module, web interface and the end user. The following figure (i) shows the basic layout for the proposed system.

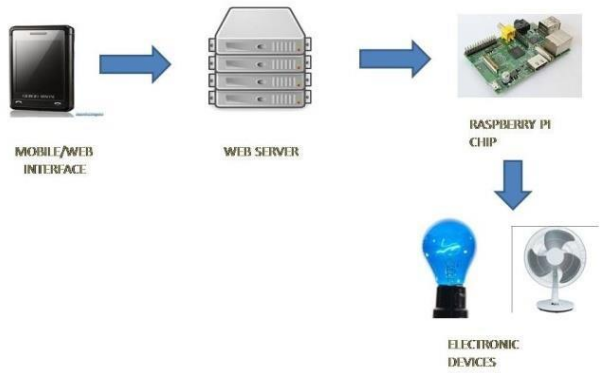

Fig. (I) System Layout

As shown in the layout raspberry pi model B will use its Wi-Fi adaptor to communicate with the server. Through this communication server and raspberry pi will pass the information of the status of the devices connected with the raspberry pi. Even this communication can be possible via Ethernet also as raspberry pi do have Ethernet port on the board so server and the pi can be connected via Lan with each other. While at front end user may use the same technology to connect with the server web based application and access the devices registered under him/her. So in the proposed system user can connect to the server through internet using compatible browser.

B. *Functionalities of the proposed home automation system*

The proposed home automation system is capable to control any number of following devices.

- Light
- Fan
- Air conditioner
- Other heavy electric devices

The proposed system does support the other functionalities apart from controlling these electric devices, like this system supports time based automatic device controlling. This service can be helpful to control heavy devices which consume more power in compare to other. For that user need to specify particular device and need to fix the automatic shutdown time for that device this will operate the device accordingly. The other important feature is access to the history by observing to it user can definitely analyze the devices being operated more than other. Thus these various features helps user to cut down the cost.

C. *Software design concept*

Software design of the proposed system is divided in to two major components first is web based application and second is Raspberry Pi firmware.The web server based application for the proposed system is designed in the advance java, JSP using Netbeans IDE 7.2 development tool. End user needs to enter credentials to enter the system and user will able to interact The server application software can be accessed from internal network or from internet if the server has real IP on the internet using any internet navigator supports advance java and JSP technology. Server application software is responsible of setup, configuration, maintain the whole home automation system. Server uses database to keep log of home automation system components in glassfish server database. The raspberry pi firmware is connected with the server using Wi-Fi modem or Ethernet cable. The status of the device or change in the device will be reflected to the GPIO pin through raspberry pi and pi will be notified through client server application. Devices to be operated are connected with raspberry pi through GPIO pins using relay switching circuit and controllers to operate more number of devices. Following figure(2) shows the architecture of the proposed home automation system.

D. *Layered architecture*

As shown in the above figure(ii) the architecture of the proposed system consists of three major layers. First user interface which supports different user interaction like authentication of the user when user going to start the interaction, user will have the detail status page for the devices registered under his/her and user can operate and make changes to those devices status through the same interface. User is also facilitated with history and analysis module in the interface. In history module user will be able to have information about when particular device of particular room get operated while in analysis module user can able to generate a graph showing various devices electricity usage. These two modules will help user to decrease the electricity wastage and increase the cost effectiveness. Now the second layer of the proposed architecture is web server which is going to handle different types of communications with the database and raspberry pi. For example to authenticate the user credentials entered by the user will compared with the entries in the database, for displaying analysis graph or history tables values the data stored in the database will be fetched and in case of updating the status database will be updated also. Third layer the hardware module is consists of raspberry pi, relay circuit for switching, microcontroller for operating more devices using gpio pins of the raspberry pi. As shown in the architecture the hardware module device raspberry pi is connected with the server using Wi-Fi or Ethernet cable. Pi will receive the current status of the devices it will pass it to the relay circuit the relay circuit due to use of transistor it will magnify the voltage value and can operate the device before passing it to the device microcontroller get

installed it will play role of device selection logic and more devices can get accessed using group of gpio pins, while at other end if any devices is directly operated through switch it will notified to server through pi using controller circuit. Thus layered architecture contains above explained layers.

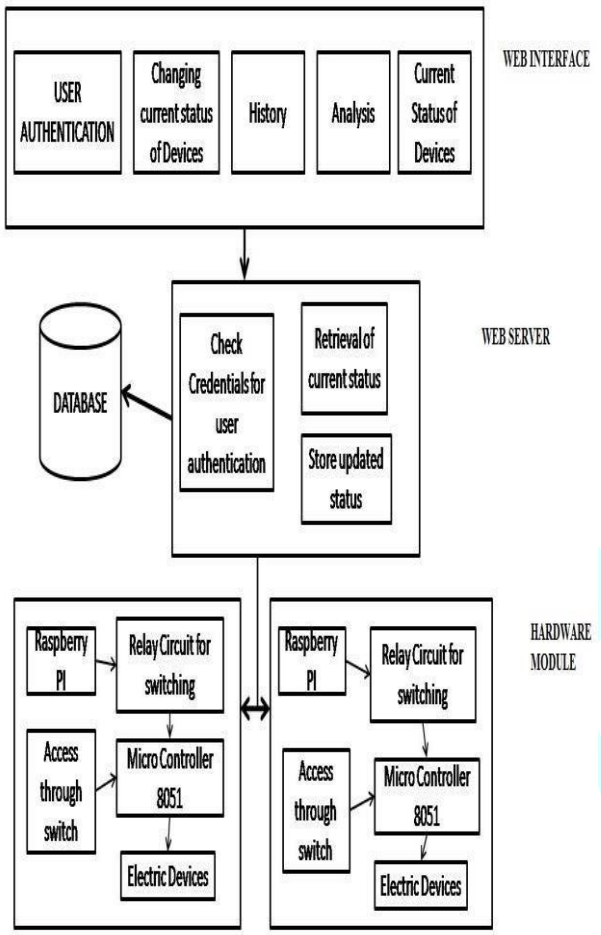

Fig (ii) Layered architecture

IV Future Work

The following points mentioned are the steps to be considered for developing the proposed system further with more functionality for the end user. Implement different hardware modules to interface more complex devices to the raspberry pi and modify the web server interface according to the hardware module to handle them. Even some sensors can be introduced in the system to decrease the human interaction and operate electric devices rather in a better way. This communication between sensors and existing hardware will introduce further modification in the system. By applying this change to the proposed system, the system will be more intelligent, cost effective and helpful to end user. Use of the sensor devices will make hardware module more capable to take decisions according to triggered alarms or sensor inputs rather referring to server for each and every event or action. And automatically this will cut the response time of the system.

V Conclusion

The proposed home automation system in the paper is significantly a low cost, scalable, remotely accessible and interfaced with user friendly design. The discussed approach in the paper is very simple in design and has fulfilled the goal to automate the electric appliances remotely using the raspberry pi connected to the server using Wi-Fi technology, satisfying conserving less energy to serve to the betterment of the society and user requirements. System implemented using raspberry pi proved to be cost-effective as compared to the previously existing systems. Therefore we can conclude that the requirements and objectives of the good automation system have been satisfied. The system design and architecture were discussed in detail gave proper information to implement the system effectively. Finally, the proposed system is better due to some of the modules implemented for the user in terms of analysis of the device usage. Thus proposed system is highly beneficial for the end user than the systems available in the market.

Acknowledgement

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[1] Ahmed ElShafee, Karim Alaa Hamed, “Design and implementation of Wi-Fi based home automation system”, World academy of science, engineering and technology journal, volume 6, 28-8-2012 [2] Alkar, A.Z., Buhur, U, “An internet based wireless home automation system for multifunctional devices”, Consumer electronics, IEEE transactions, volume 51, issue 4, Nov. 2005

[3] Carelin Felix, I. Jacob Raglend, “ Home automation using gsm”, ICSCCN 2011 [4] http://en.wikipedia.org/wiki/Automation

[5] www.electronichouse.com

[6] https://sites.google.com/site/semilleroadt/raspberrypi-tutorials/gpio