Smart Home Automation System for Physically Challenged and Elderly Care People Based on IoT

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Abstract

This paper is based on the development of a smart home automation system using Internet of Things (IoT). The main objective of this work is to develop an automation system using Raspberry Pi with wireless connection over Wi-Fi network, controlled by smart devices like mobiles, laptops or desktops. In order to achieve these functionalities, Raspberry Pi is connected to a local Wi-Fi network and then the devices connected to the same network can log into the GUI webpage by entering the IP address of the Raspberry Pi in the web browser. After logging into the web page of the device, commands are sent to the receiver end (Raspberry Pi) through the web page. Actuators and sensors are connected to the Raspberry Pi to perform the necessary actions based on those received commands. By using this smart automation system users can be able to control and monitor different home appliances and also monitor the room temperature in real time. This system will help the elderly or handicapped people to live an independent life.

Keywords: Smart Home Automation, IoT, Raspberry Pi 3, Relay Board, Temperature Sensor, Humidity Sensor

1. Introduction

Smart home automation system is mainly designed to improve the lifestyle of users [1-7]. Designed model of home automation fulfills the demands of the increasing population of today’s world [9-13]. The advantage of our model is that, features of the electrical and electronic devices connected in the system can be controlled easily. The features of our model make it possible, as it provides a home system accessing remotely, saving a lot of time and reduces human efforts, like turning off/on lights, fans and other electronic and electrical equipment. The focus of our work is to help users to operate home appliances with their own smartphones and also help elderly or handicapped people live a more independent life as long as possible. The proposed idea enables a user with any handheld device like smartphones or laptops to control the system with the browser. This application will allow the user to control all the electronic equipment or any home appliance that connected with the Raspberry Pi. For these functionalities, the Raspberry Pi and the user’s device must be connected to the same local WiFi network. We have also added a functionality for showing room temperature in real time on the user’s device allowing him to control the different appliances according to his/her requirements.
The main contributions of this paper are stated as follows:

- A model is designed to control lights, fans and other electronic devices remotely. To control these appliances remotely, smart devices need to be synchronized with the main server.
- The model is developed in such a way that the appliances can be controlled both remotely and manually. For this a 2-way master switch is connected which will enable user to decide whether he/she is going to use the manual mode or the remote mode.
- The whole system is designed to function over a local WiFi network, enabling all users to use the system concurrently that are connected to the same network.
- Temperature sensor is used to track the room temperature and indicate the user on its device in real time.

The rest of the paper is organized as follows. Related works are discussed in section 2. Section 3 presents the model used. In section 4, results are discussed and at last conclusion is presented in section 5.

2. Related Works

In this section some existing works related to smart home automation systems are focused. Jain et al [8] focused on designing a basic home automation application on Raspberry Pi through reading the subject of E-mail. The algorithm for the same has been developed in python environment, which is the default programming environment provided by Raspberry Pi. Results show the efficient implementation of the proposed algorithm for home automation. LEDs were used to indicate the switching action. Patchava et al [15] proposed a Smart Home Automation with Raspberry Pi using Internet of Things (IoT). It is done by integrating cameras and motion sensors into a web application. To design this system, authors have used the Raspberry Pi module with Computer Vision Techniques (CVT). Using this, home appliances connected through a monitor-based internet can be controlled. Raspberry Pi operates and controls motion sensors and video cameras used for sensing and surveillance. For instance, it captures the intruder’s identity and detects its presence using simple CVT. Whenever, motion is detected, the cameras will start recording and Raspberry Pi device alerts the owner through SMS and alarm call.

P Bhaskar Rao and S. K. Uma [20] presented a low cost and flexible home control and monitoring system, using an embedded microprocessor and microcontroller with IP connectivity for accessing and controlling devices and appliances remotely using Smart phone application. The proposed system does not require a dedicated server PC with respect to similar systems and offers a novel communication protocol to monitor and control the home environment with more than just the switching functionality. To demonstrate the feasibility and effectiveness of this system, authors have used devices such as light switches, power plug, temperature sensor and current sensor integrated with the home control system. Dey et al [21] have designed a home automation system using IoT. The IoT devices control and monitor the electronic, electrical and the mechanical systems used in various types of buildings. The devices are connected to the cloud server and are controlled by a single admin which facilitate a number of users to which a number of sensor and control nodes are connected. The admin can access and control all the nodes connected to each user, but a single user can control only the nodes to which the user itself is connected. This whole system using IoT will allow mobile devices and
computers to remotely control all the functions and features of home appliances from anywhere around the world using the internet connection. The system designed is economical and can be expanded as it allows connection and controlling of a number of different devices.

Kodali et al [24] focused on building a smart wireless home security system which sends alerts to the owner by using Internet in case of any trespass and raises an alarm optionally. Besides, the same can also be utilized for home automation by making use of the same set of sensors. The leverage obtained by preferring this system over the similar kinds of existing systems is that the alerts and the status sent by the WiFi connected microcontroller managed system can be received by the user on his phone from any distance irrespective of whether his mobile phone is connected to the internet. The microcontroller used by the authors in the prototype is the TI-CC3200 launchpad board which comes with an embedded microcontroller and an onboard Wi-Fi shield. By using this, all the electrical appliances in the home are controlled and managed.

3. Proposed Model

In this section the designed model is presented. Different components those are connected to the system are shown in the Fig. 1. Raspberry Pi is connected to the power source and pins are connected to the relay board and the DHT11 sensor. Different appliances are also connected to a power source from both the relay board and the manual switch. Programs are developed using Java, servlet, python and html. These programs are uploaded to the Raspberry Pi, which will help in running the whole setup.

![Figure 1. Model Design](https://pramanaresearch.org)

In the above figure the Raspberry Pi is connected to the relay board and from that relay board power supply is given to the light or fan.
3.1 Circuit design:

Circuit is designed so that, the system will enable users to operate both manually and remotely. A 2-way master switch is connected to a power source and from its one end the supply is given to the relay board and the other end is connected to the manual switchboard as shown in the figure below. The circuit follows OR logic, which provides the feature to use both manually and remotely without any interruption.

**Figure 2. Circuit diagram**

4. Results and Discussion

The proposed system uses Raspberry Pi 3, relay board, DHT11 temperature sensor and humidity sensor. Power is supplied to the relay board and the manual switchboard through the master 2-way switch. From each relay, wire is connected to corresponding light and fan as per the circuit diagram in Fig. 2.

**Figure 3. Implemented system**
This model is designed in such a way that, when the Raspberry Pi got connected to a wifi router then the devices like smart phones and laptops connected to that wifi network can control the appliances after authentication. We have used an android based application, i.e. "FING" to find IP addresses of all the devices connected to that particular network. Raspberry Pi is assigned with a fixed IP address in the network. By assigning fixed IP address to the Raspberry Pi, the problem of searching of IP address in case of reboots or reconnect of Raspberry Pi to the network is solved. Now by typing the address in a special format in the web browser, anyone can get access to the system. The format contains the IP address of the Raspberry Pi with port number followed by the folder which contains the corresponding web content on that web browser, e.g. - http://192.168.137.1:8080/abc.

After entering the IP address of the Raspberry Pi along with the path name, a web page will be generated for the validation of user where the user needs to authenticate by using the login id and password those were set before. After authentication, a web page will be generated which contains respective buttons for lights and fans as shown in the Fig. 4. This page contains a meter gauge which shows the room temperature in real time. This page also contains a log out button, to log out the user from the web page. The control flow diagram of this system is mentioned in Fig. 5. According to user requirements, when a user press a button in the web page, then the corresponding request is sent to the tomcat server. Then, the tomcat server forwards the request to the corresponding Java web program. After getting the request, the Java program will call the corresponding python program and then the tomcat server responds back to the web server. After that, the status values of the light bulbs and fans are updated on the web page. We have also implemented a graphical temperature indicator on the web page which shows the room temperature in real time by taking the temperature data from the DHT11 sensor. For concurrency management in our model, we have set a delay time of 3 to 5 seconds in the program. The tomcat server works based upon the concept of first come first served. So
after taking action on first input, the server will wait for 3 seconds before the next input is taken into consideration.

![Figure 5. Control flow of the system](image_url)

5. Conclusion

In this work, a Raspberry Pi based integrated system (smart home automation system) is developed using IoT. This system mainly uses Raspberry Pi, relay board, temperature sensor and humidity sensor. The relay board is used to control different home appliances connected to the relay board and is controlled by the Raspberry Pi. Temperature and humidity sensors are used to track the room temperature and humidity level in real time.

The main objective of this system is to enable users to control different home appliances and which in turn reduces most of the human efforts using IoT. Since human efforts are less, this system becomes more helpful to the elderly and handicapped persons. Such automated and controlled room lights can also be implemented in different locations like garages, staircases, bathrooms etc., where we do not need continuous light but only required occasionally when someone is present. This work can also be associated with other options like energy monitoring systems, which warns the user about the excess usage of energy and can also be used for home security and surveillance. An extension of this work can also be used for developing large scale projects like smart building, smart city etc.

6. References


