Smart Energy Efficient Home Automation System Using IoT

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Abstract—**Advancement in IoT based application has become the state-of-the art technology among the researcher due to the availability of Internet everywhere. To make the application more user friendly, web based and android based technologies have gained their importance in this cutting edge technology. In this paper, smart energy efficient home automation system is proposed that can access and control the home equipments from every corner of the world. For this system, Internet connectivity module is attached to the main supply unit of the home system which can be accessed through the Internet. For wireless connectivity, the static IP address is used. Home automation is based on multimodal application that can be operated using voice recognition command of the user using the Google Assistant or through a web based application. Thus, main objective of this work is to make our home automation system more secure and intelligent.**

Keywords—Home Automation, Relay, Node MCU (ESP8266), IFTTT, Adafruit, Internet of Things (IoT), Google Assistant, Voice Control, Smartphone.

I. INTRODUCTION

Human-machine interaction (HMI) has become, the more realistic in day-to-day life due to the advancement in the technology [1]–[3]. Today, HMI research has moved one step ahead and switched onto the Internet, which was previously used for communication and now used for things, i.e., IoT (Internet of Things) [4]–[6]. The aim of this application is to connect any things through the Internet that can be accessible from anywhere.

IoT application are not limited to one particular field. It has shown the significant contribution from small scale applications to the large scale applications such as, E-commerce [7], Coal Mine [8], Wearable device [9], Smart Grid [10], Laboratory Monitoring [11], Agriculture [12] and many other domains [13]–[16].

Though, we have received tremendous improvement in the technology, but still power consumption is one of the big issue all over the world. As per report, the Information and Communication Technologies (ICT) alone uses 4.7% of the world's electricity, which may likely to be increased to 10% as per report [17]–[19].

India, share about the 17% of the world population has limited energy resources and share roughly 0.6%, 0.4% and 7%, for world gas, oil and coal reserves respectively [20]. However, in India, the electricity consumption due to ICT usage has increased from 24 TWh to 31 TWh in the last five years (for the period 2009-2014). This has resulted in electricity consumption of roughly 6.5% in 2015 [19].

Thus, saving of the power is the main concern, which is the basic aim of this project. To save the power consumption, we have proposed the smart, energy efficient home automation system using IoT. Thus, aim of this research to save the power consumption (reducing the electricity bills) and at the same time provide the safety and security of the home equipments.

II. SMART HOME AUTOMATION SYSTEM

As demand for electricity is increasing day-by-day, therefore, smart home is the upcoming area of research to provide the remote access for controlling the home appliance using IoT [21]–[24]. IoT based application has also provided the boom for old aged people and the person having some sort of disability [9], [25]. This allows the user to control the home automation device such as fan, bulb etc., without even making any physical connection.

Research conducted on home automation system is reported in [21], [23], [24], [26]–[28]. Most of the previous system based on these techniques is either based on DTMF or Bluetooth system [9], [21], [26], [27], [29]–[31]. The basic problem with DTMF based home automation require dedicated PSTN channel for communication between main supply units and controlling device. On the other hand, Bluetooth is useful for short range communication that requires the operating appliance in their range.

Home automation using MQTT is presented in [28] for sending/receiving data from the sensor. For this Raspberry pi is used as a gateway for accessing the data from the sensor which are used to measure the temperature and humidity of the room. Another home automation system is presented in [23] which are based on Raspberry pi and user can control their home appliance using the web-based interface. In [26], home automation using mobile is reported in which system is designed using ZigBee.

IoT has provided the applications to turn non-smart device into smart device, which allow users to access these devices through the Internet. It converts the home into smart home and provides a more robust method of controlling the home appliance. Also, the security can be added with the help of installed camera in the home, which can be traced through the Internet. Thus, user can monitor their home and can turn ON/OFF their appliances which will definitely going to save both the electricity and electric bills.

Other features that can be included in the smart home for security purpose is to include the sensors and cameras that can prevent the intruder from entering into your home. Also, making the system more intelligent, that can turn on the light and fan of the room as soon as it detects the presence of the person.

With this motivation, we develop IoT based home automation system which uses voice as well as web-based service for controlling the home appliance. Also for security purpose, the user-define command are set which enables to operate the system.
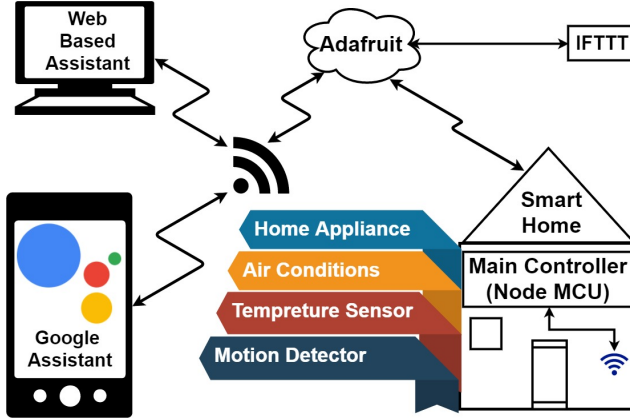

Fig.1. Smart home automation system architecture

III. SYSTEM DESIGN AND IMPLEMENTATION

Speech is one of the most important inputs used for man-machine interaction [32]. Therefore, to make smart home more user friendly, Google assistance along with web based application can be used to control the home system.

The advantage of multimodal is that in the presence of the noisy background surrounding the performance of the Google assistance degrades. Hence, in such scenario web based application can be helpful in controlling the appliance of the system. Thus, the proposed model is designed to provide better flexibility and making the system more robust. Figure 1 shows the general architecture of the smart home automation system.

As shown in the Figure 1 the smart home can be implemented with main controller unit (Main switching of the home circuit) that is connected with the 24-hour available Wi-Fi network. To ensure, that the Wi-Fi connection do not turn off, the main controller is programmed to establish automatic connection with the available network and connected to the auto power backup.

Further, the sub-units are connected with the main controller so that the devices which are not smart (here in this case we are referring to the old home appliance system) can be turned into the smart appliance. Thus, users can access and controlled their smart home using Google assistant and web based service using an IoT based application that uses Adafruit and IFTTT to maintain the communication link.

A. System Requirement

- NodeMcu (ESP8266).

- IFTTT.

- Adafruit.

- Arduino Software (IDE).

NodeMcu (ESP8266) is an open source firmware that provides the flexibility to build the IoT based application [33]. NodeMcu has gained its popularity due to its low cost and Wi-Fi enabled features. It also provides the Nodejs, that require less computation time to perform the task and use Lua script. Thus making the device to operate much faster and making it as a first choice for IoT applications.

IFTTT stands for "If This Then That", is an interface which provide the web based service in which device are connected with the mobile application [34]. Thus, making it much easier for the device to work based on the mobile application using the conditional statements.

Adafruit is a library that supports the MQTT (Message Queue Telemetry Transport) [28], [35]. It acts as an MQTT broker. MQTT is based on protocol service that provide the sending and receiving of the feed data. The advantage of MQTT is that it provides a faster rate of transmission of the data and require less data byte for the connectivity. It requires 80 bytes for establishing the connection between the device to the server and 20 bytes from server to device. Arduino IDE software is used to compile the code [36].

B. Working Models

The working of the smart home automation is shown in Figure 2. As shown, initial requirement is the Internet connectivity to access your smart home. One can access their
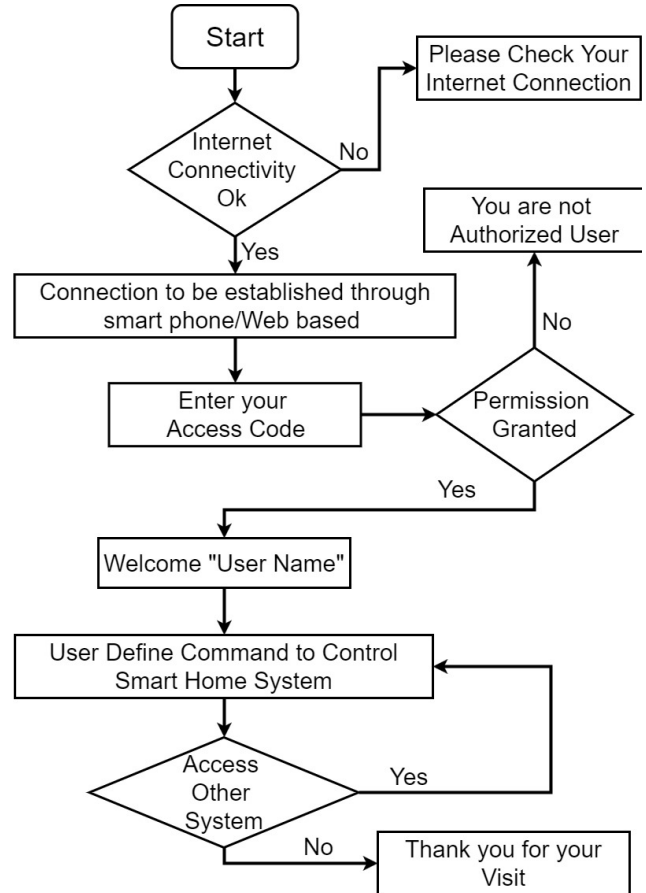

Fig.2. System flow on the smart home automation system using Google assistant
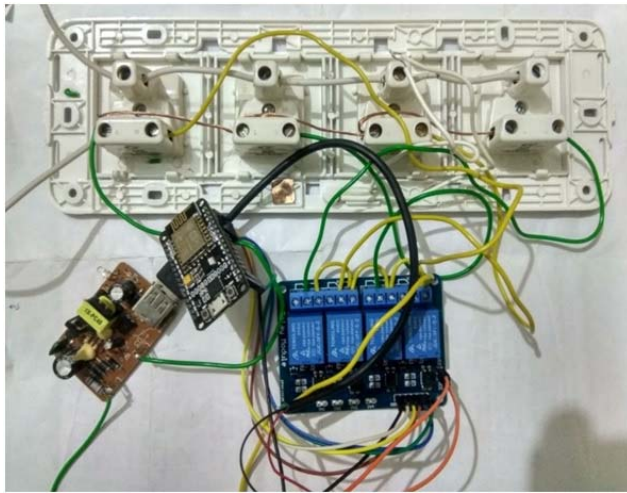
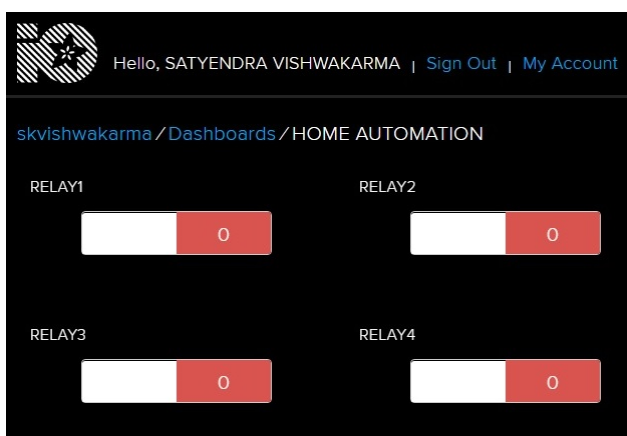Fig.3. Internal architecture of the controller unit

Fig.4. IoT home automation dashboard developed on Adafruit

Fig.5. Prototype model of control unit along with the home equipments

smart home either through the web based service or through Google assistance.

Initially, Google assistant is used for controlling/monitoring our smart home and in case of noisy background home automation can be connected through web based service. For security purpose we have provided the user access code that will be asked by the Google assistant to verify which will prevent unauthorized smart home access.

After successful connection, users will be able to access their smart home appliance using an IFTTT statement command. It will be accessed through the Adafruit for creating the connectivity between the Google assistant and the NodeMcu which is the main control unit of the smart home automation. The home appliance is connected to the main controller unit with the sets of relay. The functions of these relays are to act as an ON/OFF switch on the main control unit.

In this paper we have shown the example of the main control unit that we have designed for your smart home. Figure 3 shows the connection of the main unit with the NodeMcu. For continuous operation of the circuit, power backup is also provided with the help of rechargeable battery. Figure 4 shows the IoT home automation dashboard developed on Adafruit.

Finally, with the help of Google assistant, based on the user command the home appliance can be turned ON/OFF with the help of the designed system as shown in Figure 5. Here, we have shown the example of turning the three bulbs. However, any home appliance can be connected through the proposed control unit.

CONCLUSION AND FUTURE WORK

In this paper, we have presented the step-by-step procedure of smart home automation controller unit. With the help of the design control unit, home appliance can be converted into a smart and intelligent device using IoT. The working of the proposed model was experimentally shown with help of connecting the three bulbs. Proposed system has two advantages. First, using the IoT connectivity, we can monitor and access our smart home easily from anywhere, which will definitely will prove to be energy efficient. Secondly, it act has a helping hand for the old age and differently abled person. For future work we would like to add up more controlling units that can make our smart home more intelligent that can be practically deployed in the real time situation.

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