Smart Home Automation System Using Internet of Things

Urvi Singh
Electrical Engineering Department, Gautam Buddha University, Greater Noida , India
urvisonam@gmail.com

M. A. Ansari, SMIEEE
Electrical Engineering Department, Gautam Buddha University, Greater Noida , India
ma.ansari@ieee.org

Abstract---- Due to the rapid development in the field of the Automation industry, human life is becoming more advanced and better in all aspects. In the present scenario, Automated systems are being preferred over the non-automated system. With the rapid growth in the number of consumers using the internet over the past years, the Internet has become an important part of life, and IoT is the newest and emerging internet technology. Internet of things plays an important role in human life as well as in the educational field because they are able to provide information and complete the given tasks while we are busy doing some other work. In this paper, a prototype and implementation of Smart Home Automation with Wi-Fi technology are demonstrated. ESP8266 is used as a Wi-Fi technology. The proposed system consist of a hardware interface and software interface. In the hardware interface, the integration of ESP8266 Wi-Fi technology for controlling home appliances and sensors is manifested, and an application is provided for controlling to multiple users of home, with smart phones, tablets, and laptops. This system is one of the best methods for controlling home devices with ease with multiple users and one of the best method for an energy management system. The access to the whole system is given by its admin only to different users. This system is also expandable for controlling various appliances used at home and also for the security and safety purpose of the home through sensors as long as it exists on Wi-Fi network coverage.

Keywords---- Smart Home Automation (SHA), Internet of Things (IoT), ESP8266 Wi-Fi Technology, Arduino, Sensors

I. INTRODUCTION

A "Smart Home Automation" system is a system that allows consumers to control various appliance of the

different kind used and also makes controlling of home appliances a very easier and saves energy. Nowadays automation system for home and building are used quite often [1]. On the other hand, they increase the comfort particularly when everyone is busy with their work. "Home automation systems" installed in houses apart from allowing centralized controlling of ventilation , heating, air condition and lighting [2], increase comfort as well.

So, they provide an overall reduction in cost and also useful in saving the energy which is certainly the main problem today. Wired communication forms the backbone of many well established smart home system. But costs are very high for already existing home automation systems. In contrast home automation systems can be of great use for home environment. Also, in the past Wi-Fi system have been used all around [4].

In home networking, Wi-Fi have become more common in current years. There are many advantages of smart homes and building automation systems that do not only use a wired network [5].

The advantages of Smart Home Automation usually fall into the categories, including energy savings, home safety, user convenience, and better control.

The following main attributes of Smart Home Automation are as follows [6]:

a. Energy Savings: Smart light bulbs, fans, and switchboard uses less energy as well as reduces utility cost.

b. Home Safety: Many home automation system provides the best technologies for home security. In order to make home safer and secure users buy these devices. Automated sytem for lighting and sensors detecting motion aid people in entering in a room and walking at night.

c. User Convenient: Home automation provides great convenience to end users as they perform role task autonomously. For instance, you could use sensors indoors for switching on/off lights as required.

d. Better Control: This system provides better control to end users within their home. One can easily know the happenings inside their home with this system.

e. Comfortable Atmosphere: All Connected devices around our home can aid to develop a convenient and comfortable environment by providing reliable lighting temperature and sound.

f. Provide Peace of Mind: This technology may provide consumers peace of mind. The prototype of SHA is depicted in Figure 1.

Fig. 1. Prototype of Smart Home Automation System

II. INTERNET OF THINGS (IoT)

The IOT can connect numerous kinds of things, for example, personal computer, tablets , and smart phones to the internet and also facilitates a new kind of communications between two or more things, or between things and people. Any object with an "IP address" can transmit data over a network successfully because of IoT. Many problems get their solution through internet, which can connect devices even in remote areas. The IoT improves the living standard of life with its inovating ideas. The development of IoT will revolutionise sectors like automation, transportation, health centre, energy and houses [7][8].

In this paper, Wi-Fi technology is used as a Internet of Things. Wi-Fi is a famous wireless networking paradigm and uses radio waves for providing high speed internet. A common mistake is made when Wi-Fi is considered as short for wireless fidelity, but, infact, Wi-Fi simply means IEEE 802.11x. Wi-Fi, as defined by the Wi-Fi alliance, which is an organisation owning the Wi-Fi registered trade mark, is any wireless LAN (WLAN) product based on IEEE 802.11 standards. The different version of Wi-Fi are given by various IEEE 802.11 protocol standards, with the different radio technologies affecting their ranges, radio bands, and speeds achieved. In Figure 2, the general block diagram of working of IOT is shown.

Fig. 2.   Block diagram of working of IoT

III.   SYSTEM ANALYSIS

The SHA system consists of hardware implementation which has the capabilities to control different home appliances of ratings 230V and 5A in users home with the ESP8266 Wi-Fi technology. Along with the controlling of appliances different sensors like PIR sensor, Temperature and humidity sensors and flame sensor along with the GPS and GSM modules are used for home safety purpose as well as home security purpose which can sense the accidental fires, short circuits, etc. The block diagram for the hardware implementation of SHA is shown in Figure 3.
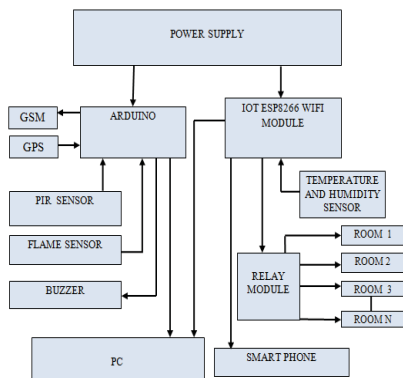
Fig. 3.   Block Diagram for Smart Home Automation System

TABLE.I.   LIST OF COMPONENTS

S.No	Components	Voltage (Volt)	Current (Amp)	Quantity (No.)
1	Power Supply	12V	1A, 2A	2
2	Voltage Regulator	5V	-	2
3	Extension Board	230V	5A	1
4	ESP8266 Wi-Fi Module	3.3V	-	2
5	PIR Sensor	5V		1
6	Temperature & Humidity Sensor	5V	-	1
7	Flame Sensor	5V	-	1

IV.   HARDWARE DESCRIPTION

A.   Power Supply

A power supply is a device which is responsible for supplying power to a load. The basic function of a power supply is to power the load by converting current from source to the valid current, , frequency and voltage. Few power supplies are different standalone parts of equipments, while some are made into load which they power. In the proposed system two separate standalone power supply of rating 12V, 1A is used for GSM and GPS modules and 12V, 2A is used for ESP8266-01 and ESP12 Wi-Fi modules. Figure 4, shows the circuit for power supply of 12V and 1A.
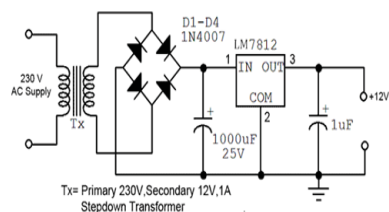
Fig. 4.   Power Supply of 12V, 1A

B.   Relay

A relay is a switch that isoperated electrically. Relays operate a switch mechanically by using an electromagnet, but other working principles like solid-state relays are also used. In order to monitor a circuit by a different low-power signal, relays are used , or when different circuits have to be administered by one signal. 4 input pins of a relay are connected to ESP12 Wi-Fi Module which takes 5V supply from it and can increase up to 10A, 250V supply. The pin description of SPDT relay is shown in Figure 5.
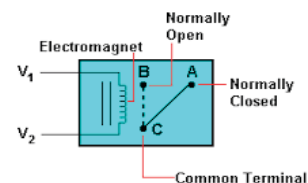
Fig. 5.   Pin Diagram of SPDT relay

C.   Buzzer

A buzzer is used as an audio signalling device. It may be mechanical, electromechanical, or piezoelectric type. Mainly these are used as buzzers or beeper for confirming the user's input such as it can be used with PIR motion sensor and beeps when motion is found outside the home.

D.   PIR Motion Sensor

A PIR Motion Sensor is "Passive Infrared Sensor" which is used in the system. It is an electrical sensor that senses infrared (IR). They are generally used in detecting the motion by PIR based motion detectors. Figure 6, shows the working diagram for PIR sensor.
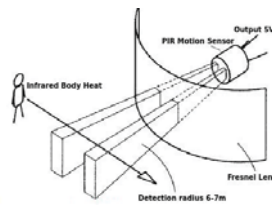
Fig. 6.   PIR Motion Sensor Working

E.   Temperature and Humidity Sensor

DHT11 Temperature and Humidity Sensor is used in the developed system. It has a calibrated digital output signal with capability of temperature and humidity sensor. It has a supply voltage of 5 V, the temperature range of 0-50 °C error of ± 2 °C and humidity of 20-90% RH ± 5% RH error. The pin description of the sensor is shown in Figure 7.
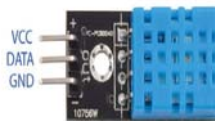

Fig. 7.   DHT11 Temperature and Humidity Sensor

F.   Flame Sensor

The flame sensor finds infrared light sources and flame having wavelengths in the range of 760 nm to 1100 nm. The flame sensor can be used in fire alarms and other devices detecting fire. Figure 8, shows the pin diagram of the flame sensor. Figure 8, shows the pin description of flame sensor.
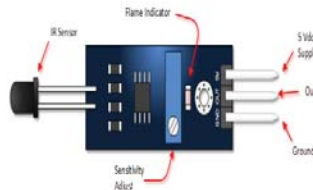

Fig. 8.   Flame Sensor

G.   Voltage Regulator

A voltage regulator which maintains a fixed voltage level automatically is used in this system. A voltage regulator may use a negative feedback or a simple feed-forward design. It may use electronic or an electromechanical mechanism. Based on the design, it can be used to operate one or more AC or DC voltage. The pin description for 7805 voltage regulator is shown in Figure 9.
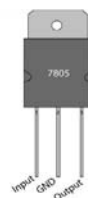

Fig. 9.   7805 Voltage Regulator IC pin diagram

H.   ESP8266 Wi-Fi Module

The ESP8266 Wi-Fi module which used in this system is depicted in the Figure 10. This Wi-Fi module is connected to the internet for making our home smart by the use of the Internet over the cloud server. The different pin diagram of Wi-Fi module is shown in Table 1.
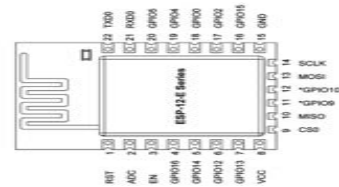

Fig. 10.   Pin Diagram of ESP12 Wi-Fi Module [17]

TABLE.II.   PIN DESCRIPTION OF ESP8266 WIFI MODULE

Pin No.	Pin Names	Usage
1	Ground	Connected to the ground of the circuit
2	Tx	Connected Rx pin of the microcontroller
3	Rx	Connected Tx pin of the microcontroller
4	GPIO4	General purpose pin for input/output
5	GPIO5	General purpose pin for input/output
6	Reset	Resets the pin
7	Vcc	Connected to 3.3V
8	CH_EN	Chip Enable-Active high
9	GPIO12	General purpose I/O pin
10	GPIO13	General purpose I/O pin

I.   GSM and GPS

GSM is Global System for Mobile communications and GPS is Global Positioning System. GSM is a network, in which cell phones connect by finding the cells in the closest vicinity. In this system GSM along with the GPS is used for home safety purpose. GPS is a satellite-based system for radio navigation. The users are not required to transmit any data in GPS, and it operates independently of any internet or telephonic reception, though these techniques can increase the use of the GPS information.

V.   SOFTWARE DESCRIPTION

In the presented system different Software for programming and controlling of Smart Home Automation is used. IDE which stands for the integrated development environment is an open-source software which is used for writing program and also for uploading code into Arduino and ESP8266 Wi-Fi Module. An application named "Smart Home Automation" is created using ESP8266 and blynk app which provides a platform for controlling purpose. This will only work if the system is connected to Wi-Fi. The flowchart is shown in Figure 11 for Smart Home Automation application.
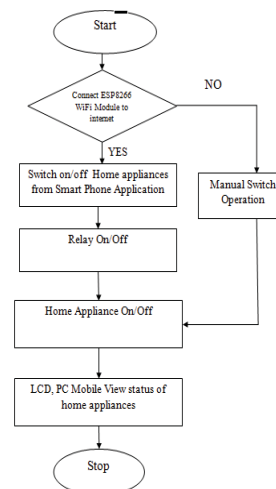

Fig. 11.   Flowchart for home automation system

VI.   IMPLEMENTATION SETUP

The implementation for the SHA system is shown in the form of hardware. The implementation setup of SHA system consists of different hardware modules which are connected through ESP8266 Wi-Fi Module and Arduino microcontroller for controlling home appliances as well as for home safety and security purpose through accidental fires, short circuits, etc. In Figure 12, the charging of mobile is depicted with the help of the AC adapter which is done with the aid of relay and Wi-Fi module along with the mobile application. The whole hardware setup is divided into three cases. In the first case home automation with ESP8266 Wi-Fi is shown. In the second case temperature and humidity reading with IOT is shown. In third case fire alert with GPS location for fire, short circuit and overvoltage is shown.
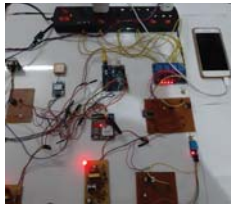

Fig. 12. Hardware Implementation of Proposed Smart Home Automation System

VII. RESULTS AND DISCUSSION

The whole SHA system hardware setup can be divided into three parts for better understanding which are described in the form of different cases below. In case 1, the controlling of home appliances is discussed. In case 2, climate controls of home is discussed and in the last case i.e. in case 3, security of home is discussed.

CASE I: Controlling of Home Appliances

The hardware implementation of the system using ESP8266 Wi-Fi module is depicted in Figure 13, which shows switching of different home appliances of ratings 230V and 5A with easy access and control to multiple users from all around the whenever its need is required. This provides the advantages of home automation system completely. Smart lighting switching, and controlling can aid in making efficient use of energy by automatically switching off/on, when required.
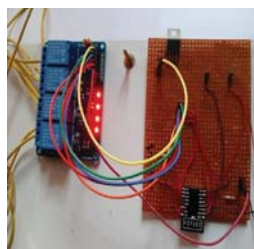

Fig. 13. The hardware setup of Smart Home Automation with Wi-Fi Connection

The result of this system is obtained by using the smart-home automation application using blynk app. The interface of smart home automation using blynk application is shown in Figure 14. In this switching of lights of different room, lights are depicted. This switching can be done from anywhere from the home as well as from the outside of them until the system is connected to wifi through the internet.

(a)   (b)

Fig. 14. Smart Home Automation app using Blynk app using a smart phone, (a)When all the lights of the Rooms are OFF and (b) When all the the lights of the Rooms are ON.

Figure 15, shows the link which shared with users for controlling home appliances from all around the home and outside. This way the energy consumption of home also can be controlled. It can also be shared easily with multiple users but its access is given only to users of the home so that it works efficiently.
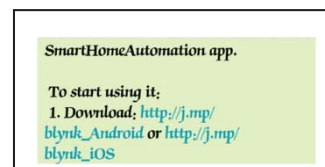

Fig. 15. Link of Smart Home Automation shared with other users

CASE II: Climate Controls of Home

In Figure 16 the temperature and humidity sensor with a Wi-Fi connection is depicted. This Wi-Fi connection is used with humidity and temperature sensor so that the home condition can be easily checked. It is also useful in energy management system. A humidity sensor measures, senses and reports both air temperature and moisture. This is very helpful in creating a database for future analysis of the home condition.
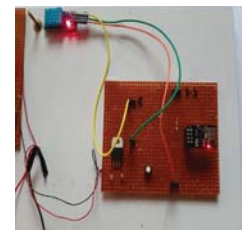

Fig. 16. Temperature and Humidity sensor with Wi-Fi Connection

Figure 17 and Figure 18 depicts the graphs of temperature and humidity versus time of home atmosphere of a single day and at a specific time duration which gets updated as the humidity and temperature of room changes. These graphs data are taken with the help of DHT11 temperature and humidity sensor and send to the internet for further data. With the help of these data, the occupants of a home can analyze the home environment from anywhere around and take the necessary steps whenever required. This is both cost-saving and energy saving, and it also aids one to stay on top of the life when one goes to the office in the morning without thinking anything else apart from just arriving to work on time.
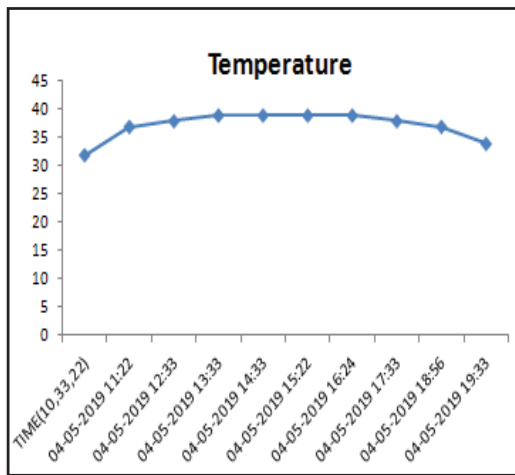
147

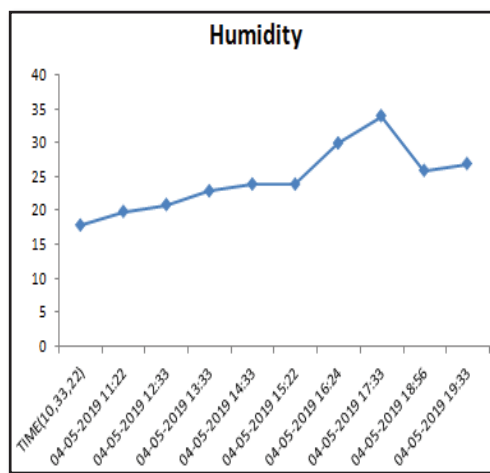Fig. 17.   Graph of Temperature Vs Time of home atmosphere

Fig. 18.   Graph of Humidity Vs Time of home atmosphere

Figure 19 and Figure 20 shows the database for temperature and humidity sensor for the smart home. Here DHT11 Temperature and humidity sensor are used for measurement. The DHT11 temperature ranges bewteen 0 to 50 degree Celsius with accuracy of +/-2 degrees and the DHT11 humidity % range is from 20 to 80 with accuracy of 5%. These data can be accessed from anywhere around through internet. These data are useful for future analysis. Hence, sensing, measuring, monitoring and controlling humidity and temperature is a very important task which is mentioned below in the database.

Fig. 19.   Database for Temperature Sensor

Fig. 20.   Database for Humidity Sensor

CASE III: Security Of Home

Figure 21 execute the PIR sensor setup with the help of buzzer for the safety purpose of the home. With the help of PIR motion sensor which is Passive Infrared sensor has a Fresnel lens which detects the motion of an object outside the home. Therefore, it is very useful for home safety purpose. A PIR-based motion sensor is used to detect the movement of animals, people or other objects.

The PIR motion sensor uses a small buzzer of 3.3V which beeps whenever the motion is detected outside the home with the help of PIR motion sensor in the range of 3 to 7 meters. In figure 20 the working of Flame sensor is also shown with the help of GSM which is Global System for Mobile communications and GPS which is Global Positioning Systems are used for home security and safety purpose.
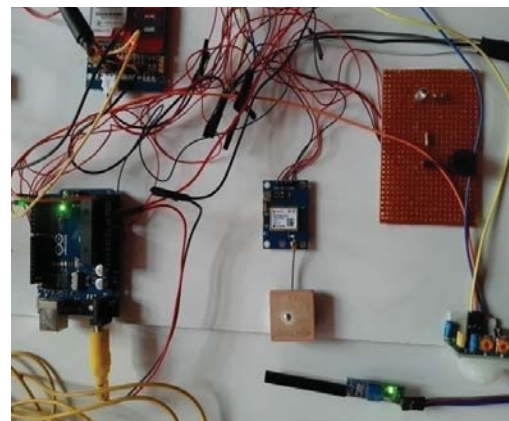

Fig. 21.   The hardware setup for home security purpose

Figure 22, shows the message on mobile phone which we will get in case if fire accident occurs in our home with the help of flame sensor and GSM and GPS modules within the range of 760 nm to 1100 nm. In the message, we are getting a message of latitude and longitude of a home where the accident has occurred. Longitude and latitude define a particular location through geographical coordinates when used together. These coordinates are what the Global Position System or GPS provides with an accuracy.With the help of this information, the fire brigade can easily find the place over the internet and reach the home as soon as possible.

Fire Alert: Aleart Location is:
Latitude:28.715217
Longitude:77.108283
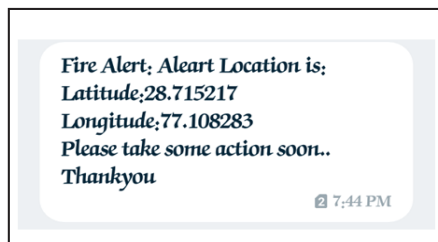Please take some action soon..
Thankyou
7:44 PM

Fig. 22.   Message on mobile phone with the help of GSM and GPS modules

VIII. CONCLUSION

The SHA has been working satisfactorily by using the ESP8266 Wi-Fi module and internet over mobile phones, tablets, and laptops. Also, the system is not only used in controlling of home appliances but it is also designed for monitoring purpose which is done with the help of the sensor used in it for safety and security purpose. So, in this way, it presents a prototype and implementation of "smart home automation" using Wi-Fi technology over mobile phones, laptops, and tablets. This whole system can be extended for controlling many other appliances of the home by using Smart Home Automation application and ESP8266 Wi-Fi module and data which are obtained with the help of sensors can also be expanded for monitoring purpose as well as for safety purpose of the home by analyzing over the internet for future improvements.

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