IoT Based ıntegrated smart home automatıon system

*****Eng. N. Satheeskanth[1], Marasinghe S.D[2], R.M.L.M.P Rathnayaka[3], Eng. A. Kunaraj[4], Eng. J. Joy Mathavan[5]

[1,2,3,4,5] Faculty of Technology, University of Jaffna.

[1]sathees117@gmail.com

[2]sakunsinghe@gmail.com

[3]lalithamadhusanka7@gmail.com

[4]kunaraj12@gmail.com

[5]joymathavan1991@gmail.com

Abstract. The comfort of human in home can be categorized under several types. Among these categories, the most significant ones are the thermal comfort, which is related to ambient temperature and humidity, followed by the visual comfort, related to room's colors and lightning, and hygienic comfort, associated with air quality. All these conditions can be monitored within the acceptable range using home automation system. Automation can be accomplished using the Internet of Things (IoT). This gives the inhabitant accesses to certain data in the house and the ability to control some parameters remotely. This paper presents the complete design of an IoT based sensing and monitoring system for a smart home automation. This system use NodeMCU-ESP8266 microcontroller board for wireless communication, to provide the user with remote control of various appliances within their home and to store the data in the server.

Keywords: NodeMCU-ESP8266 Microcontroller, arduino, smart home, home automation, IoT.

1 Introduction

The concept of "automation" has existed for many years. Home automation has become more beneficial because of its safety features and security reasons. Nowadays, home automation became more advanced and precise to monitor all the home appliances. Home automation system has become an energy efficient and highly approachable smart home technique. It involves basic features to maintain the user satisfaction and comfort. The project aimed at designing an advanced home automation system using normal web server and Wi-Fi technology. The devices can be switched ON/OFF and sensors can be read using a Personal Computer (PC) through Wi-Fi. Automation is the most frequently spelled

term in the field of electronics. The hunger for automation brought many revolutions in the existing technologies. To utilize the connectivity of internet, an advanced Wi-Fi automation system was developed to control the appliances in the house.

This proposed system is a precise combination of smart phone and PC which includes NodeMCU-ESP8266 microcontroller board, Wi-Fi module and relay circuit. The controlling device for the automation in the project is an Arduino NANO. The data sent from PC over Wi-Fi will be received by NodeMCU connected to Arduino NANO. Arduino NANO reads the data and decides the switching action of electrical devices connected to it through relays. This Home automation system has two modes, automatic control and manual control. These features are related to the electrical energy consumption at unwanted times. LDR sensors and the PIR sensors are used here to de-energize appliances when the user doesn't respond to the appliances that are energized and not being used for a particular time period. In this home automation system, multi-user access is allowed with the security.

In auto mode, the relay module controlled by the DHT11 sensor, PIR sensor and LDR. This system can check the temperature, humidity and the gas level inside the house. Users can control the room temperature based on the identified temperature and the preferred temperature can be set accordingly. When the actual temperature reaches the pre-defined temperature, the temperature conditioning appliances start working. If the gas level increase inside, it will be indicated on the panel board and the buzzer will alarm. The block diagram of proposed home automation system is shown in Fig 1.

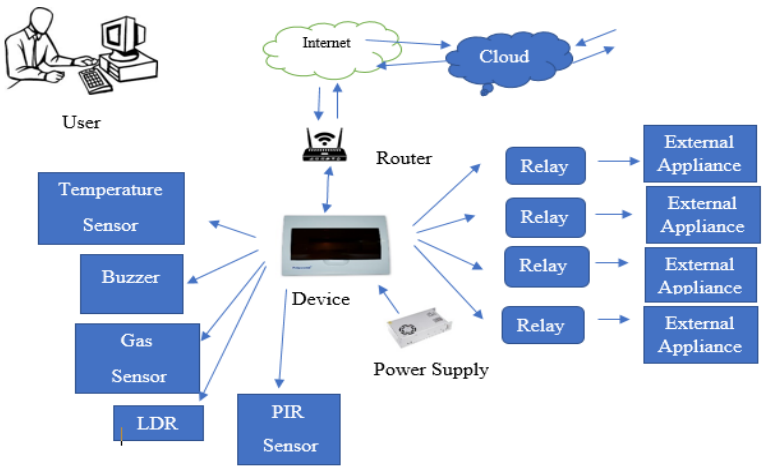

Fig. 1. Block diagram of the home automation system

2 Literature review

A smart home automation control using Bluetooth and GSM module was proposed in the research work of A. A. Zaidan et al., in which Bluetooth and GSM module is used as communication and security protocols in IoT based smart home applications [1]. J. Chhabra and P.Gupta proposes additional security measures using voice control for authorization of home automation [2]. Later, S. Badabaji and V. S. Nagaraju came up with an IoT based home automation system using microcontroller LPC2148 and GSM module which is quite expensive for deployment in domestic environment [3]. E. N. Ganesh in his research used Bluetooth and GSM wireless communication methods to control the home automation systems through web based applications [4]. In his research, Bluetooth was used to control the indoor appliances and GSM to control the outdoor appliances. Bluetooth can reduce system costs since most cell phones and laptops have this as built-in application. Users can monitor and control the appliances from remote places by sending SMS through GSM. However, such a system has limitations in two cases. Bluetooth has a limited range and data rate, and GSM is expensive because of SMS costs need to be beared by user [5]. Smart home automation based on sensor technology can automatically control home appliances using android-based smartphones as a remote controller. Here, Raspberry-Pi is used as the microcontroller and bluetooth is used as the communication protocol. Wi-Fi is used to connect the smartphone to the Raspberry Pi controller, which is connected with household appliances in the same network. All sensors update their data to a local server via Raspberry Pi. However, in this method, user cannot access the server and directly use the android mobile to send the commands to the Raspberry Pi controller outside the range of Wi-Fi [6][7]. A home automation and environmental monitoring system developed using Arduino Mega 2560 microcontroller along with Bluetooth module is proposed by D. Anandhavalli et al [5] and using RFID for the same purpose is proposed by D. M. Konidala et al [8]. Several sensors and switches were used to control home appliances through websites or Android applications. The website controls Arduino by passing information to it as instructions as described by N. David and et al in their reserch work [9]. Arduino Mega is more expensive than NodeMCU, and the use of Bluetooth is unsuitable for Smart Home applications due to its limited range. R. K. Kodali and S. Soratkal analyzed about Message Queuing Telemetry Transport (MQQT)-based home automation system using WiFi module ESP8266 [10]. Actuators and sensors were connected to ESP8266, and MQTT was used for controlling and monitoring home automation appliances. Wi-Fi was used as the communication between the prototype and devices and the devices were controlled by MQQT using WiFi module ESP8266. Arduino IDE was used to program the ESP8266 module as MQTT which is resulted in low bandwidth and low power consumption. The reason behind the selection of ESP8266 board was, it is cheaper than other microcontrollers, like Raspberry Pi or Arduino UNO. However, the only drawback with this system is, while switching, safety and security measures were ignored, and the developed system was not validated.

3 System description

The system consists of different sensors like temperature, gas, PIR and LDR. Initially the system connects to the internet through Wi-Fi. Once the connection is established, it starts reading the parameters of sensors. The threshold levels for the required sensors are set. The sensor data are sent to the web server and stored in the cloud and also displayed on the LCD screen. The condition of the house through the obtained data can be analyzed anywhere, any time. In the proposed system, the temperature and cooking gas leakage in the house is being monitored and the data thus obtained are stored in cloud for analysis and also it is displayed in the LCD and in the web user interface. If the temperature exceeds the pre-defined threshold level, the cooler turn ON automatically and it turns OFF when the temperature is back to the predefined value. Similarly, when there is a leakage of gas in the house, alarm is turn on alerting the user about the leakage. The presence of the humans are detected using the PIR motion sensor. The system turn ON the bulbs when the presence of human is there and turn OFF when the person is away. LDR is also integrated in the system. In case if the user forgets to turn OFF the outdoor lights in the morning, it'll switch OFF automatically. The dimmer circuit is provided to reduce the light intensity of the room according to the requirement of the user. The speciality here is, the light intensity can be controlled via internet or mobile from a distance. The user can also monitor the electric appliances through the internet via web server. If the lights or any electrical appliances are left turned ON in hurry, it can be seen and turned off from anywhere by typing the IP address of the web server.

3.1 Motion detection system

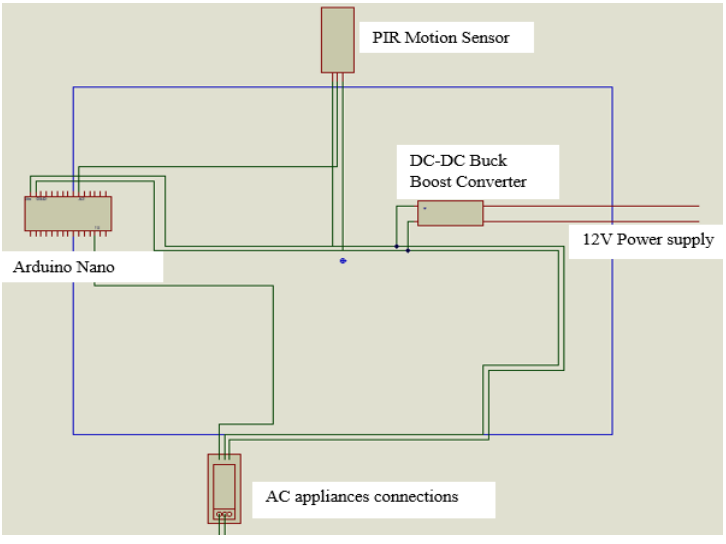

Fig.2. Motion detection system

PIR based motion detection sensors are used here as shown in Fig. 2. Humans can generally emit thermal energy with wavelength around 9-10 micro-meter every day [11]. This sensor is designed to detect these wavelengths and operate accordingly. When a person enter into the room, the PIR sensor, a motion detector divides the rays into two slots. When a person enter into the room, then differential change occurs in the sensor. Due to this change, the sensor identifies the person entered into the room and sends notification to the web server.

3.2 Temperature and Humidity monitoring system

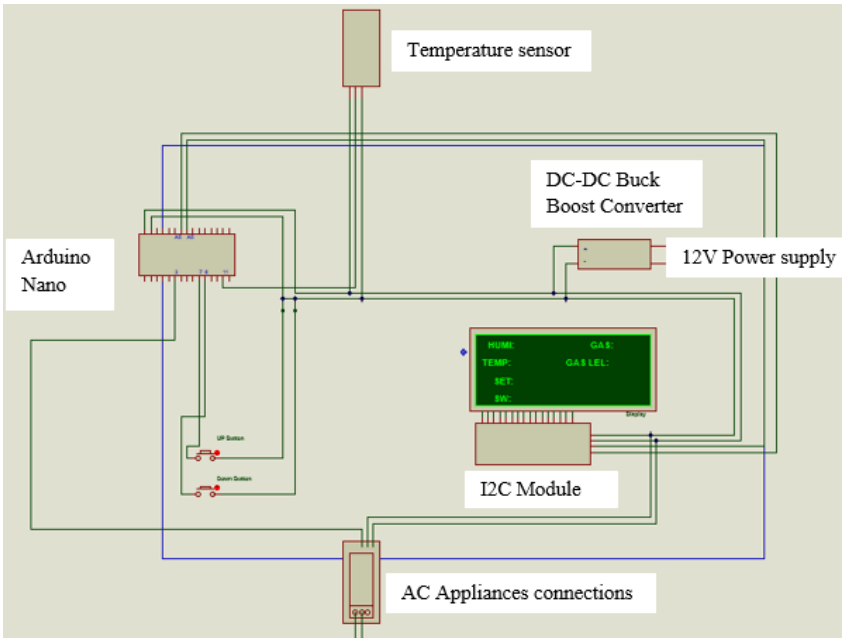

Fig.3. Temperature and Humidity detection system

DHT-11 Temperature and Humidity sensors are used here to monitor the temperature and humidity of the system as shown in Fig. 3. These sensors read the ambient temperature and humidity respectively and relay the data to the microcontroller as digital data [8]. According to the obtained data, if the temperature is high than the pre-defined value, the air conditioner will start automatically. The data pin of temperature and humidity sensor DHT11 is connected to pin A0 of the Aurdino Nano board. VCC and ground of DHT-11 temperature and humidity sensor is connected to the common VCC and ground of Aurdino nano board. Once the air conditioner is ON and when the temperature of the room reaches the pre-defined value, the air conditioner turns OFF automatically.

3.3 Gas leakage detection system

Gas sensor can detect LPG (Liquefied Petroleum Gas), smoke, alcohol, propane, hydrogen, methane, and carbon monoxide concentrations between 200 to 10,000 ppm (parts-per-million) [12]. MQ2 smoke sensor is used here for the detection of any gas leakage as shown in Fig. 4. It is connected to pin A0 of the Aurdino Nano board. VCC and ground of MQ2 smoke sensor is connected to the common VCC and ground of Aurdino nano board. If the gas level is high, the system detects the level of gas and ring the alarm so that the house owner can understand the situation and act accordingly.

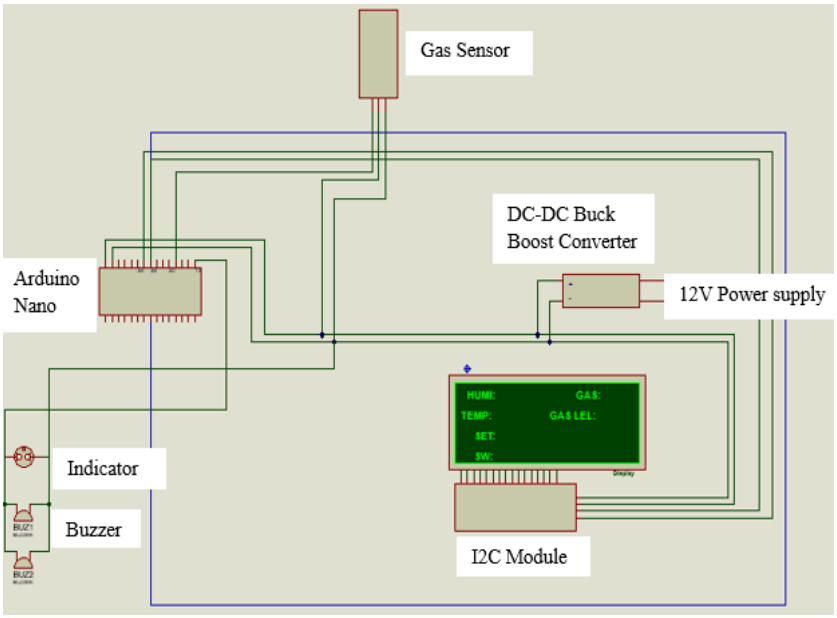

Fig.4. Gas leakage detection system

3.4 Automatic Daylight power saver system

A photoresistor (or light-dependent resistor, LDR, or photo-conductive cell) is a light-controlled variable resistor. The resistance of a photo resistor decreases with increasing incident light intensity. A photo resistor is made up of a high resistance semiconductor. In the dark, a photoresistor can have a resistance as high as several mega ohms (MΩ); while in the light, a photoresistor can have a resistance as low as a few hundred ohms. LDR sensors are used here to switch ON the lights when there is darkness.

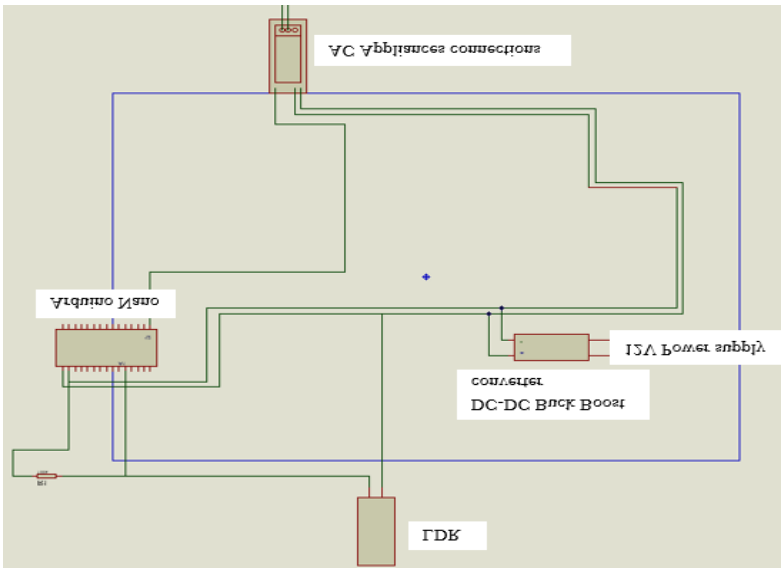

Fig. 5. Automatic daylight power saver system

3.5 Device control system

In this project, the relays are used to provide connection between two or more points in response with the input signal. It is connected to the fan and bulbs that acts as output. Relays are used in many applications because of their relative simplicity, long life and proven high reliability. Their function is to protect, regulate and control the power. The relay module is operating at around 5V level. Relays are used to operate the appliances.

3.6 Authentication interface system

The central server can be accessed by the user authorized by the “user name” and a “password”. Central server provides the user with the necessary data storage in the database. Upon gaining access to the central server, based on the information given, the user can then make queries or send commands. The IoT devices usually have an authentication method, it can be used for user administration or it can be used to connect the device to a central controller. When the user enters the correct information, it is directed to open the web page. On this web page, the appliances in the house can be controlled. They can be monitored, turn ON or OFF based on the desire of the house owner depending on the sistuation of the house. The passwords can be tried until the correct password is entered. The user name and password can be changed as like any other device. Authentication is required as shown in Fig. 6.

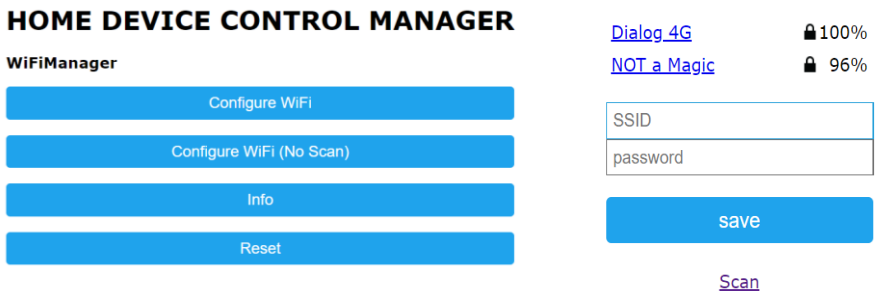

Fig. 6. Authentication interface

3.7 User interface

The appliances like fan, lights and any other loads are connecteded to the NodeMCU modules. NodeMCU modules is used here for easy portability, since complete wiring of the home cannot be done for automation. Nodes are distributed in the rooms to manage the appliances available in each room in parallel. The control of relays is done through the control panel. Appearance of control panel in the software is shown in Fig.7.

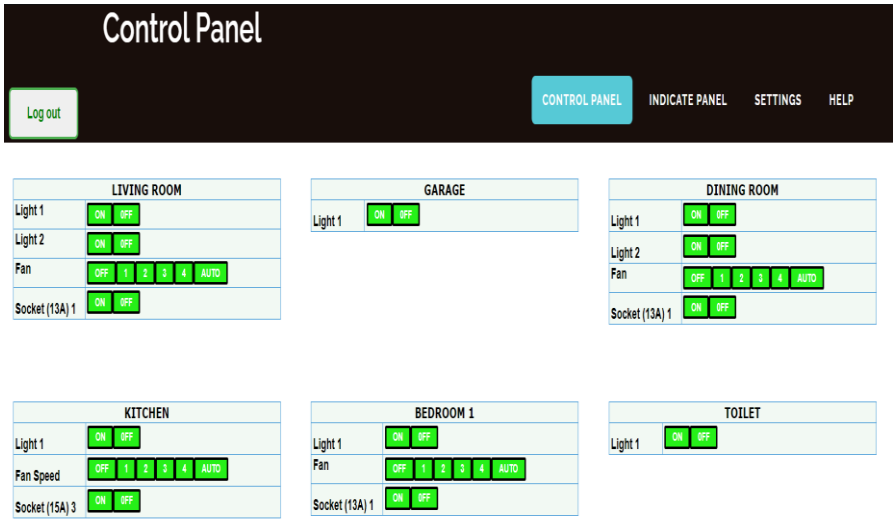

Fig.7. User interface

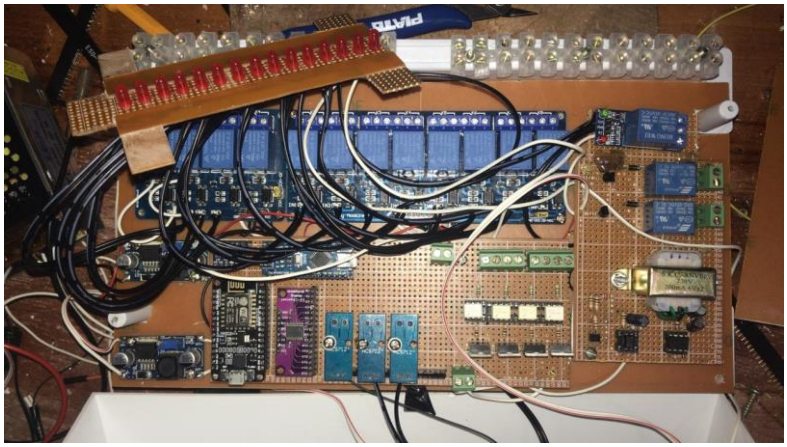

Fig. 8. Hardware implementation

Fig. 9. Final hardware of the product

Fig. 10. Front view of the final device

4 Conclusion

The IoT based home automation system was developed and tested where household appliances can be controlled using the designed online application. The hardware of the system is shown in Fig. 8 and fnal product is shown in Fig. 9 and Fig. 10. The user is connected to the same network as the module and due to this, the exchange of signal takes place frequently. This gives users the ability to automate their home. In this paper, motion detection system, temperature and humidity monitoring system, gas leakage monitoring system and lighting control system are added and tested, considering they are the prime targets for a comfortable and safety living of an average human. The proposed design of the smart home is very flexible and can be easily expanded and applied to larger buildings by increasing the number of sensors, measured parameters, and control devices. Many advancements can be added to this system, like adding motor to control window drapes, fire sensor to prevent mishaps etc. More functionality and smartness could be also added to the existing system for making the house automation system grow, adapt, and evolve by itself using advanced artificial intelligence.

5 References

1. A. A. Zaidan, B. B.Zaidan, M.Y.Qahtan, O.S.Albahri, A.S.Albahri, Mussab Alaa, F.M.Jumaah, Mohammed Talal, K.L.Tan, W.L.Shir, C.K.Lim ‘‘A survey on communication components for IoT based technologies in smart homes,’’. Telecommun. Syst., vol. 69, no. 1, pp. 1–25 (2018).
2. P. Gupta and J. Chhabra. ‘‘IoT based Smart Home design using power and security management", International Conference on Innovation and challenges in cyber security (2016)
3. S. Badabaji, V. S. Nagaraju. ‘‘An IoT based smart home service system", International journal of pure and applied mathematics volume 119 No.16 pp.4659 - 4667 (2018.)
4. E. N. Ganesh, ‘‘Implementation of IOT architecture for SMART HOME using GSM technology", International journal of computer techniques Volume 4 Issue 1 (2017)
5. D. Anandhavalli, Noorul S.Mubina, Bharathi.P “Smart home automation control using Bluetooth and GSM", International Journal of informative and futuristic research pp 2547-2552 (2015)
6. Labus, B. D. "A smart home system based on sensor technology" Facta Universitatis, Electron. Energetics, Vol.29 No.3 pp.451 - 460 (2015).
7. M. L. Sharma, Sachin Kumar, Nipun Mehta ‘‘Smart home system using IoT", International research journal of engineering technology vol.4 issue 11(2017).
8. D. M. Konidala, ‘‘Security frame work for RFID-based applications in smart home environment,’’. vol. 7, no. 1, pp. 111–120 (2011)
9. N. David, Abafor Chima, Aronu Ugochukwa, Edoga Obinna “Design of a home automation system using arduino", International journal of scientific and Engineering research , Volume 6, Issue 6 (2015)
10. N. Kodali, and S. Soratkal ‘‘MQTT based home automation system using ESP8266", IEEE region 10 Humanitarian technology conference (2016).
11. Fatma vatansever and Michael R. Hamblin,"Far infrared radiation (FIR): its biological

effects and medical applications", US National Library of medicine, National institute of health.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3699878/

12. Kumar Keshamoni, Sabbani Hemanth. "Smart Gas Level Monitoring, Booking & Gas Leakage Detector over IoT" International Advance Computing Conference IEEE. (2017).