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Smart Home Controlling System

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Abstract: To minimize the need for human involvement, increased security and improved energy efficiency, a smart home control system can be integrated into current household appliances. The main objective of this project is to develop a home automation system as technology is advancing, therefore houses are also getting smarter. The proposed prototype of home automation in this study allows users to turn on or off any household equipment remotely via the Internet of Things (IoT). This paper presents a low cost and flexible home control and monitoring system using microcontroller, with Arduino Uno board connectivity for accessing and controlling devices and appliances remotely using BTDisplay app. All the basic appliances at home can be controlled by user from mobile device. The user will also be notified in any change if it goes beyond their given range. All the hardware, software and test fields design are discussed in this paper.

Keywords: Smart Home Controlling System, Internet of things (IoT), Proteus Software, Arduino, BTDisplay Application

1. Introduction

Human machine interaction (HMI) has become more realistic day by day due to the advancement of the technology [1]-[3]. In this day, HMI research have moved a step ahead and switched onto the Internet, which previously used for communication and now it being used for things like the IoT (Internet of things) [4]-[6]. The aim of this application is to connect any things through wirelessly 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, Ecommerce [7], Coal Mine [8], Wearable device [9], Smart Grid [10], Laboratory Monitoring [11], Agriculture [12] and many other domains [13] – [16].

This project is an IoT based project which use BTDisplay [9] that is a one type of IoT platform to connect various hardware devices to the cloud, design apps and to control the home lighting by give a command through this application in a mobile phone.

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 by giving the information to the user when he leaves their home with lights left on and allow them to control the on or off light wirelessly.

2. Steep Analysis

As the demand for electricity grows by the day, smart homes are the upcoming area of research to provide remote access for controlling home appliances [17]– [20]. IoT-based applications have also boosted the lives of the elderly and

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people with disabilities [9], [25]. This allows the user to control the home automation device such as fan, bulb etc., without even making any physical connection.

The results of a study on a home automation system have been reviewed in [17], [19], [20], [22]– [24]. The majority of previous systems based on these techniques are either DTMF or Bluetooth systems [9], [17], [22], [23], [25]– [27]. The fundamental issue with DTMF-based home automation is the need for a dedicated PSTN channel for communication between main supply units and controlling devices. On the other hand, Bluetooth is useful for short range communication that requires the operating appliance in their range.

IoT has provided applications that convert non- smart devices into smart devices, allowing users to access these devices via the Internet. It transforms the house into a smart house and provides a more robust method of controlling home appliances. In addition, security can be increased by installing a camera in the home that can be tracked via the Internet. As a result, users can monitor their homes and turn on/off their appliances, saving both electricity and money on their utility bills.

Other security features that can be included in a smart home include sensors and cameras that can prevent intruders from entering your home. In addition, to make the system more intelligent, it can turn on and off the room's light and fan without even to be at home.

With this motivation, the created IoT-based home automation system uses Bluetooth services to control home appliances. In addition, for security reasons, only the owners of this system are set, allowing the system to be operated.

3. Engineering Design

Internet of things provides us with a lot of new technology which would turn the cities into smart cities and all the things can be controlled remotely. These new technologies can decrease the power consumption in home by remotely control the appliances which turns the lighting on or off automatically. This system will include a home light controller (Arduino Uno board) which will control the entire system. The Arduino Uno board will be connected with wireless module, Bluetooth module and types of components that essential to ensure the system perform efficiently. The entire data will then eventually be transmitted through the wireless module over to a specified server. The home lighting can also be manually turned on and off if ever needed. This work is accomplished with the proper arrangements of the microcontroller Arduino Uno, Bluetooth Module, 1k ohm resistor, 2n2222 transistor and relay module.

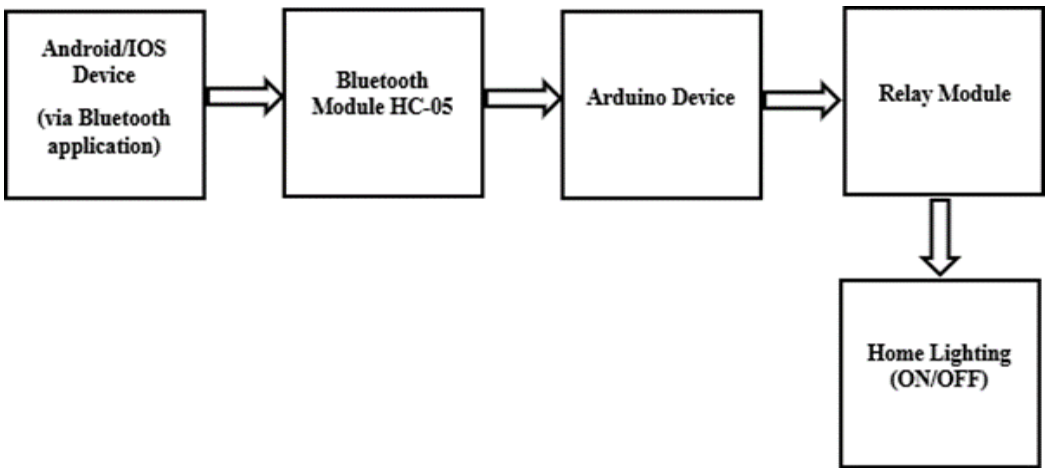


Fig. 3.1 - Block diagram of Smart Home Controlling System

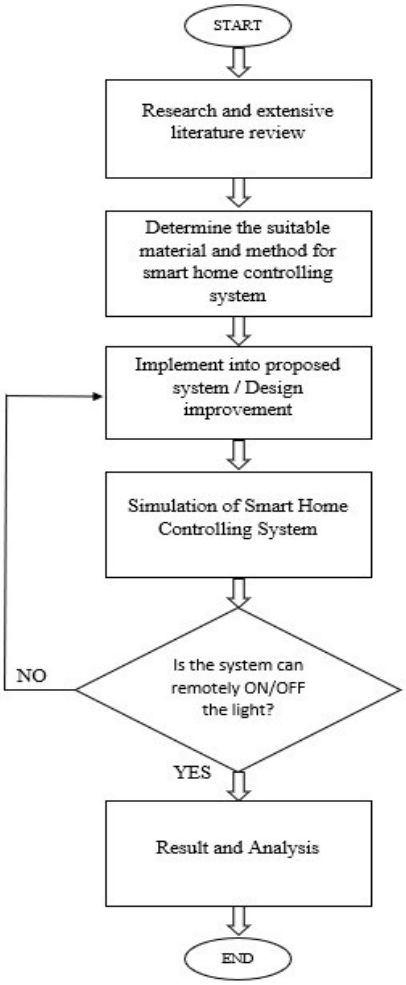


Fig. 3.2 - Flowchart of the project

3.1 Proteus Software

Proteus is a complete development platform from product concept to design completion. Its advantages are intelligent principle layout, hybrid circuit simulation and accurate analysis, single-chip software debugging, single-chip and peripheral circuit co-simulation, PCB automatic layout and wiring. Proteus have huge list of components and many libraries available which can be added to include more components. For this project, the used of microcontroller like Arduino Uno are used and the coding that have been set need to install into the Arduino Uno in the Proteus software. It is being used for fast check-up of coding that have written in Arduino IDE into the Arduino Uno from the Proteus simulation. The design of smart home monitoring system is developed and simulated in this software to show exactly the process on how to control home lighting remotely.

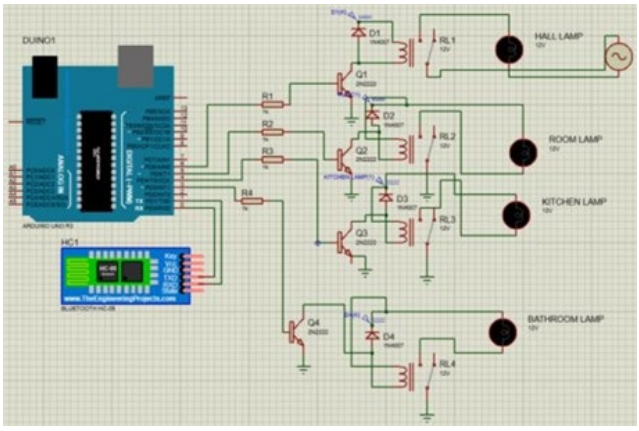


Fig. 3.3 - Design of smart monitoring system in Proteus Software

3.2 Arduino IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application for Windows, macOS or Linux that is written in functions from C and C++. It is used to write and upload programs to Arduino Uno compatible boards with help of the other software such as Proteus. The coding needs to verify before upload it into the Arduino Uno. If there are any errors in the Arduino code a warning message will shows up prompting the user to make changes regarding to the error. For this project, the coding that have been written and verify in Arduino IDE need to be uploaded to the Arduino board in the Proteus software in order to make the system working as remotely control to turn ON or OFF home lighting. The coding that has been verify will generate “hex. File” and it will be uploaded in the Arduino board.

Fig. 3.4 - Arduino IDE software

3.3 BTDisplay Application

The BTDisplay app is a well-designed interface builder for the Internet of Things. It can control hardware and software remotely that are connected with Bluetooth. BTDisplay application is connect to the Bluetooth HC-05 Module that is connected to Arduino board and text or command can be sent directly to the terminal of Arduino Uno. With this application, used of voice command can be utilized by clicking on “listener” button and it converts the voice input into text and forwards it to Arduino Uno terminal. By clicking on the speaker so that the AI can read out the text written inside the text box and also can translate language by clicking on language selection or auto forwarding of text when using voice input. For this development, the Bluetooth HC-05 Module is used as intermediary communication device for BTDisplay app in mobile phone to the Arduino Uno in order to control the home lighting remotely.

Fig. 3.5 - BTDisplay application in mobile phone

3.4 Microcontroller

There are various microcontrollers available that being applied in the smart lighting system for home automation. The microcontroller is developed with their own advantages and disadvantages relative to each other's. Application of these microcontroller must be considered separately to fulfil the stated objective for development of the particular system. The Arduino Uno is a microcontroller board with an integrated development environment (IDE) for creating, compiling, and uploading codes to the microcontroller. It is based on ATmega328 series controllers. These systems provide sets of digital and analog I/O pins that can interface to various expansion board and other circuits. It has 14 digital input and output pins (of which six are pulse width modulation (PWM)) and six analog inputs for communication with the electronic components such as sensors, switches, motors, and so on. It also has 16 MHz ceramic resonators, a USB connection jack, an external power supply jack, an ICSP (in-circuit serial programmer) header, a reset button, GND pins (for grounding), and 5 V pin (for supplying 5 volts). Its operating voltage is 5 V, with an input voltage 7 to 12 V (limit up to 20 V).

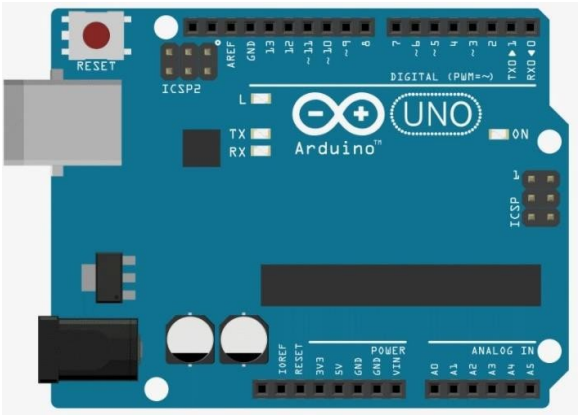


Fig. 3.6 - Arduino Uno board

3.5 Bluetooth HC-05

The HC-05 Bluetooth Module is a simple Bluetooth SPP (Serial Port Protocol) module that allows for the construction of a transparent wireless serial connection. It communicates via serial transmission, making it simple to connect to a controller or PC. The HC-05 Bluetooth module allows data to be transferred between master and slave mode, which means users may use it for both receiving and delivering data. The input voltage of Bluetooth HC-05 is DC 5V. This module commonly has 5 pins where each pin has its own function to ensure the module work as it need to do. VCC pin is 5V DC pin to connect to the source. GND is Ground pin to connect to the ground. TXD or UART- TXD is a Bluetooth serial signal sending pin which connect the microcontrollers' RXD pin. RXD or UART- RXD is a Bluetooth serial receiving pin which connect with the microcontroller's TXD pin. KEY pin is mode switch input which function as if it input is low level or connect to the air, the module is at paired or communication mode. If its input high level, the module will enter to AT mode.

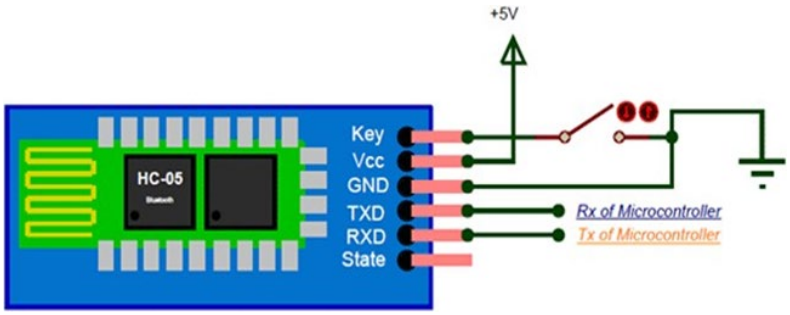


Fig. 3.7 - Bluetooth HC-05 module

3.6 Relay Module

A relay is used as an operated switch that can be turned on or off, letting the current go through or not. It can be controlled with low voltages, like the 5V provided by the Arduino board. The relay modules commonly have two channels consists of an electromagnet that when energized it causes a switch to close or open.

Fig. 3.8 - Relay module

4. Engineering Testing

Nowadays people live in the twenty-first century, and automation in any form, such as residential or industrial, plays a significant role in human life. When it comes to industrial automation, the term refers to massive equipment or robots that aid in enhancing productivity, energy, and time efficiency. In this project, users will create a simple home automation project with simple components that will allow us to turn on and off various electrical appliances. The project is Arduino-based, and I used an Arduino UNO to complete it. In this project Arduino and Arduino application will be used in Proteus software. Components used in this project are Arduino UNO, HC-05 Bluetooth Module, resistor, 2N2222, relay and 4 yellows led represent the bulb. The 4 bulbs in this project will be placed at different places one for hall, one for room, one for kitchen and one for bathroom.

4.1 Simulation Results using Proteus Software

Figure 1.9 below shows the result of using Proteus on the right side by using smartphone the users should declare “all on” to turn the light on for the left side of the Proteus simulation circuit. All of the circuit connected to the bulb will turn on for 4 places that are hall, room kitchen and bathroom.

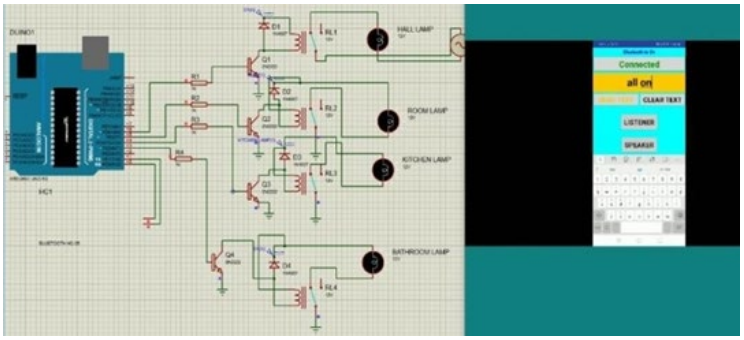


Fig. 4.1 - Circuit diagram when all bulb turns on

Figure 10 below shows the result of using Proteus on the right side by using smartphone the users should declare “all off” to turn the light off for the left side of the Proteus simulation circuit. All of the circuit connected to the bulb will turn off for 4 places that are hall, room kitchen and bathroom.

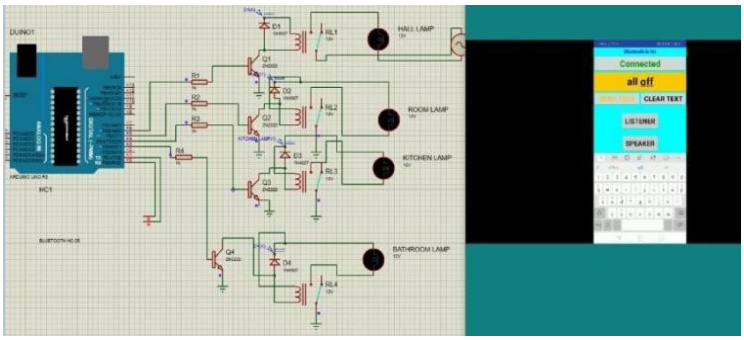


Fig. 4.2 - Circuit diagram when all bulb off

In another ways, the users also can decide which location of the bulb they want to turn it off or turn it on for example if they want to turn on the hall lamp the users should declare “hall light on” by using smartphone and the lamp will immediately turn on only for one location as shown in Figure 2.1 below.

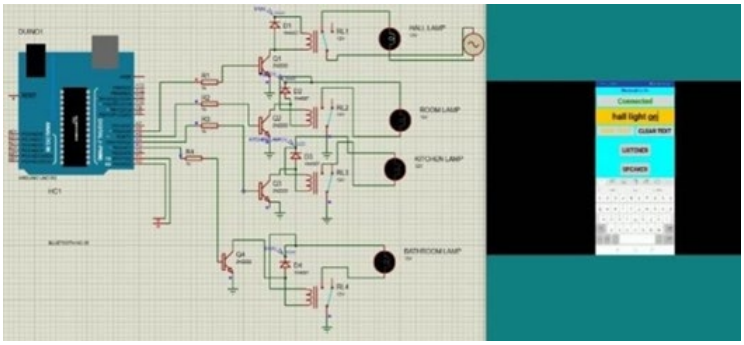


Fig. 4.3 - Circuit diagram when hall light on declared

The users also can turn off the location that they did not want to use the lamp anymore. On the right side by using smartphone the user should declared “hall light off” and the lamp placed at hall only will turn off and the others lamp still turn on if before this the user declared “hall light on”. This is shown in Figure 2.2 below.

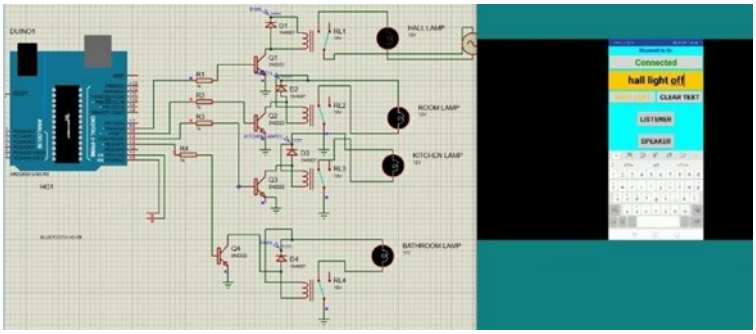


Fig. 4.4 - Circuit diagram when hall light off declared

5. NABC Analysis

The NABC was created in order to establish a more systematic way to comprehending value propositions, or the value of unique thinking. This method allows idea-makers to express their ideas while also evaluating their worth based on a set of central factors. To pitch is the process of introducing one's proposal using NABC. To pitch entails attempting to sell a concept in a clear and straightforward manner. However, it is preferable to elaborate or go into detail only when answering questions, rather than during the presentation itself, which should always be brief and concise. N for Need and most important factor in the method because an idea without a practical need for it remains just what it is. A for Approach that usually a point of departure for most activities, but with the NABC method, A always comes after N. B is for Benefit that stands for the innovative elements of an idea, in other words that which constitutes its uniqueness. C for Competition existing in the area concerned. C is often mistaken for N. C, however, focuses on the reality within which a concept has to function.

Each day, a lot of energy is wasted in homes due to fans and lamps that are left on even though no one is in the building. The goal of this project is to remind a user when they leave their home if the basic appliances such as lamps are unintentionally left on. This are the basic and major electricity consuming appliances in our home. Even it is not many, but the amount of a thousand houses in the same condition is big enough.

All functionality is done by a mobile app developed in Android, from which house applications are managed through the internet. Wireless monitoring system for smart home application is a system in which simple house facilities can be controlled by a computer from anywhere, such as turning on and off lights. All of this can be accomplished with the help of a computer. One can attach as many devices as desired such as sensors, appliances, and many more up to a limit of eight. The mobile application interfaced with the BTDisplay server, which monitors everyday energy usage and also provides awareness to conserve electricity by notification using BTDisplay features. Nowadays, in ordinary home area they use light equipped with motion sensors. The differences that system with our system is the system did not use motion sensors but is use IOT to inform the users and also control it.

The need in this project is to make sure the user’s home stay safe from any incident such as having a short circuit or fire. The main approach is use of IoT platform which always keep reminding users to notify if any basic appliances

are not switch off before they left their house. There are many benefits that users get from this project such as can control their electricity bill, can protect their home from any incident, always keep their home's basic appliances in switched off and the most important is users are not left behind by using the latest technology such as IoT. For the competition in this project, it easy for users to keep monitors their home by using BTDisplay in their own smartphone from far away.

6. Conclusion

As a conclusion, the system designed focuses on energy conservation, cost reduction, safety improvement and easier maintenance for the future system. It is considered as an automatic system since user can monitor and control the electricity in their home through mobile phone remotely, provided that the internet connection is available for both parties. This system utilizes the technology of IoT that enables everything to be controlled and organized by means of internet accessibility. IoT will be used in many applications and industry because IoT should make work using machine become easier. People can control and monitor machine or electrical appliances without need to be hands on or presence at that location. A lot of improvements can be offered pertaining to electricity saving, home appliances, user safety issue and current technology involvement. For the recommendation, in future this system can alert the users to reduce the prediction of user behaviour and increase in energy consumption. In safety recommendation, this system can add the fire system and avoidance of expected attacks. In order to keep everyone in healthy condition, this system can be upgrade and having health guidance.

Acknowledgement

The authors would like to thank to all lecturers especially supervisor and coordinator, family members and friends who are involved directly or indirectly.

Appendix A: Arduino Codes (Smart Home Controlling System)

```
String voice; void setup() {
Serial.begin(9600); pinMode(6, OUTPUT); pinMode(5, OUTPUT); pinMode(4, OUTPUT); pinMode(3, OUTPUT);
}

void loop() { while(Serial.available()){ delay(3);
char c = Serial.read(); voice+=c;}

if(voice.length() >0){ Serial.println(voice); if(voice == "hall light on")
{digitalWrite(6, HIGH);}
else if(voice == "hall light off")
{digitalWrite(6, LOW);}
else if(voice == "room light on")
{digitalWrite(5, HIGH);}
else if(voice == "room light off")
{digitalWrite(5, LOW);}
else if(voice == "kitchen light on")
{digitalWrite(4, HIGH);}
else if(voice == "kitchen light off")
{digitalWrite(4, LOW);}
else if(voice == "bathroom light on")
{digitalWrite(3, HIGH);}
else if(voice == "bathroom light off")
{digitalWrite(3, LOW);} else if(voice == "all on")
{digitalWrite(3, HIGH);
```

digitalWrite(4, HIGH); digitalWrite(5, HIGH); digitalWrite(6, HIGH);} else if(voice == "all off")
{digitalWrite(3, LOW); digitalWrite(4, LOW); digitalWrite(5, LOW); digitalWrite(6, LOW);} voice = "";}

Appendix B: Smart Home Controlling System Testing

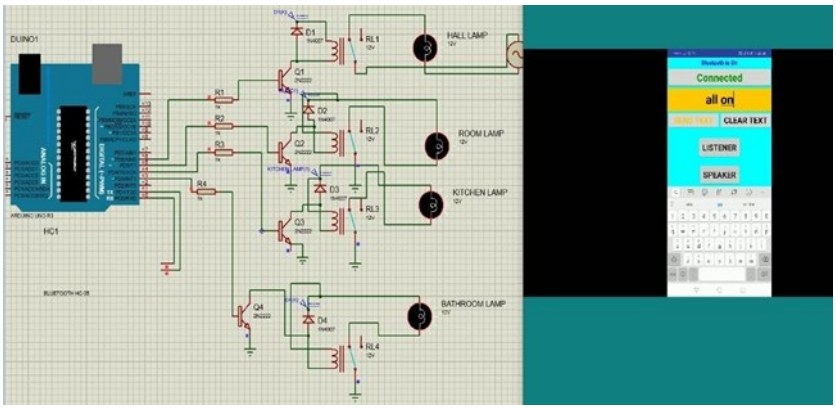


Fig. 4.5 - Circuit diagram when all on declared

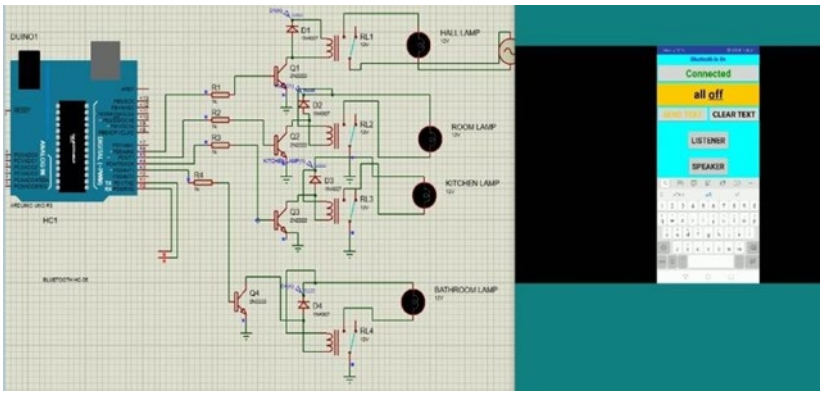


Fig. 4.6 - Circuit diagram when all off declared

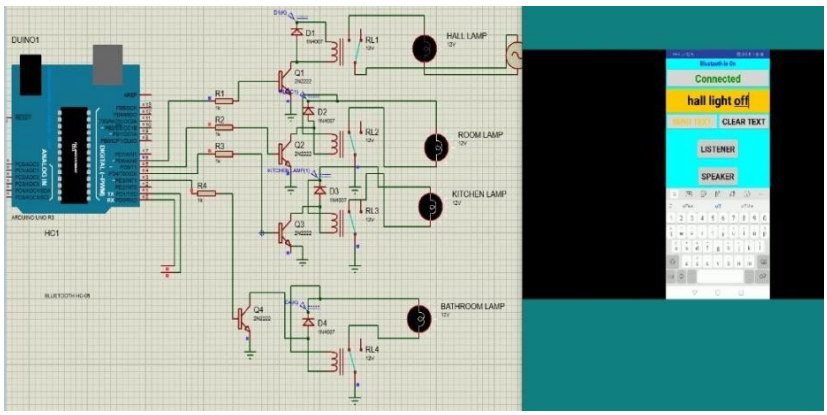


Fig. 4.7 - Circuit diagram when hall light off declared

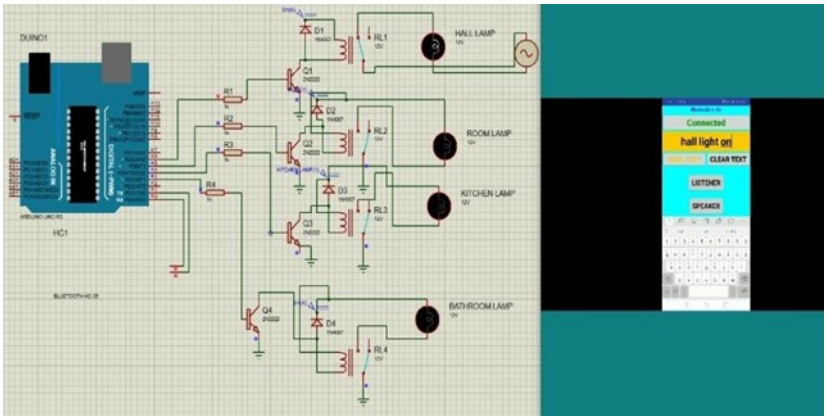


Fig. 4.8 - Circuit diagram when hall light on declared

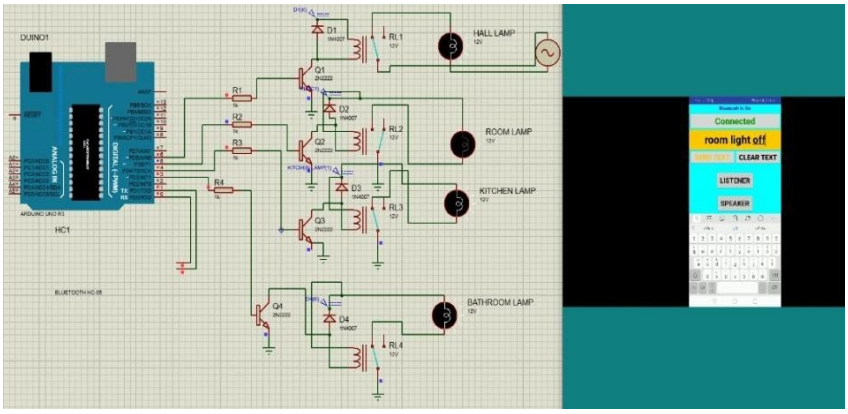


Fig. 4.9 - Circuit diagram when room light off declared

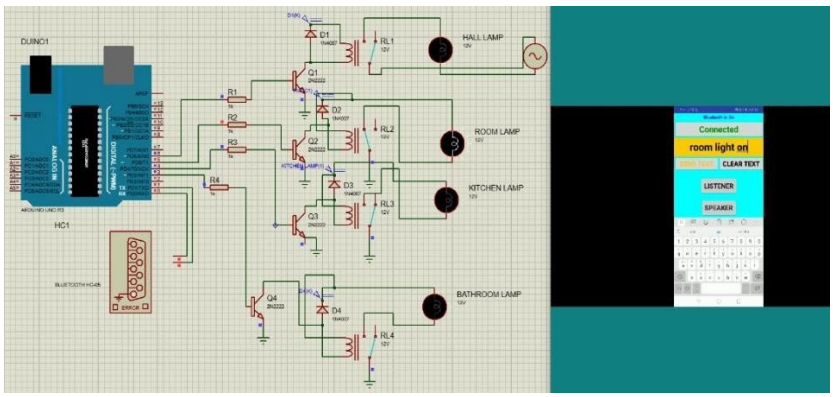


Fig. 4.10 - Circuit diagram when room light on declared

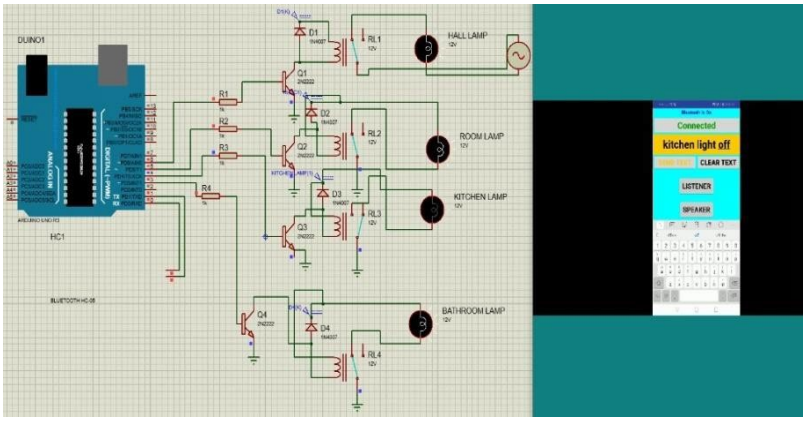


Fig. 4.11 - Circuit diagram when kitchen light off declared

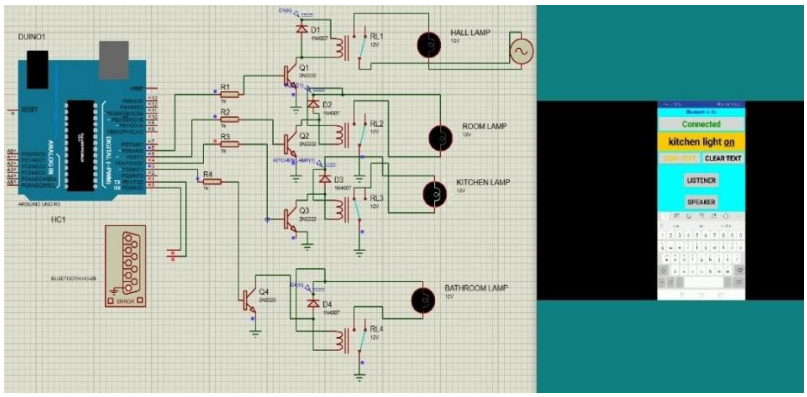


Fig. 4.12 - Circuit diagram when kitchen light on declared

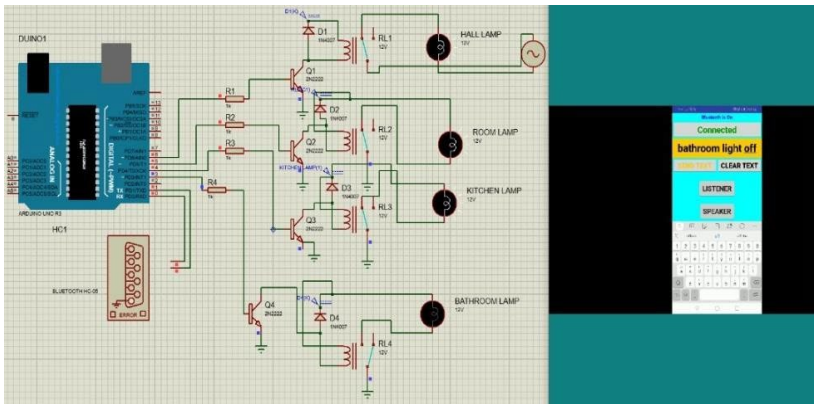
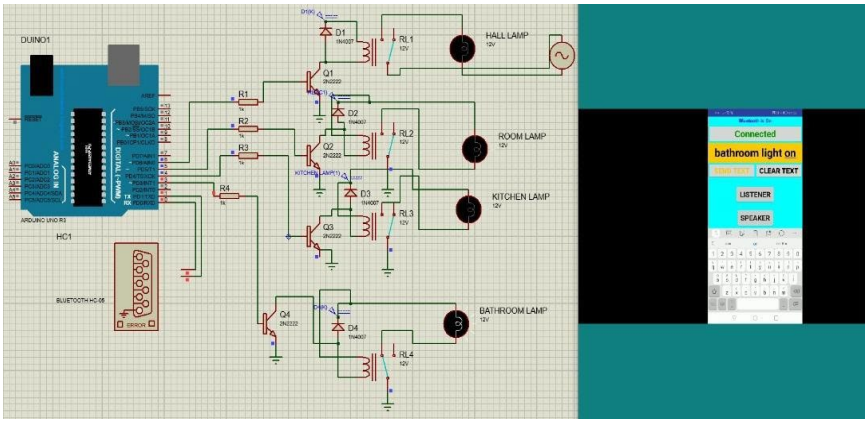


Fig. 4.13 - Circuit diagram when bathroom light off declared

Fig. 4.14 - Circuit diagram when bathroom light on declared



References

[1] P. Damacharla, A. Y. Javaid, J. J. Gallimore and V. K. Devabhaktuni," Common Metrics to Benchmark Human-Machine Teams (HMT): A Review," in IEEE Access, vol. 6, pp. 38637-38655, 2018

[2] O. Benderius, C. Berger and V. Malmsten Lundgren," The Best Rated HumanMachine Interface Design for Autonomous Vehicles in the 2016 Grand Cooperative Driving Challenge," in IEEE Transactions on Intelligent Transportation Systems, vol. 19, no. 4, pp. 1302-1307, April 2018

[3] Z. Xu, R. Wang, X. Yue, T. Liu, C. Chen and S. Fang," FaceME: Face-to-Machine Proximity Estimation Based on RSSI Difference for Mobile Industrial Human Machine Interaction," in IEEE Transactions on Industrial Informatics, vol. 14, no. 8, pp. 3547-3558, Aug. 2018

[4] S. Ziegler, S. Nikoletsea, S. Krco, J. Rolim and J. Fernandes," Internet of Things and crowd sourcing - a paradigm changes for the research on the Internet of Things," 2015 IEEE 2nd World Forum on Internet of Things (WF-IoT), Milan, 2015, pp. 395-399.

[5] J. Voas, B. Agresti and P. A. Laplante," A Closer Look at IoT 's Things," in IT Professional, vol. 20, no. 3, pp. 11-14, May. /Jun. 2018.

[6] S. Singh and N. Singh," Internet of Things (IoT): Security challenges, business opportunities & reference architecture for E-commerce," 2015 International Conference on Green Computing and Internet of Things (ICGCIoT), Noida, 2015, pp. 1577-1581

[7] S. Singh and N. Singh," Internet of Things (IoT): Security challenges, business opportunities & reference architecture for E-commerce," 2015 International Conference on Green Computing and Internet of Things (ICGCIoT), Noida, 2015, pp. 1577-1581.

[8] P. Kunkun and L. Xiangong," Reliability Evaluation of Coal Mine Internet of Things," 2014 International Conference on Identification, Information and Knowledge in the Internet of Things, Beijing, 2014, pp. 301-302.

[9] A. J. Jara," Wearable Internet: Powering Personal Devices with the Internet of Things Capabilities," 2014 International Conference on Identification, Information and Knowledge in the Internet of Things, Beijing, 2014, pp. 7-7.

[10] Q. Wang and Y. G. Wang," Research on Power Internet of Things Architecture for Smart Grid Demand," 2018 2nd IEEE Conference on Energy Internet and Energy System Integration (EI2), Beijing, 2018, pp. 1-9.

[11] T. Sun, Y. Xu, J. Li and H. Zhang," Research on Internet of Things Middleware Technology for Laboratory Environmental Monitoring," 2018 International Conference on Virtual Reality and Intelligent Systems (ICVRIS), Changsha, 2018, pp. 544-547.

[12] Q. F. Hassan," Internet of Things Applications for Agriculture," in Internet of Things A to Z: Technologies and Applications, IEEE, 2018.

[13] Y. Hsieh," Internet of Things Pillow Detecting Sleeping Quality," 2018 1st International Cognitive Cities Conference (IC3), Okinawa, 2018, pp. 266- 267.

[14] Q. F. Hassan," Implementing the Internet of Things for Renewable Energy," in Internet of Things A to Z: Technologies and Applications, IEEE, 2018.

[15] X. Li, P. Wan, H. Zhang, M. Li and Y. Jiang," The Application Research of Internet of Things to Oil Pipeline Leak Detection," 2018 15th International Computer Conference on Wavelet Active Media Technology and Information Processing (ICCWAMTIP), Chengdu, China, 2018, pp. 211-214.

[16] F. A. Rachman, A. G. Putrada and M. Abdurohman," Distributed Campus Bike Sharing System Based-on Internet of Things (IoT)," 2018 6th International Conference on Information and Communication Technology (ICoICT), Bandung, 2018, pp. 333-336.

[17] Y. Kung, S. Liou, G. Qiu, B. Zu, Z. Wang and G. Jong," Home monitoring system-based internet of things," 2018 IEEE International Conference on Applied System Invention (ICASI), Chiba, 2018, pp. 325-327.

[18] Y. Sun, Y. Xia, H. Song and R. Bie," Internet of Things Services for Small Towns," 2014 International Conference on Identification, Information and Knowledge in the Internet of Things, Beijing, 2014, pp. 92-95.

[19] D. Pavithra and R. Balakrishnan, "IoT based monitoring and control system for home automation," Global Conference on Communication Technologies (GCCT), Thuckalay, 2015, pp. 169-173.

[20] H. V. Bhatnagar, P. Kumar, S. Rawat and T. Choudhury, "Implementation model of Wi-Fi based Smart Home System," International Conference on Advances in Computing and Communication Engineering (ICACCE), Paris, 2018, pp. 23-28.

[21] M. C. Domingo, "An overview of the Internet of Things for people with disabilities," Journal of Network and Computer Applications, vol. 35, Issue 2, pp. 584-596, 2012.

[22] A. Olteanu, G. Oprina, N. Tapus and S. Zeisberg, "Enabling Mobile Devices for Home Automation Using ZigBee,"19th International Conference on Control Systems and Computer Science, Bucharest, 2013, pp. 189-195.

[23] R. Piyare and M. Tazil, "Bluetooth based home automation system using cell phone," 2011 IEEE 15th International Symposium on Consumer Electronics (ISCE), Singapore, 2011, pp. 192-195.

[24] Y. Upadhyay, A. Borole and D. Dileepan, "MQTT based secured home automation system," Symposium on Colossal Data Analysis and Networking (CDAN), Indore, 2016, pp. 1-4.

[25] T. Wang, Y. Li and H. Gao, "The smart home system based on TCP/IP and DTMF technology," 2008 7th World Congress on Intelligent Control and Automation, Chongqing, 2008, pp. 7686-7691.

[26] T. M. Ladwa, S. M. Ladwa, R. S. Kaarthik, A. R. Dhara and N. Dalei, "Control of remote domestic system using DTMF," International Conference on Instrumentation, Communication, Information Technology, and Biomedical Engineering 2009, Bandung, 2009, pp. 1-6.

[27] N. M. Morshed, G. M. Muid-Ur-Rahman, M. R. Karim and H. U. Zaman, "Microcontroller based home automation system using Bluetooth, GSM, Wi-Fi and DTMF," 2015 International Conference on Advances in Electrical Engineering (ICAEE), Dhaka, 2015, pp. 101-10.