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HOME AUTOMATION USING ARDUINO

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Abstract

The main objective of this project is to develop a home automation system using an Arduino board with Bluetooth being remotely controlled by any Android OS smartphone. As technology is advancing so houses are also getting smarter. Modern houses are gradually shifting from conventional switches to centralized control systems, involving remote controlled switches. Presently, conventional wall switches located in different parts of the house makes it difficult for the user to go near them to operate. Even more, it becomes more difficult for the elderly or physically handicapped people to do so. Remote controlled home automation systems provide a most modern solution with smartphones. In order to achieve this, a Bluetooth module is interfaced to the Arduino board at the receiver end while on the transmitter end, a GUI application on the cell phone sends ON/OFF commands to the receiver where loads are connected. By touching the specified location on the GUI, the loads can be turned ON/OFF remotely through this technology. The loads are operated by an Arduino board through optoisolators and thyristors using triacs.

1 Introduction

1.1 Research Background

Home automation systems are getting popular and widely used in a lot of houses worldwide. It has tons of advantages to users even more to the handicapped and/or elderly users in which it will make it easier for them to control their home appliances. Home automation systems can be labeled to two mediums in which how it is connected and they are either wired or wirelessly connected. The main difference between these two kinds is that home appliances are linked wirelessly to a central controller if it is a wireless home automation system. On the other hand, the appliances are connected to a central controller if the medium uses wired communication methods. Wireless systems have been introduced in order to dispose of wired communication among home appliances. Arduino based, Bluetooth based home automation will be applied.

Another study shows that 85 percent of the market share is Android and a total of 3.5 Billion android smartphones were shipped in the second half of 2018. Android smartphones became the top operating system in the market in the present time worldwide and it became the most popular operating system known to man.

1.2 Problem Statement

In the present day home automation is becoming essential for the purpose of improving our life condition. Convenience and ease of using home appliances is what home automation is offering. Home automation offers a futuristic way of life in which an individual gets to control his entire house using a smartphone, from turning on a TV to locking/unlocking doors; it also offers an efficient use of energy.

But to get or acquire such a system installed will cost a lot of money and that is the major reason why home automation has not received much demand and attention, adding to that also the complexity of installing it and configuring it. Thus it is essential to make it cost effective and easy to configure, if this is granted to people then they will be willing to acquire it in their homes, offices and schools. In other words, a system modification for home automation is required in order to lower the price of applying it to houses. Also home automation offers ease of mind and body to handicapped and/or elders in their houses by just one click to do what they want as stated above.

1.3 Objective of the Study

- To construct a wireless home automation system controlled by a smart- phone specifically an android device.
- To design and implement a cost effective home automation system yet an efficient one.
- To design a user friendly and a safe system to control home appliances especially aimed to aid the elders and handicapped.

1.4 Significance of the Study

This study will be undertaken to create a home automation system at low cost and easy to create, this will benefit both the manufacturer and the client. It will help the manufacturer by making it easy and cheaper to apply it, and it will also benefit the clients by making it cost effective and the most important advantage is that it will make the house a much more convenient place for the clients especially for the elders and the handicapped.

2 Components

2.1 Arduino

Arduino is open source physical processing which is based on a micro-controller board and an incorporated development environment for the board to be programmed. Arduino gains a few inputs, for example, switches or sensors and control a few multiple outputs, for example, lights, engine and others. The Arduino program can run on Windows, Macintosh and Linux operating systems (OS) opposite to most microcontrollers frameworks which run only on Windows. Arduino programming is easy to learn and apply to beginners and amateurs. Arduino can be utilized to create interactive items, taking inputs from a diverse collection of switches or sensors, and controlling an assortment of lights, engines, and other physical outputs. Arduino activities can be remaining solitary, or they can be associated with programs running on your machine (e.g. Flash, Processing and Maxmsp.) The board can be amassed by hand or bought pre-assembled; the open-source IDE can be downloaded free of charge.

2.1.1 Diagrams of Arduino Uno

Figure1 is the circuit diagram of Arduino Uno.

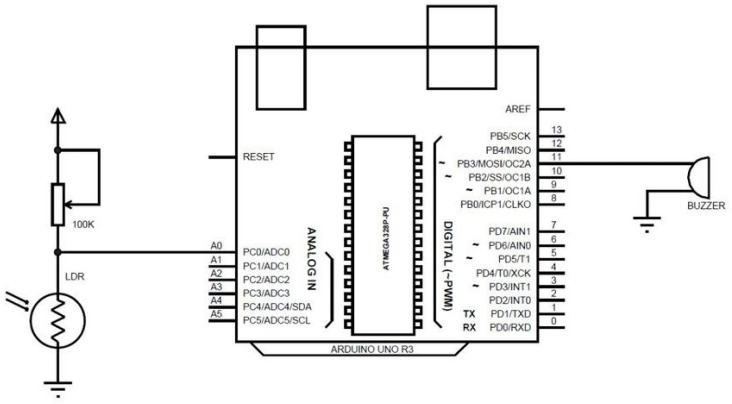


Figure 1: Arduino Uno Circuit Diagram

Figure-2 is the pin diagram of Arduino Uno.

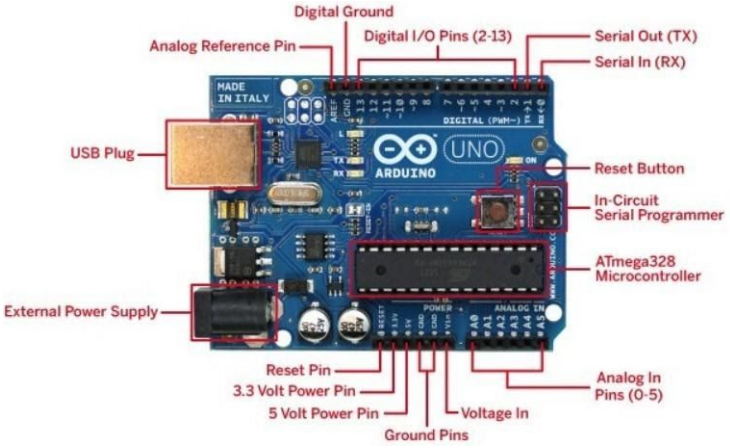


Figure 2: Arduino Uno Pin Diagram

2.1.2 Features of Arduino Uno

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 M

2.1.3 Why Choose Arduino

There are numerous different microcontrollers and microcontroller plat- forms accessible for physical computing. Parallax Basic Stamp, Net media's BX-24, Phidgets, MIT's Handy board, and numerous others offer comparative usefulness. These apparatuses take the chaotic subtle elements of micro- controller programming and wrap it up in a simple to-utilize bundle. Arduino additionally rearranges the methodology of working with micro-controllers; moreover it offers some advantages for instructors, students, and intrigued individuals:

- Inexpensive - Arduino boards are moderately cheap compared with other microcontroller boards. The cheapest version of the Arduino module can be amassed by hand, and even the pre-assembled Arduino modules cost very low.
- Straightforward, clear programming method - The Arduino programming environment is easy to use for novices, yet sufficiently versatile for cutting edge customers to adventure as well. For educators,it's favorably engaged around the Processing programming environment, so understudies finding ways to understand how to program in that environment will be familiar with the nature of Arduino.
- Cross-platform- The Arduino programming runs multiple operating systems Windows, Macintosh OSX, and Linux working frameworks. So we conclude that Arduino has an advantage as most microcontroller frameworks are constrained to Windows.
- Open source and extensible hardware - The Arduino is concentrated around Atmel's Atmega8 and Atmega168 micro-controllers. The plans for the modules are circulated under a Creative Commons license, so experienced circuit designers can make their own particular interpretation of the module, extending it and improving it slightly inexperienced customers can build the breadboard variation of the module remembering the finished objective to perceive how it capacities and save money.

2.2 Bluetooth

Bluetooth is a standard utilized as a part of connections of radio of short extension, bound to substitute connections which use wires between electronic gadgets like personal digital assistants (PDA), cell phones, personal computers (PC), Laptops, and numerous different gadgets. Bluetooth technology can be utilized at homes, offices, schools, hospitals and in cars. Users can get instantaneous connections with several kinds of devices through this technology continuously. The method for transmission utilized guarantees security against external interference and well-being in sending out data. Between the essential qualities, these must be mentioned; the strength, low cost, small consume of energy, low complexity and the ease of use.

2.2.1 How Bluetooth Works

Each gadget must have a microchip installed in it that receive and transmits the frequency of 2.4 GHz that is accessible throughout the whole world (with a few varieties of transmission Bandwidth in diverse nations).

Other than the data, three channels of voice are accessible. The data can be traded to speeds of up to 1 megabit per second (2 megabits for second in the Second Generation of this Technology). A plan of “frequency hop” (hops of frequencies) permits the gadgets to get connected comprehensively in territories where an incredible electromagnetic interference exists. Other than that is given plans of encryption and check.

2.2.2 Importance of Bluetooth to Create Home Automation System

Bluetooth technology has been one of the critical innovations to home automation systems or Smart Living. It is a remote technology created to take the place of wired devices to wireless one which link gadgets like cell phones and PCs (Laptops/desktops). Bluetooth permits remote gadgets to have the ability to connect with one another inside reach. The system of a set of Bluetooth gadgets is called “piconet”, which is an ideal technology to system a brilliant advanced home automation system.

2.2.3 Features of Bluetooth Module (HC-05 Bluetooth module)

- Bluetooth protocol: Bluetooth Specification v2.0+EDR
- Frequency : 2.4GHz ISM band
- Modulation : GFSK(Gaussian Frequency Shift Keying)
- Emission power : (less than equal)4dBm, Class 2
- Sensitivity : (less than equal)-84dBm at 0.1 percent BER
- Speed : 2.1Mbps(Max) / 160 kbps, Synchronous: 1Mbps/1Mbps
- Security : Authentication and encryption
- Profiles : Bluetooth serial port
- Power supply : +3.3VDC 50mA
- Working temperature :-20 - +75 Centigrade
- dimension : 26.9mm x 13mm x 2.2 mm
- Mode: Slave
- Baud rate(default): 9600 baud rate
- Pin code(default):1234

2.2.4 Diagrams of Bluetooth's

Figure 3 is the circuit diagram of Bluetooth Module (HC-05 Bluetooth module).

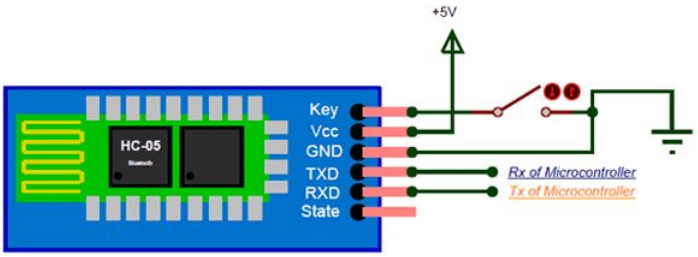


Figure 3: HC-05 Bluetooth module Circuit Diagram

Figure 4 is the pin diagram of HC-05 Bluetooth module.

Figure 4: HC-05 Bluetooth module Pin Diagram

2.3 Relay Module

A relay is an electrically operated switch. Many relays use an electro- magnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.
The Arduino Relay module allows a wide range of microcontroller such as Arduino, AVR ,PIC, ARM with digital outputs to control larger loads and devices like AC or DC Motors, electromagnets, solenoids, and incandescent light bulbs. This module is designed to be integrated with 2 relays that it is capable of control 2 relays .The relay shield use one QIANJI JQC-3F high-quality relay with rated load 7A/240VAC,10A/125VAC,10A/28VDC.The re-lay output state is individually indicated by a light-emitting diode.

2.3.1 4 Channel Relay Module

This is a 5V 4-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equipped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by a microcontroller.

2.3.2 Features of 4 Channel Relay module

- Size: 75mm (Length) * 55mm (Width) * 19.3mm (Height)
- The maximum output of the relay: DC 30V/10A, AC 250V/10A
- VCC is a system power source, and JD VCC is a relay power source. Ship 5V relay by default.
- Optical coupling isolation, good anti-interference.
- LEDs on each channel indicate relay status.
- Output four SPDT relay.
- Berg pins for connecting power and trigger voltage

2.3.3 Applications of Relay Module

Relays are used wherever it is necessary to control a high power or high voltage circuit with a low power circuit, especially when galvanic isolation is desirable. The first application of relays was in long telegraph lines, where the weak signal received at an intermediate station could control a contact, regenerating the signal for further transmission. High-voltage or high-current devices can be controlled with small, low voltage wiring and pilots switches. Operators can be isolated from the high voltage circuit. Low power devices such as microprocessors can drive relays to control electrical loads beyond their direct drive capability. In an automobile, a starter relay allows the high current of the cranking motor to be controlled with small wiring and contacts in the ignition key.

Elector-mechanical switching systems including Stronger and Crossbar telephone exchanges made extensive use of relays in ancillary control circuits. The use of relays for the logical control of complex switching systems like telephone exchanges was studied by Claude Shannon, who formalized the application of Boolean algebra to relay circuit design in A Symbolic Analysis of Relay and Switching Circuits. Relays can perform the basic operations of Boolean combinatorial logic. For example, the boolean AND function is realized by connecting normally open relay contacts in series, the OR function by connecting normally open contacts in parallel. Inversion of a logical input can be done with a normally closed contact. Relays were used for control of automated systems for machine tools and production lines.

2.3.4 Diagrams of Relay Module

Figure 5 is the circuit diagram of 4 Channel-Relay Module

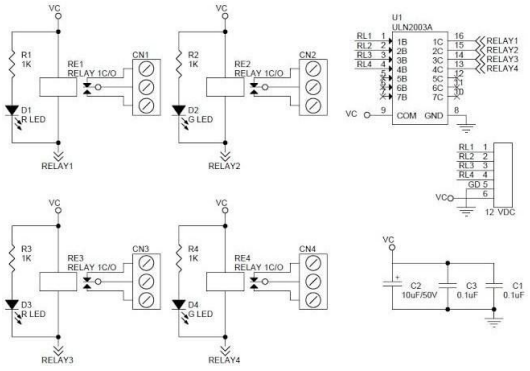


Figure 5: 4 Channel Relay Module Circuit

Diagram Figure 6 is the pin diagram of 4 channel Relay

Figure 6: 4-channel-Relay Module Pin Diagram

2.4 Android Phone and Android App

In this Project an android phone (Oneplus 7) is used as the remote control for the user alongside with an App. Developed a simple Android app using MIT app inventor called ‘Voice Controlled Home Automation’ that will make controlling the pins of Arduino-Uno from an Android phone wirelessly possible.

2.5 Other Components

- Jumping Wires.
- Normal wires.
- Light Bulbs.
- Motor
- Socket.

3 Methodology

In this section we will be describing the methodology of this project.

3.1 System Diagram

Figure 7 shows the system breakdown of this project. In this project two types of communication are used, first one is wireless (Via Bluetooth) and the second one is wired (appliances connected to the controller). HC-06 is a Bluetooth module that will enable the android phone to wirelessly connect with the controller.

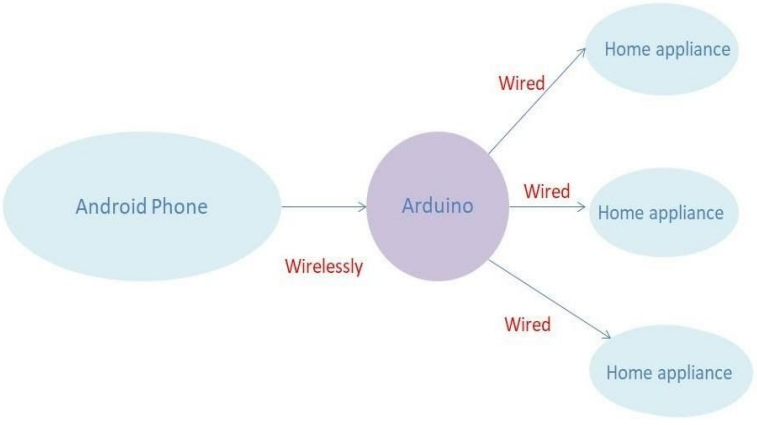


Figure 7: System Diagram

3.2 Block Diagram

Figure 8 shows the Block Diagram of the Project

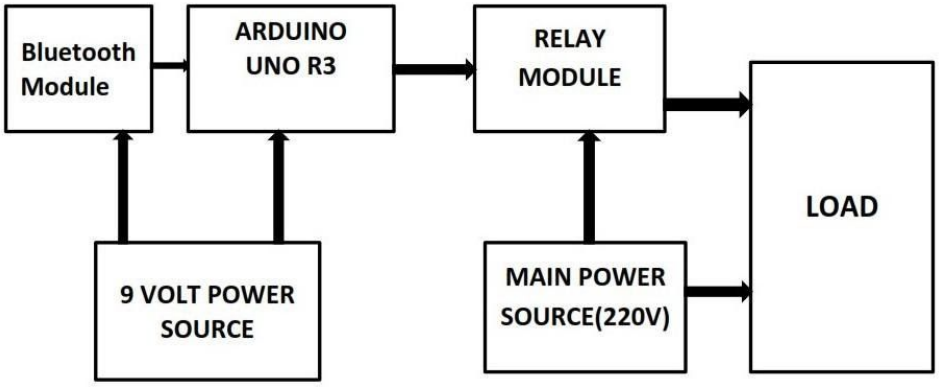


Figure 8: Block Diagram

3.3 Circuit Diagram

Figure 9 shows the Circuit Diagram of the Project

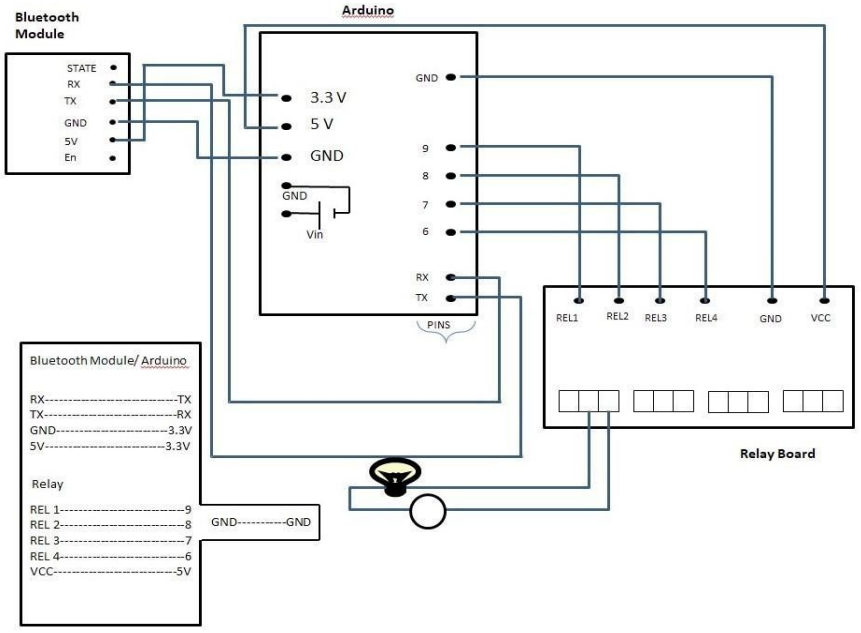


Figure 9: Circuit Diagram

3.4 Programming in Arduino

In order for the Arduino-Uno board to be able to interact with the application used in this project a certain program (code) needs to be uploaded to the Arduino-Uno.

In order for the Arduino board to interact with our app the following code was uploaded.

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

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

if(voice.length() >0)
{
  Serial.println(voice);
  if(voice == "light on")
  {digitalWrite(6, HIGH);}
  else if(voice == "light of")
  {digitalWrite(6, LOW);}
  else if(voice == "fan on")
  {digitalWrite(5, HIGH);}
  else if(voice == "fan of")
  {digitalWrite(5, LOW);}
  else if(voice == "night lamp on")
  {digitalWrite(4, HIGH);}
  else if(voice == "night lamp of")
  {digitalWrite(4, LOW);}
```

```
else if(voice == "all on")
{digitalWrite(4, HIGH);
  digitalWrite(5, HIGH);
digitalWrite(6, HIGH);}
else if(voice == "all of")
{digitalWrite(4, LOW);
  digitalWrite(5, LOW);
digitalWrite(6, LOW);}
voice = "";}}
```

Figure 10 shows the compiling of code in Arduino

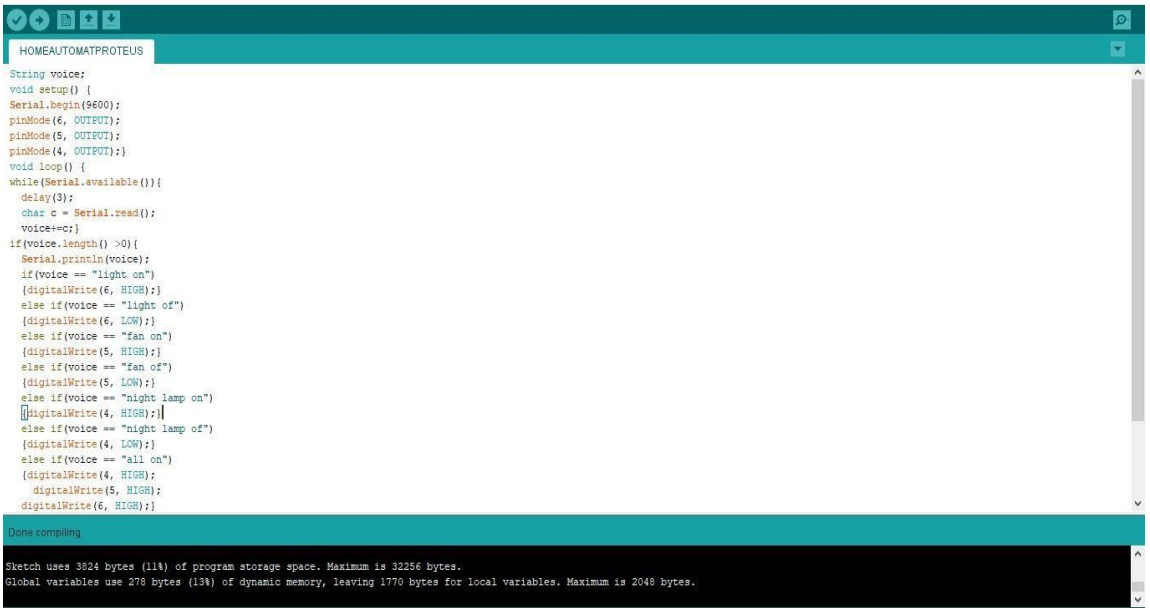


Figure-10: Compiling code in Arduino-Uno board

3.5 Connecting the necessary components in Proteus

A connection between the Arduino-Uno and the Bluetooth module is required in order to enable the android to control the Arduino-Uno. The Bluetooth module was configured with the COM ports of the PC. Then all the other components were wired together. At first resistors were connected to Arduino pin no. (4, 5, 6) all resistors configured to 1k ohm. Then the resistors were wired to the relays following diodes, switches and finally 1 light bulb, 1 fan and 1 night lamp.

Figure 11 shows the connection of components

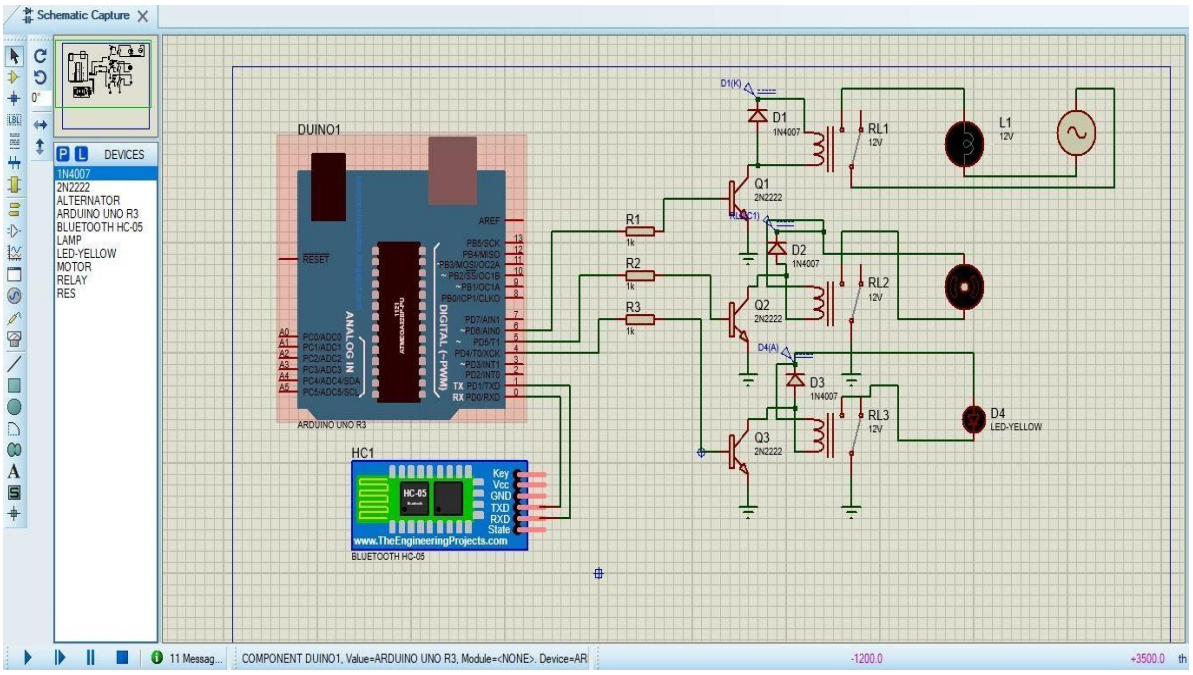


Figure-11: The connection of components

3.6 App Development

In order to control the project via Bluetooth an app was built using MIT app development website.

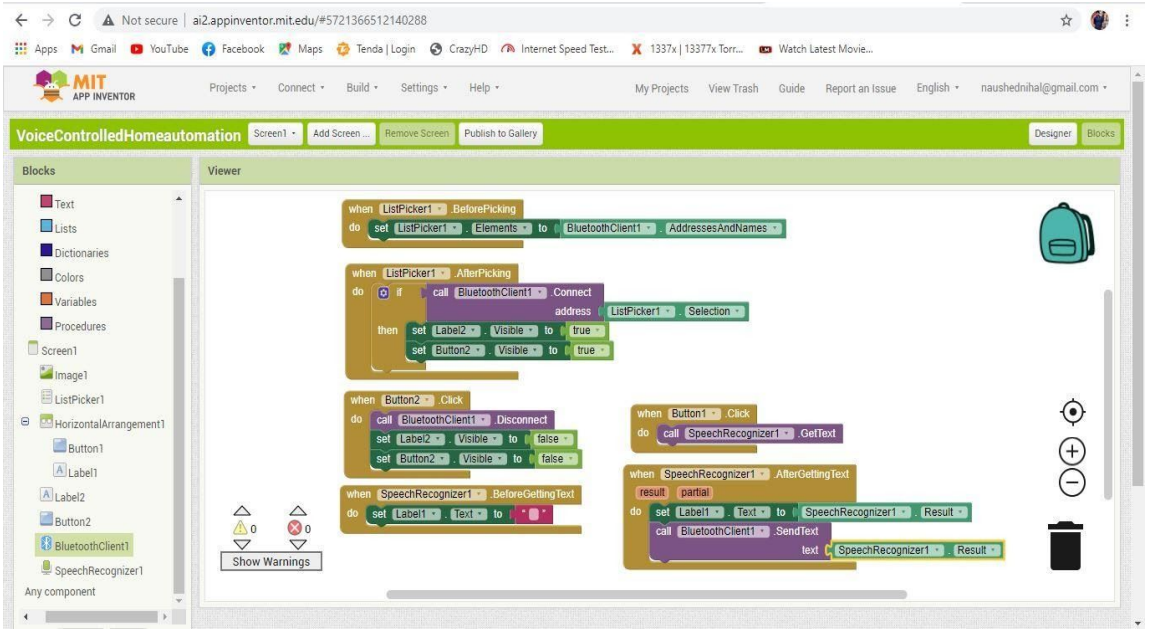


Figure-12: App development using MIT app inventor

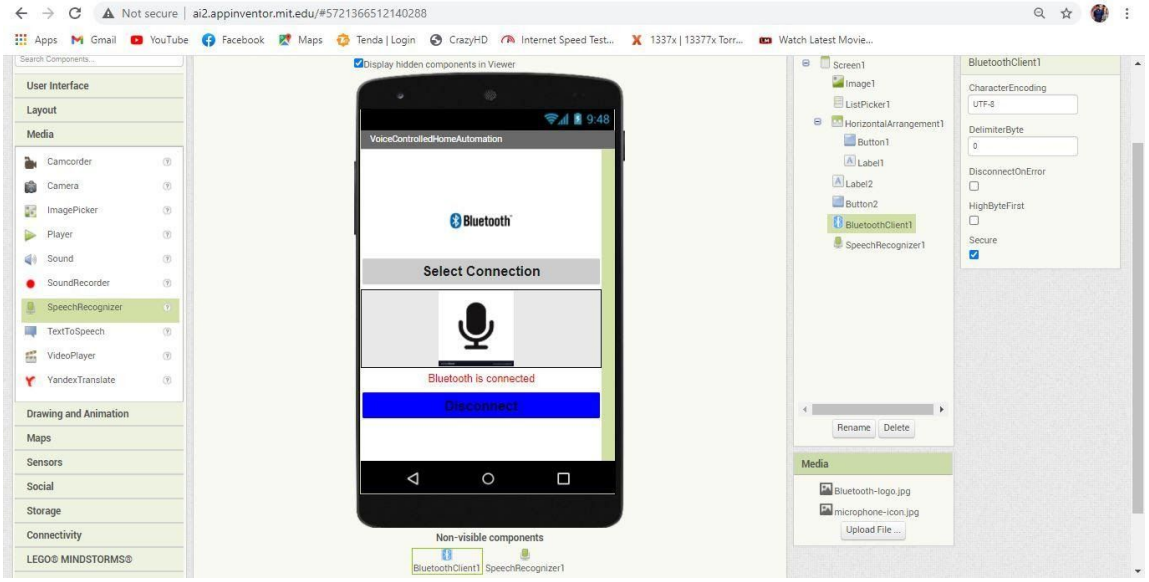


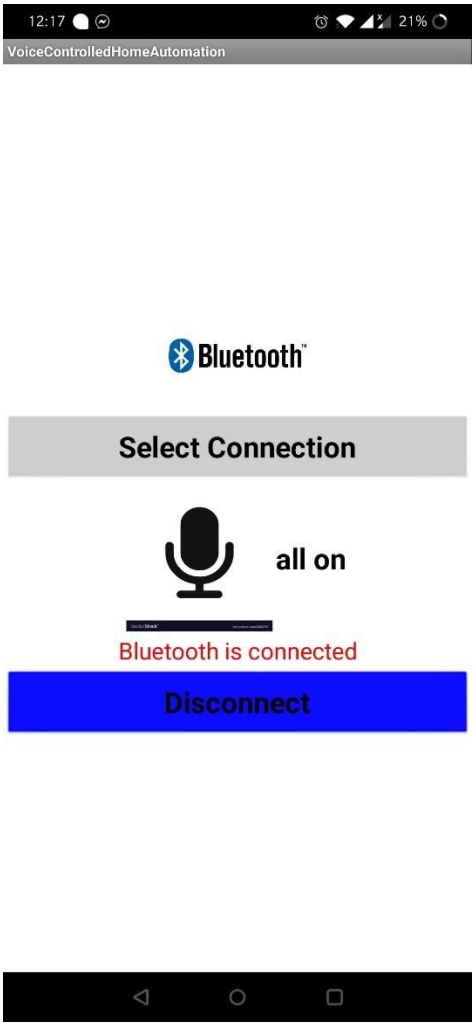
Figure-13: App development complet

3.7 Testing the Connection

After installing the app on the phone and connecting the Arduino-Uno board with the Bluetooth module a test to make sure that the phone is connected with Arduino via the Bluetooth module is needed.

- Open the app in the Android device.
- Search for Bluetooth devices via the App.
- Connect to the Bluetooth module.
- Once the Bluetooth is connected the program can be run through voice command.

When the voice command were given as “All On” all the components were turned on.



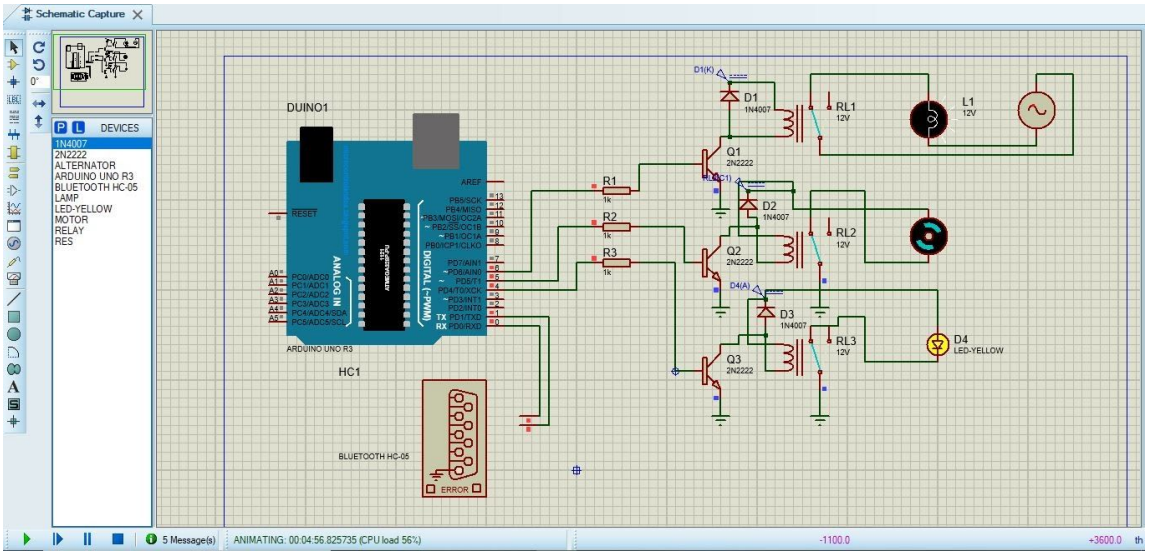


Figure- 14: Turning on all the component

When the voice command were given as “All Of” all the components were turned off

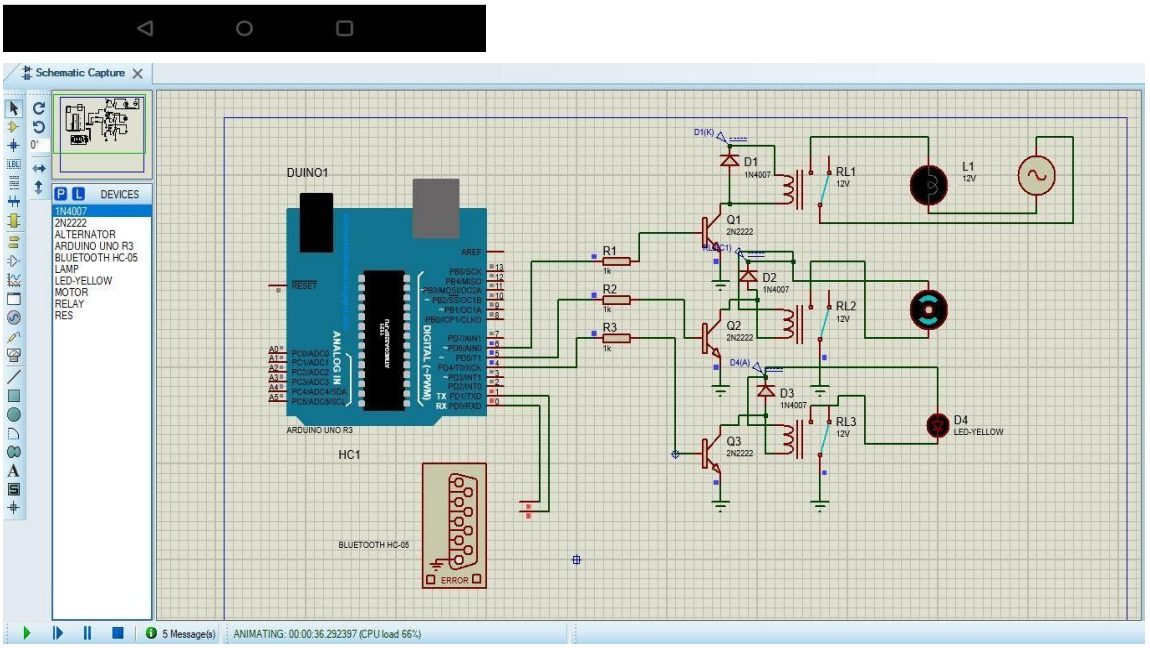


Figure-15: Turning off all the components.

4 Results and Discussions

In this section we will discuss the results and any limitations or prob- lems we encountered during the period of the project.

4.1.1 Results

Managed to successfully apply the HOME AUTOMATION SYSTEM USING ARDUINO and it was user friendly and cost effective. User friendly as anyone can use just a click of a button on an android screen and everything works. And it is cost effective as in it will cost exactly as the project requires (optimum price).

4.1.2 Limitations and Problems Encountered

Some problems and issues were encountered during this project. Bluetooth connection between the android phone and the Arduino-Uno board was unsuccessful in the early stages of this project. This problem was solved by online search on the matter.

Another problem that occurred was crashing of software. As it is a software simulation based project, the 'Proteus' software kept crashing.

5 CONCLUSION AND FUTURE WORKS

This section confers on the conclusion of Bluetooth Based Home Automation System Using Android Phone and discusses some future recommendations.

5.1 Conclusion

It can be concluded that HOME AUTOMATION SYSTEM USING AR-DUINO was a success. This system consists of an Arduino-Uno board, a Bluetooth Module, an Android phone, power sockets, home appliances and an android Application. It is user friendly and it is cost effective.

Also it can be concluded that the objectives of this project has been successfully met and they are as follows:

- Constructed a wireless home automation system controlled by a smart-phone specifically an android device.
- Designed and implemented a cost effective home automation system yet an efficient one.
- Designed a user friendly and a safe system to control home appliances especially aimed to aid the elders and handicapped.

5.2 Future Recommendations

There are some recommendations for Future works. Some of them are:

1. Better to use relay modules and connect it directly than using normal relays with breadboards.
2. Try to find a way to amplify the Bluetooth module signal to work in greater distance.
3. Test each and every component before using them especially the relays for safety purposes.

References

[1] Richard Lebaron and Laura Tyler Perryman. Implantable relay module, January 15 2019. US Patent App. 10/179,244.

[2] Laura Tyler Perryman and Chad Andresen. Relay module for implant, January 26 2016. US Patent 9,242,103.

[3]http://ai2.appinventor.mit.edu/#5721366512140288