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ABSTRACT

Automation of the surrounding environment of a modern human being allows increasing his work efficiency and comfort. In the present times, we can find most of the people clinging to their mobile phones and smart devices throughout the day. Hence with the help of his companion a mobile phone, some daily household tasks can be accomplished by personifying the use of the mobile phone. Home Automation System (HAS) has been designed for mobile phones having Android platform to automate an 8 bit Bluetooth interfaced microcontroller which controls a number of home appliances like lights, fans, bulbs and many more using on/off relay. This project work presents the automated approach of controlling the devices in a household that could ease the tasks of using the traditional method of the switch. The most famous and efficient technology for short range wireless communication-Bluetooth is used here to automate the system. The HAS system for Android users is a step towards the ease of the tasks by controlling one to twenty four different appliances in any home environment.

1 INTRODUCTION

The foremost aim of technology has been to increase efficiency and decrease effort. With the advent of 'Internet of Things' in the last decade, we have been pushing for ubiquitous computing in all spheres of life. It thus is of extreme importance to simplify human interfacing with technology. Automation is one such area that aims that achieves simplicity whilst increasing efficiency. Voice controlled House Automation System aims to further the cause of automation so as to achieve the goal of simplicity [1]. The primitive man realized that an effective way to communicate with one another is through voice. With minimum effort, ideas could be narrated with relative ease. When the first computers came around, achieving the level of sophistication so as to narrate commands using voice to a machine was only realized in science fiction. However with tremendous breakthroughs in the field, we are at the precipice of truly using voice to interface with devices. Using this effective yet ingrained form of communication we would humanize technology to a great extent. Voice controlled House Automation System deploys the use of voice to control devices [8]. Voice controlled House Automation System leverages the power of Arduino to provide a holistic voice controlled automation system. Using Natural Language Processing and the available hardware in most smart phones, it translates voice to be used for controlling electrical devices.

1.1 Objectives

The following list of objectives must be fulfilled to successfully help elderly and disabled individuals.

1. Develop Bluetooth appliance controller: The Bluetooth will interface with the microcontroller to perform the desired automation. The microcontroller will get the signals from the Bluetooth enabled mobile phone and it will be processed.

2. Develop an application for a mobile phone: An application needs to be developed for the mobile phone, which needs to communicate with the Bluetooth receiver HC 06.

3. Integrate the device to the controller: The foremost priority that has to be kept in mind when developing a Smart Home is that it has to be cost-efficient. The appliance controller has to be inexpensively integrated with the appliances in the house with an easy installation.

4. Test the set up and analyze the data: After the system is set-up, with the help of a mobile device and a controller, tests are conducted while data is recorded and analyzed.

Utilizing the opportunity of automating tasks for a smart home, mobile phone commonly found in normal household can be joined in a temporary network inside a home with the electronic equipments. Android, by Google Inc. provides the platform for the development of the mobile applications for the Android devices. Home automation system is a mobile application developed using Android targeting its vast market which will be beneficial for the masses. Bluetooth is a short-range wireless communication technology that comes in handy as the solution while communicating over an ad hoc network environment like the home environment for connecting the home appliances with the mobile phones. Bluetooth works over 2.4 GHz frequency range up to the range of 100 m with 1 Mbps speed, providing a safe and efficient solution for controlling home automation. Android is the customizable, easy-to-use operating system that powers more than a billion devices across the globe from phones and tablets to watches, TV, cars and more to come. Furthermore, it utilizes a custom virtual machine that was designed to optimize memory and hardware resources in a mobile environment.

Android is open source; it can be liberally extended to incorporate new cutting edge technologies as they emerge. Android breaks down the barriers to building new and innovative applications. Android provides access to a wide range of useful libraries and tools that can be used to build rich applications. Google's argument is that Android is open because the code is opened to all, because Google doesn't charge for the platform, and because developers have access to it all. The only restriction is on Google services, for which the company demands that phone makers conform to certain specifications. Google's take on Android is that they make it as open as possible.

Some of these home automation systems target those seeking luxury and sophisticated home automation platforms; others target those with special needs like the elderly and the disabled. The aim of the reported Wireless Home Automation System (WHAS) is to provide those with special needs with a system that canrespond to voice commands and control the on/off status of electrical devices, such as lamps, fans, television etc, in the home. The system should be reasonably cheap, easy to configure, and easy to run.

Figure 1-1 : Interface of Android Application

There have been several commercial and research projects on smart homes and voice recognition systems. An integrated platform for home security, monitoring and automation (SMA) from uControl [3]. The system is a 7-inch touch screen that can wirelessly be connected to security alarms and other home appliances. The home automation through this system requires holding and interacting with a large panel which constraints the physical movements of the user [4]. Another popular commercially available system for home automation is from Home Automated Living (HAL) [5]. HAL software taps the power of an existing PC to control the home. It provides speech command interface. A big advantage of this system is it can send commands all over the house using the existing highway of electrical wires inside the home's walls. No new wires means HAL is easy and inexpensive to install. However,

most of these products sold in the market are heavily priced and often require significant home make over.

Home automation is not a new concept in today's world, it is used to provide convenience for user to remotely control and monitor the appliances and it provides a better use of electricity. The efficient use of electricity makes the HOME automation to play an important role in daily life. As by the growth of PC (personal computers), internet, mobile phone and wireless technology makes it easy for a user to remotely access and controls the appliances. A lot of research has been done and many solutions have been proposed to remotely access the HOME appliances. Some of them used internet, wireless technology to communicate and control home appliances, others used Bluetooth and GSM technology for controlling the home appliances.

Smart spaces are intelligent environments that are able to acquire and apply knowledge about its inhabitants and their surroundings in order to adapt to the inhabitants and meet the goals of comfort and efficiency [3]. These goals of comfort and efficiency are met through the use of mobile phones in the remote control of the smart spaces. These capabilities rely upon effective prediction, decision making, robotics, wireless and sensor networking, mobile computing, databases, and multimedia technologies. There are a number of benefits inherent to Smart Homes. First, for many, it's an important consideration - a Smart Home can save money. This is achieved through savings in heating, cooling, water, and other utility costs.

2 LITERATURE REVIEW

K. Y. Lee and J. W. Choi [1], in their research on the Housing Learning and Improvement Network in 2003, defined a Smart Home as a "unit where all the appliances of the house are connected together and controlled and monitored remotely." The following paragraphs will give a summary of the previous research works in the field of Smart Homes. K. Y. Lee, and J. W. Choi [1], in their research Home automation Home automation was first introduced into the world market in the 1970s, but it failed to meet the expectations of people and was unsuccessful. There were various reasons associated with the failure of the home automation system. The system was neither user friendly nor cost efficient. Currently, the foremost point to be kept in mind when designing system is that it should be cost-efficient and easy to install.

2.1 Speech Recognition System

R. Gadalla [2], in their research the concept of Smart House aims to integrate technology into houses to a level where most daily tasks are automated and to provide comfort, safety and entertainment to the house resident. In order to maintain a natural medium of communication, the house employs a speech recognition system capable of analyzing spoken language, and extracting commands from it. The application now utilizes the Microsoft Speech Application Programming Interface (SAPI), a software layer which sits between applications and speech engines and The Microsoft Speech Recognition Engine (MS SRE), which is free to use.

The system can be optimized using Context Free Grammar (CFG) to give enhanced recognition in the intended application. Speech synthesis is achieved using any SAPI compliant text to speech engine. Further developments will focus on designing a telephony system using Microsoft Telephony Application Programming Interface (TAPI), that will allow the house to be remotely controlled from anywhere in the world. House residents will be able to call their house from any part of the world and regardless of their location the house will be able to respond to and fulfill their commands.

2.2 Home OS

Innovation is breeding heterogeneity and complexity that frustrates even technically-savvy users‟ attempts to improve day-to-day life by implementing functionality that uses these devices in combination. For instance, it is impossible for most users to view video captured by their security camera on their Smartphone when they are not at home. Heterogeneity across devices and across homes also makes it difficult to develop applications that solve these problems in a way that work across a range of homes. To simplify the management of technology and to simplify the development of applications in the home, we are developing an "operating system" for the home. HomeOS provides a centralized, holistic control of devices in the home. It provides to users intuitive controls to manage their devices. It provided to developers high-level abstractions to orchestrate the devices in the home. HomeOS is coupled with a HomeStore through which users can easily add obtain applications that are compatible with devices in their homes and obtain any additional devices that are needed to enable desired applications. I conducted studies to both understand the difficulties that people face today in managing modern technologies in the home and understand how they would like to manage and secure them in an ideal world. Based on these findings, I have developed a research prototype of HomeOS. Our current prototype includes support for a range of devices (e.g., switches, cameras, TVs) and applications. Experimental results show that it is easy for developers to write applications and for non-technical users to manage their home networks with HomeOS.

R. Piyare [3],in their research electronically control of household activities has long been explored in various ways. From electronic remote control using infrared sensor to voice controlled application, we are continually trying to find a better way to control electrical and electronic devices to ease our daily life. This work presents the development of low cost remote home control system using speech recognition module HC05. The system focused on controlling fan, lamp and other electrical appliances. The voice command is analog input. The main control unit accepts voice command from the user and fed to Arduino. Arduino senses the input signal, processes it and give instructions to the relay which in turn turns on/off the electrical loads.

Kailash Pati Dutta[5], in their research automation of the surrounding environment of a modern human being allows increasing his work efficiency and comfort. In the present times, we can find most of the people clinging to their mobile phones and smart devices throughout the day. Hence with the help of his companion a mobile phone, some daily household task scan be accomplished by personifying the use of the mobile phone. Home Automation System (HAS) has been designed for mobile phones having Android platform to automate an 8 bit Bluetooth interfaced microcontroller which controls a number of home appliances like lights, fans, bulbs and many more using on/off relay. This paper presents the automated approach of controlling the devices in a household that could ease the tasks of using the traditional method of the switch. The most famous and efficient technology for short range wireless communication- Bluetooth is used here to automate the system. The HAS system for Android users is a step towards the ease of the tasks by controlling one to twenty four different appliances in any home environment.

Computerization of the encompassing environment of a present day individual permits expanding his work proficiency and solace. There has been a huge improvement in the zone of an individual's standard undertakings and those can be mechanized. In the present times, we can discover the greater part of the general population sticking to their cell telephones and brilliant gadgets for the duration of the day. Subsequently with the assistance of a buddy cell phone, everyday family assignments can be refined by embodying the utilization of the cellular telephone.

Home Automation System (HAS) has been intended for devices running Android which acts as a medium to mechanize a 8 bit Bluetooth interfaced microcontroller, Arduino. It has been programmed to control various home apparatuses like lights, fans and numerous other home appliances all the more utilizing on/off transfer. This paper shows the computerized methodology of controlling the gadgets in a family that could be a replacement of conventional switches. The most celebrated and effective innovation for short range remote correspondence Bluetooth is utilized here to computerize the framework. The HAS framework for Android clients is a stage towards the simplicity of the assignments by controlling one or more distinct machines in any home environment.

The system as the name indicates, 'Home Automation using Voice Recognition and Arduino' makes the system more flexible and provides attractive user interface compared to other home automation systems. In this system we integrate mobile devices into home automation systems. A novel architecture for a home automation system is proposed using the relatively new communication technologies.

BarisYuksekkaya, A. AlperKayalar, M. BilgehanTosun, [7], in their research the system consists of mainly three components is a Bluetooth module, Arduino microcontroller and relay circuits. Bluetooth is used as the communication channel between android phone and the Arduino microcontroller. We hide the complexity of the notions involved in the home automation system by including them into a simple, but comprehensive set of related concepts. This simplification is needed to fit as much of the functionality on the limited space offered by a mobile device's display.

HumaidAlShu'eili, GourabSen Gupta, SubhasMukhopadhyay[11], in their research the recent years, the voice controlled home automation systems have seen a rapid change due to introduction of various wireless technologies. This system is the most suited to seniors and the disabled persons especially those who live alone and since recognize voice so it is secure. The words manipulated home automation system is designed to control all lights and electrical home appliances in a home or office using voice instructions. All that the end user needs is an Android Operating System (OS) Smartphone, which exists in almost everybody's hand nowadays, and a control signal. The control circuit involves an Arduino Uno microcontroller, which steps the user commands and controls the switching of devices. The connection between the microcontroller and the Smartphone is made via Bluetooth, a widespread wireless technologies used for writing data & integer data. So in this paperwork our aim is to design a voice reputation wireless based home software system.

The methodology for a project named "Speaker Identification based automation system through speech recognition". Automation industry is growing rapidly; the central goal of design of speaker identification based automation is to provide an efficient and convenient integration and inter-operation among appliances in households and industry. Home automation systems must comply with the

household standards and convenience of usage. This paper discusses the overall design of a wireless speaker identification based automation system which is built and implemented. Along with hardware, necessary software tools like MATLAB should present a comfortable user interface for security.

Rojas-Rodríguez Rafael, Aceves-Pérez Rita1, Cortés-AburtoObed, García-Meneses Carlos1, Vela-Valdés [14],in their research the automation centers on recognition of voice commands stored in data base and it is matched with incoming voice command of user. It uses low-power RF ZigBee transceiver wireless communication modules which are relatively cheap. Speaker identification based automation system is intended to control lights and electrical appliances in a home or office using voice commands.

The home automation system has been experimentally proven to work satisfactorily by connecting sample appliances to it and the appliances were successfully controlled from a wireless mobile device. The Bluetooth client was unsuccessfully tested on a multitude of different mobile phones from different manufacturers, thus proving its portability and wide compatibility. Furthermore, flexible types of connections are designed as backup connections to the system. The connected GUIs are synchronized to the control board. They indicate the real−time switches status. The system is designed in user-friendly interface. The easy to use interface on Window and Android GUI provides simple control by the elderly and disabled people.

Implementing voice recognition technique for home control system can make our life easier. This type of control system can be applied to the situations where it is not feasible to manually control the home appliances. It can help disabled and elderly living at home. The effectiveness of the system depends on several factors, which are the user pronunciation, the level of noise in the room where the system is set up and the distances between the transmitter and receiver modules.

Voice recognition Home Automation System is a very useful project for the adults and physically disabled persons, who are not able to do various activities efficiently when they are at home and need one’s assistant to perform those tasks. It is

easy to use. The functionality of the system is easy to understand. It is very useful for winter season and more useful who are physically injured. The cost of the system is not very high. The proposed project undertakes a viable solution the need of automation at the very basic level, that is, in our homes. The project will enable us to bring every appliance at every corner of our home under our control from a single point without having to get up and manually switch on or off the appliance. The use of a Bluetooth module assists the use of this sys-tem from various locations in our house. So every user can choose the system for their home automation system without any hesitation.

T. Tamura et. al. [15], in their research, constructed the welfare techno houses in Japan in 2003. The motive behind the project was to monitor the health of the disabled and older people living in the home, thereby improving their quality of life. D. J. Cook et. al. [16] successfully conducted the MavHome project at the University of Texas, Arlington. The project used sensors to detect the state of the environment, and with the help of controllers, took the necessary action to maintain equilibrium. These sensors form an ad-hoc network to make the decisions. H. Kanmaet. al. [17] conducted a medical research to monitor people who require medical help and present a wireless solution at the University of McGill in Canada. The project made use of cell phones and inexpensive sensors. It worked by making use of wireless protocols such as Bluetooth, ZIGBEE, as well as GSM and analyzing data through an adaptive architecture.The research had an architecture that consisted of three main parts. First, sensors collected the medical data and transmitted it via sensors to mobile devices. Second, an application called J2ME on mobile devices processed the collected data. Finally, all the data that was collected was combined to address the needs of the elderly.

The major benefit of this project is that it could be implemented at an inexpensive price in a short span of time. In the past few years, significant research has been conducted in the field of Smart Homes to make the technology better for handicapped and elderly people. N. Liang et. al. [18] have described challenges related to Smart Homes and conducted research at the University of Erlangen, Germany, for the betterment of these populations and identified the benefits in-order to help them lead more independent lives.

3 SYSTEM ARCHITECTURE

The Home Automation System (HAS) was produced utilizing Android Studio throughout exploration and now a User Interfaced (UI) Android Application program actualized on an Android based Bluetooth empowered cellular telephone, and a 8-bit microcontroller(Arduino) based transfer driver circuit with Serial Bluetooth Module, which can speak with the Home Appliances over Bluetooth join. The framework depends on serial information transmission utilizing Bluetoothremote correspondence as a part of request to encourage the machines control in a HAS. This framework guarantees a secured trade of information on remote correspondence. It additionally underpins customary ON/OFF arrangement of machines. A client interface (UI) on the Android empowered cellular telephone offers framework association.

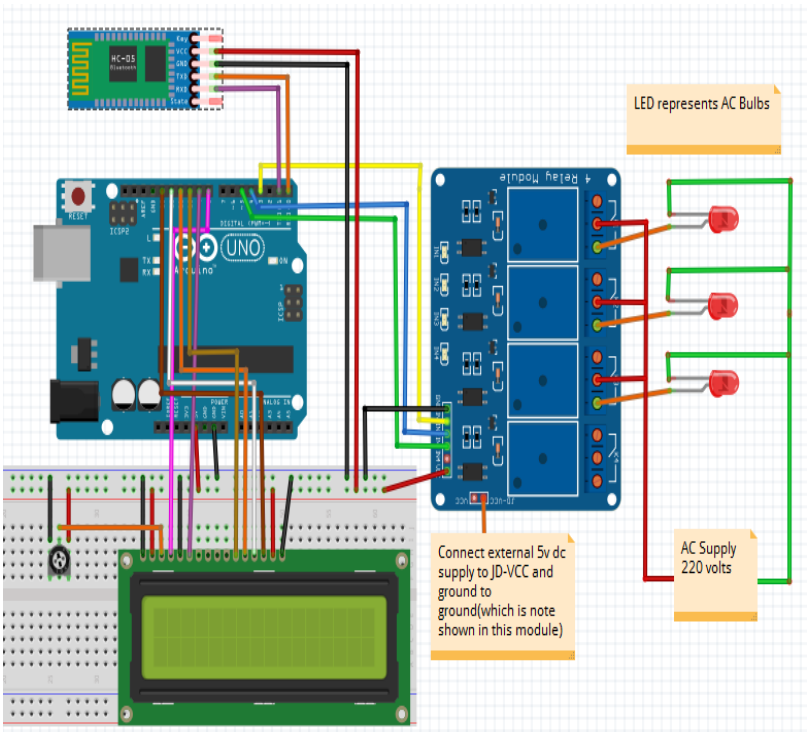


Figure 3-1 : System Architecture

The Voice-operated Android and Arduino Home automation system uses an Android based Bluetooth enabled phone for its application and the Arduino Uno as the microcontroller. The key components of this system are Android based phone, Wi-Fi module, Arduino Uno, Relay boards.

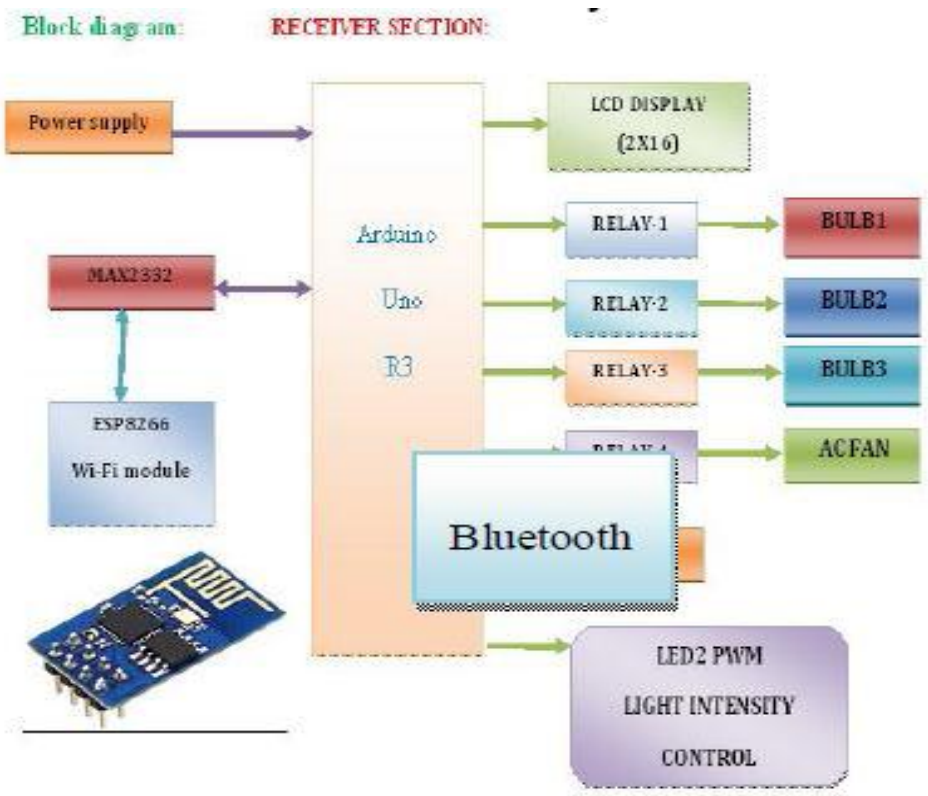


Figure 3-2 : Overview of the proposed Home Automation system

3.1 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328p. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button [2]. It contains everything needed to support the microcontroller. We either need to connect it to a computer using a USB cable or power it with an AC to-DC adapter. The Arduino circuit acts as an interface between the software part and the hardware part of the project [1].

The Wi-Fi module transmits the text to the Arduino Uno serial port. The text is matched against the various combinations of predefined texts to switch the appliances on/off. The appliance name and a command for on/off are stored as predefined command. For example, to switch on a television the user needs to say “television on” and to switch it off he needs to say “television off”.

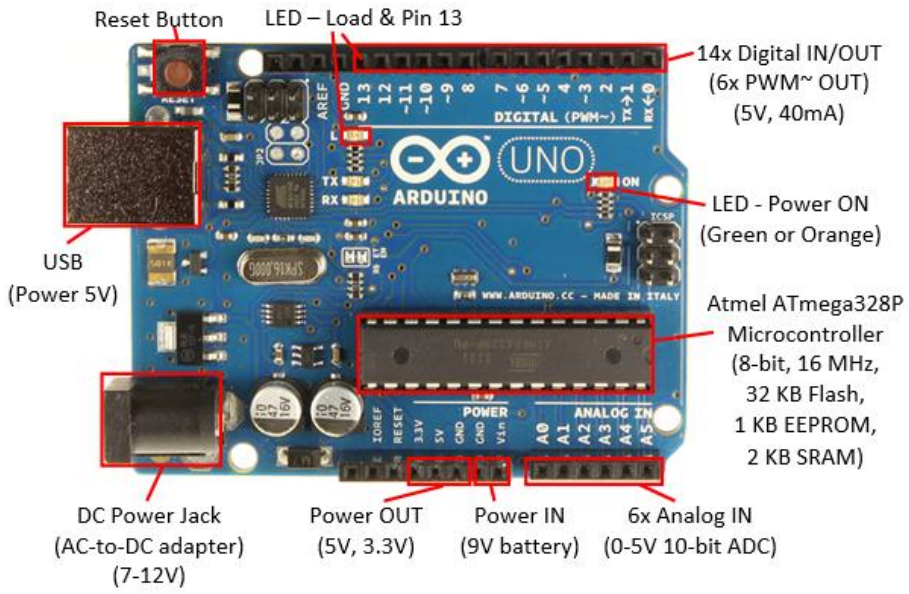


Figure 3-3 : Arduino Uno

The appliances are connected via the relay boards to pin numbers 2, 3 and 4 of the Arduino Uno. When the matching text is detected the corresponding pin number is given a high or low output signal to switch the appliance on and off respectively.

3.1.1 Reasons for Choosing Arduino Uno

There are various successful microcontrollers including MIT‟s Handyboard, Phidgets, and Netmedia‟s BX-24 but the Arduino offers numerous advantages for individuals, including students and instructors that give it an upper hand compared to the other microcontrollers. The advantages of the Arduino are listed as follows.

1. **Less expensive:** Arduino boards are inexpensive compared to other microcontrollers that are available in the market. A preassembled Arduino board is available for as low as $50.
2. **Compatible:** Arduino is compatible with all the operating systems including Linux, Macintosh, and Windows, whereas other microcontrollers are restricted to Windows.
3. **Easy to program:** The environment used to program Arduino and the ways to perform the coding are user friendly even for beginners.

4. **Expandable programming and open source:** The programming language of an Arduino is an open source and can incorporate the Arduino code into the AVR-C code if needed.
5. **Allows easy and fast prototyping:** There are a number of pre-wiring and free code libraries, which help to test an idea instead of spending time in building and creating an excessive amount of low level codes

3.1.2 Pin Configuration:

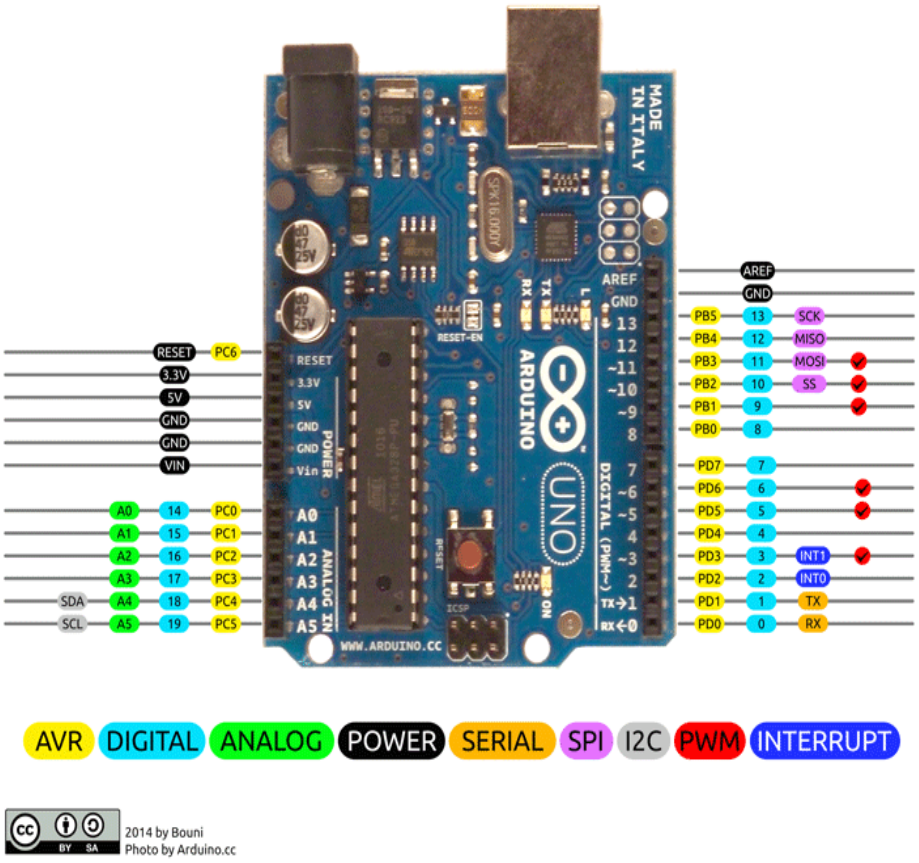


Figure 3-4 : Pin Configuration of Arduino Uno

3.1.3 Pin Description

Table 3-1 : Pin Description of Arduino Uno

Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output Pins	Digital Pins 0 – 13	Can be used as input or output pins.
Serial	0(Rx),1(Tx)	Used to receive and transmit TTL serial data.
External	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

3.1.4 Arduino Uno Technical Specifications

Table 3-2 : Arduino Uno Technical Specification

Microcontroller	ATmega328P – 8 bit AVR family
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V	50 mA
Flash Memory	32 KB (0.5 KB is used for Boot loader)
SRAM	2 KB
EEPROM	1 KB
Frequency(Clock Speed)	16 MHz

3.1.5 Overview

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be

used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

3.1.6 How to use Arduino Board

The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in Arduino programming. Each pin operate at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 K Ohms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

- **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- **External Interrupt Pins 2 and 3:** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using analogWrite() function.
- **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.
- **In-built LED Pin 13:** This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with analog Reference() function.

- ❖ Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library.

Arduino Uno has a couple of other pins as explained below:

- ❖ **AREF:** Used to provide reference voltage for analog inputs with analogReference() function.
- ❖ **Reset Pin:** Making this pin LOW, resets the microcontroller.

3.1.7 Communication

Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. There are two RX and TX LEDs on the Arduino board which will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

3.1.8 Arduino Uno to ATmega328 Pin Mapping

When ATmega328 chip is used in place of Arduino Uno, or vice versa, the image below shows the pin mapping between the two.

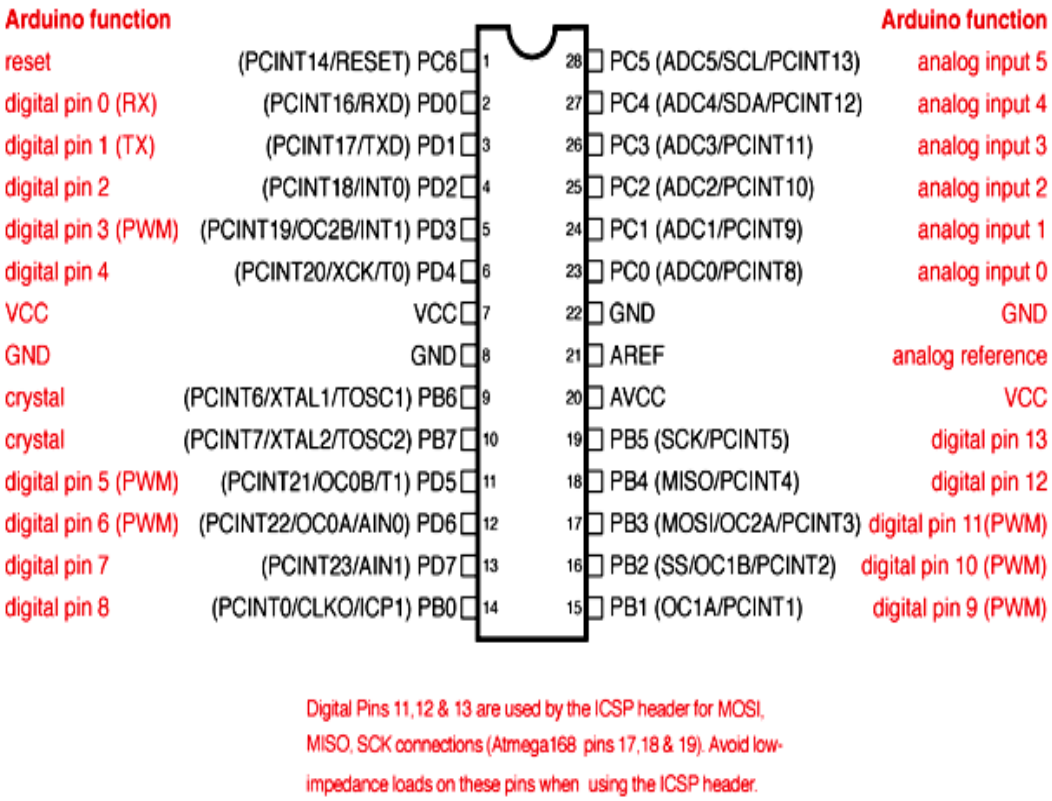


Figure 3-5 : Arduino Uno to ATmega328 Pin Mapping

3.1.9 Programming Arduino

Once Arduino IDE is installed on the computer, connect the board with computer using USB cable. Now open the Arduino IDE and choose the correct board by selecting Tools>Boards>Arduino/Genuino Uno, and choose the correct Port by selecting Tools>Port. Arduino Uno is programmed using Arduino programming language based on Wiring. To get it started with Arduino Uno board and blink the built-in LED, load the example code by selecting Files>Examples>Basics>Blink. Once the example code (also shown below) is loaded into your IDE, click on the 'upload' button given on the top bar. Once the upload is finished, you should see the Arduino's built-in LED blinking. Below is the example code for blinking:

```
// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
pinMode(LED_BUILTIN, OUTPUT);
}
// the loop function runs over and over again forever
void loop() {
digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)
delay(1000);                       // wait for a second
digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
delay(1000);                       // wait for a second
}
```

3.1.10 Applications of Arduino Uno

- Prototyping of Electronics Products and Systems
- Multiple DIY Projects.
- Easy to use for beginner level DIYers and makers.
- Projects requiring Multiple I/O interfaces and communications.

3.2 Bluetooth Module

Bluetooth is a wireless technology standard for exchanging data over short distances (using short wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs). The Bluetooth module being used allows us to transmit and receive signals. It receives the text from the Android phone and transmits it to the serial port of the Arduino Uno. Integrating all the modules gives the model of the proposed system.

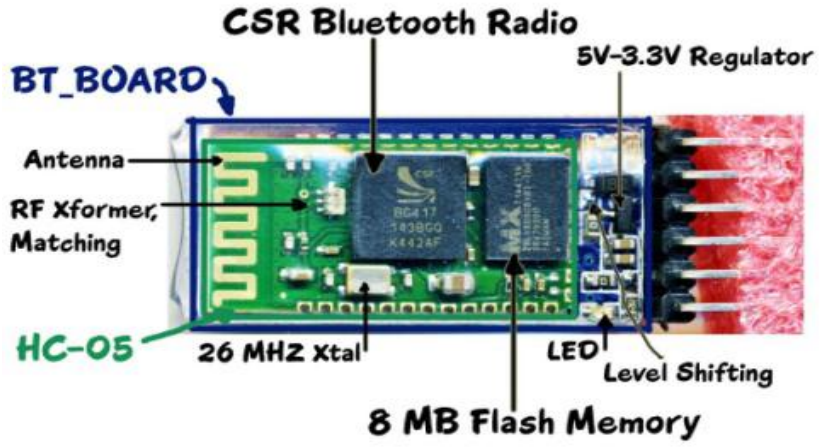


Figure 3-6 : Bluetooth Module

Bluetooth Sub-modules work well with Arduino and other Microcomputers.HC-05 is a more capable module that can be set to be either Master or Slave.HC-05 is small (3 cm long) and run on 3.3V power with 3.3V signal levels, they have no pins and usually solder to a larger board. The module has two modes of operation, Command Mode where we can send AT commands to it and Data Mode where it transmits and receives data to another Bluetooth module.“Breakout" Boards that make these easy to use are available and recommended. These mount the sub module like that shown on the right on a slightly larger board.

The working of the model is as described here. All the appliances that are to be controlled is linked with relays to interface with the UNO. These relays act for triggering of the devices from the server. The Bluetooth board receives the signals from the server and sends it to the UNO board. This processor triggers and on the corresponding device. If there is no signal from the server, the UNO board does not receive any signal from the processor and relay is in idle position or open mode.

3.2.1 Importance of Bluetooth in Home Automation

Home Automation, or Smart Home, has benefited from the critical innovations of Bluetooth technology can be used to connect devices such as mobile phones and laptops. Wired devices require a point to point connection but communication can be established between multiple devices with Bluetooth. A group of Bluetooth devices is called a piconet and this technology is apt for building a Smart Home. The different

appliances of the house (light, fan, etc.) which are controlled via Bluetooth. Bluetooth provides a good platform as it is readily available in almost all the smart phones which are present in the market today and is easy to understand and use. This provides the flexibility to people of all ages to use Bluetooth in a handy manner.

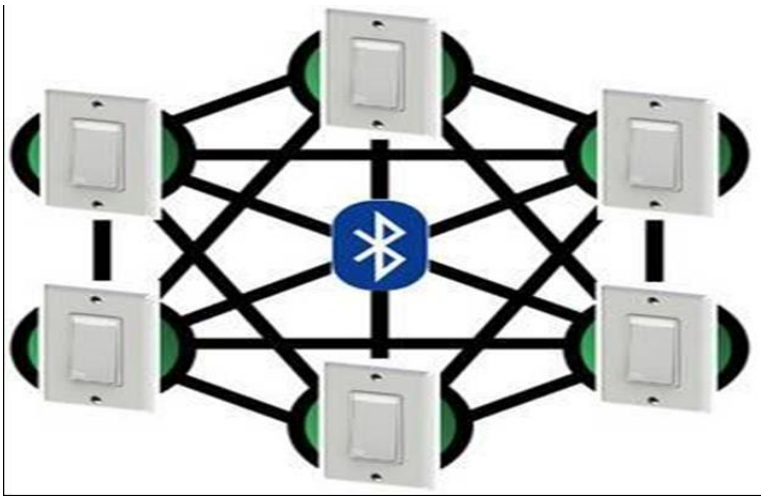


Figure 3-7 : Bluetooth for home automation.

3.3 Android Based Phone

Android is a mobile operating system (OS) based on the Linux kernel and currently developed by Google. With a user interface based on direct manipulation, the OS uses touch inputs that loosely correspond to real-world actions, like swiping, tapping, pinching, and reverse pinching to manipulate on-screen objects, and a virtual keyboard. We have used the Android platform because of its huge market globally and it's easy to use user interface [5]. Applications on the Android phones extend the functionality of devices and are written primarily in the Java programming language using the Android software development kit (SDK). The voice recognizer which is an in built feature of Android phones is used to build an application which the user can operate to automate the appliances in his house. The user interface of the application is shown below:

Figure 3-8 : Interface for the Voice Control Application

The microphone button is tapped and the voice command is given to switch the corresponding device on/off. The voice recognizer listens and converts what is said to the nearest matching words or text. The Bluetooth adapter present in the phone is configured to send this text to the Bluetooth module on the Arduino Uno board that would in turn control the electrical appliances through the relay boar.

3.4 Relay Boards

A relay is an electromagnetic switch. In other words it is activated when a current is applied to it. Normally a relay is used in a circuit as a type of switch (as shown below). There are different types of relays and they operate at different voltages. When a circuit is built the voltage that will trigger it has to be considered.

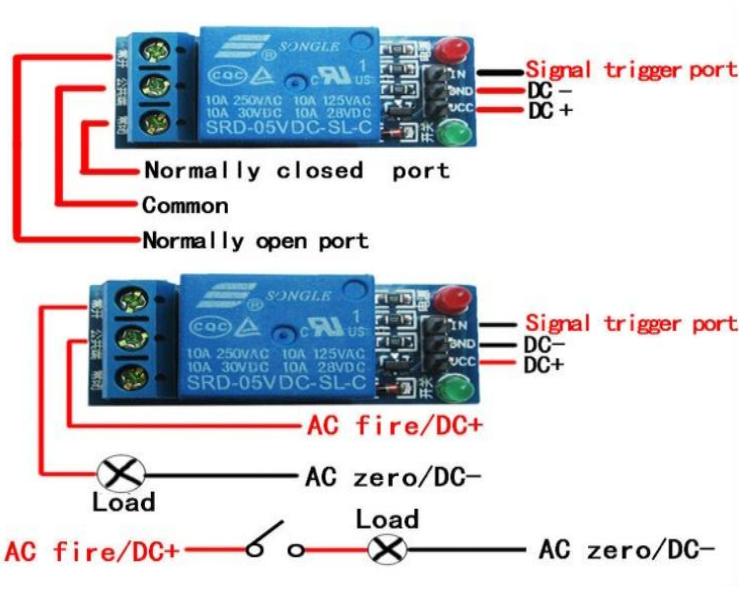


Figure 3-9 : Relay Boards

In this project the relay circuit is used to turn the appliances on/off. The high/low signal is supplied from the Arduino Uno microcontroller. When a low voltage is given to the relay of an appliance it is turned off and when a high voltage is given it is turned on.

4 SYSTEM DESIGN

4.1 Block Diagram of the System

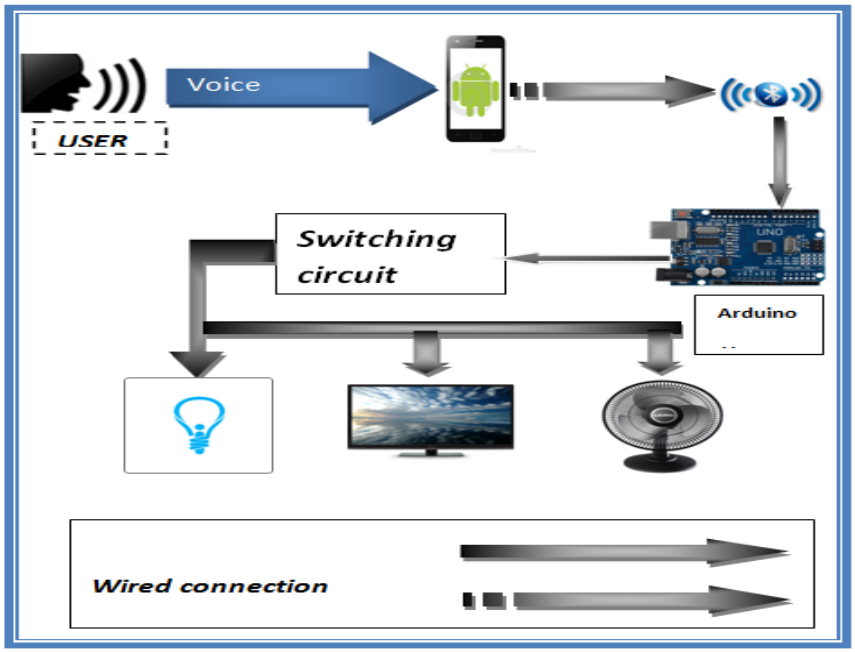


Figure 4-1 : Block Diagram of the System

The Voice Arduino Home automation system uses an Android based Bluetooth enabled phone for its application and the Arduino Uno as the microcontroller. The key components of this system are:

- Arduino Uno
- Bluetooth module
- Bread board
- Android based phone

4.1.1 Android Based Phone

Android is a mobile working machine (OS) primarily based at the Linux kernel and currently evolved by using Google. With a person interface based totally on direct manipulation, the OS makes use of contact inputs that loosely correspond to actual-global moves, like swiping, tapping, pinching, and opposite pinching to govern on-display items, and a virtual key-board. We have used the Android platform because of its massive market globally and it's clean to use consumer interface programs on the

Android phones [4] enlarge the functionality of devices and are written generally in the Java programming language the use of the Android software program improvement pack-age (BT Voice App). The voice recognizer [5] [6] that's an in constructed characteristic of Android telephones is used to build an application which the per-son can perform to automate the appliances [7] in his residence. The user interface of the utility is proven below:

Figure 4-2 : Interface for the Voice Control Application

The microphone voice command is given to switch the corresponding device on/off. The voice recognizer listens and converts what's said to the nearest matching phrases or text. The Bluetooth adapter gift inside the cell phone is configured to send this article to the Bluetooth module on the Arduino Uno board that might in flip manage the electric appliances.

4.1.2 Bluetooth Module

Bluetooth is a wireless technology [8] general for exchanging data over short distances (the usage of brief-wavelength UHF radio waves inside the ISM band from 2.four to 2.485 GHz) from constant and cell devices and building non-public area networks (PANs) .The Bluetooth module [4] being used permits us to transmit and acquire signals . It gets the textual content [9] from the Android Smartphone and transmits it to the serial port of the Arduino Uno.

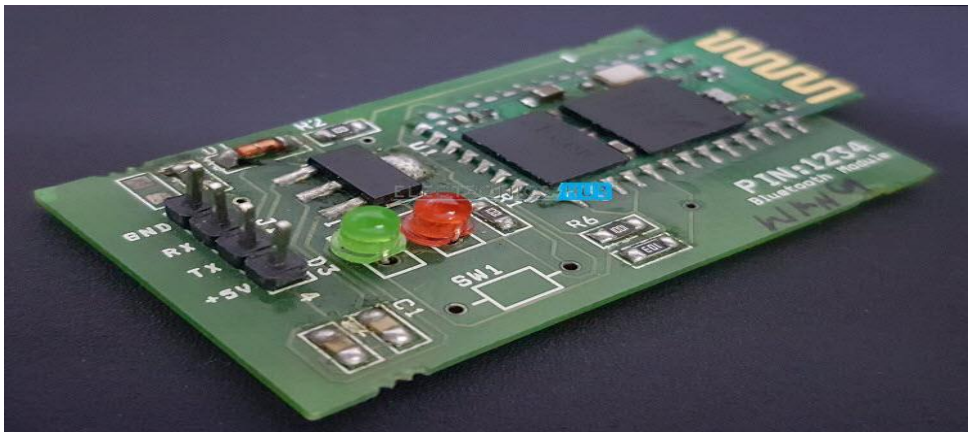


Figure 4-3 : Bluetooth Module Hc-05

4.1.3 Arduino Uno

The Arduino Uno [10] [3] is a microcontroller board primarily based on the ATmega328p [10]. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a electricity jack, an ICSP header, and a reset button.

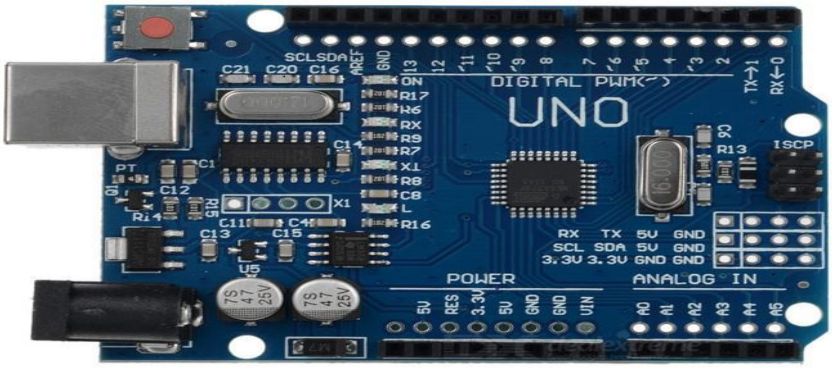


Figure 4-4 : Arduino Uno

It contains everything needed to support the micro-controller. We either want to attach it to a computer the use of a USB cable or power it with an AC-to-DC adapter. The Arduino circuit acts as an interface among the software element and the hardware a part of the project. The Bluetooth module transmits the text to the Arduino Uno serial port. The text is matched in opposition to the numerous combinations [11] of predefined texts to replace the appliances on/off. The appliance name and a command for on/off are saved as predefined command as an in-stance, to interchange on a TV the person desires to mention “tv on” and to replace it off he needs to say

"TV off". The appliances are connected via the relay boards to pin numbers 2, 3 and 4 of the Arduino Uno.

4.2 Use Case Diagram:

Use case diagrams are intended to model the functional requirements of the system. It shows a set of use cases and actors and their relationships. It is always selected to be the start point of software design. The following figure shows the use case diagram of the HACS system from the end user point of view

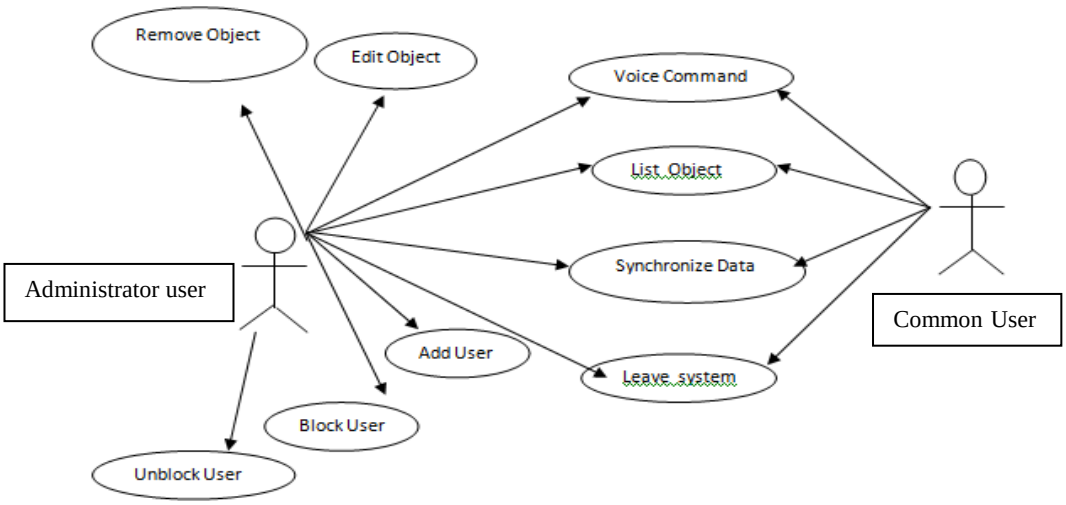


Figure 4-5 : Use Case Diagram

4.2.1 Actors

- **User**
  User refers to the person who has an account and a password, can log in on HACS, and operate home appliances remotely by HACS.
- **Admin**
  Admin is a kind of user who has special rights, for example Add/Remove Device and Add/Remove Remote System, other than basic operations.

4.3 Flowchart:

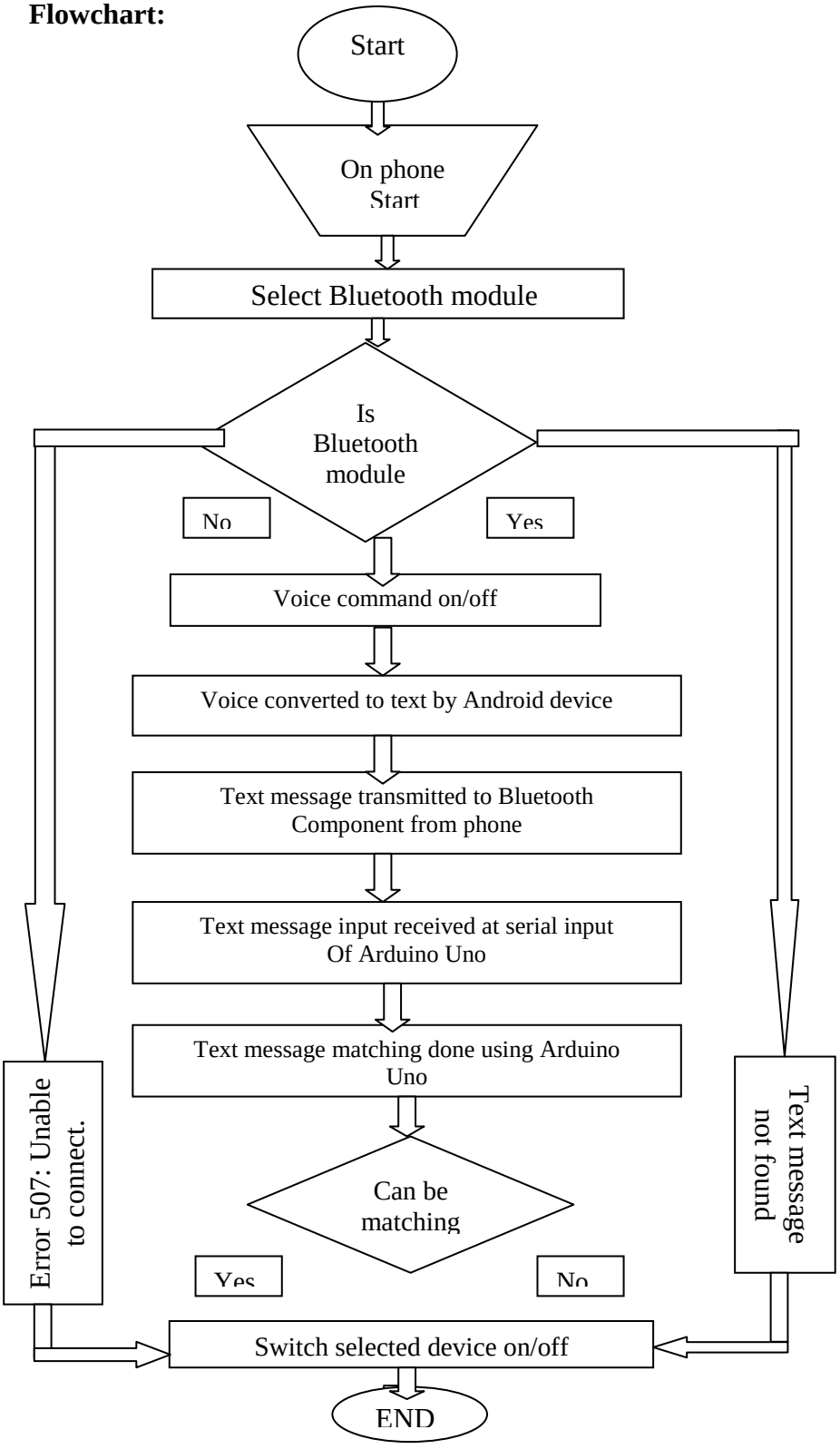


Figure 4-6 : Flowchart of System

4.3.1 Transmitter module

The transmitter module is designed to be portable- and voice operated. The main part of the transmitter is Arduino Uno, as the microcontroller and EasyVR 2.0 board as the speech recognizer. EasyVR works as a slave board and communicates by using UART. The baud rate used is 9600 and the frame consists of 8 Data bits, No parity and one stop bit. Figure-2 shows the circuit diagram of transmitter module. Voice recognition for this system is implemented using Arduino EasyVR 2.0 module. EasyVR is chosen because of it's ability to integrate with Arduino boards ,and its' low power consumption where it only uses 3.3V to5V. In this system, the user-defined Speaker Dependent(SD) triggers is use to activate the system while the built in Speaker Independent (SI) commands is use to run the output device by using US English language. It used hidden Markov model HMM to train the command for the system.

The EasyVR is embedded with RSC Family 428which handles speech recognition process. It uses Hidden Markov Model (HMM) to train the command for the system. HMM portrayed speech signal the need to make two assumptions, one internal state of the transfer is only related to a previous state, and the other is that the output value is only relevant to the current state (or the current state of the transfer), these two assumptions greatly reduced the model complexity. The acoustic characteristics of the system and the output values are usually calculated from the respective frames [10].Attached to the EasyVR module is a unidirectional electret condenser microphone which uses3V for operating voltage. The load impedance is 2.2K and the sensitivity of the microphone is -38dB. The others kind of microphones are not supported by EasyVR module.

EasyVR Commander Software, which comes with the hardware, is used to configure and to program commands and sounds into an EasyVR module, with the provided "bridge" program. The coding for "bridge" program is developed in the Arduino IDE. There are several types of ready to run basic control, speaker independent commands in the software. All of them have their own function according to the user needs and available in different languages such as US English, Italian, Japanese, German, Spanish, and French. EasyVR also supports up to 32 user-

defined Speaker Dependent (SD) triggers or commands (any language) as well as Voice Passwords.

4.3.2 Receiver module

The heart of the receiver module is Arduino Pro Mini, which is a microcontroller board based on theATmega328. It runs at 5V and 16 MHz and has 14 digital input/output pins (of which 6 can be used as PWM (outputs), 6 analog inputs, an on-board resonator, a reset button, and holes for mounting pin headers. A six pin header can be connected to an FTDI cable or Spark fun breakout board to provide USB power and communication to the board. This microcontroller controls the RF receiver and both outputs: the lamp and fan. The receiver module can work well for low performance, non-critical applications. The operating voltage is 5V DC with receiving frequency of 315MHz. The receiver sensitivity is 105dB with the help of external antenna 32cm single core wire, wound into a spiral. Figure-3 below shows the circuit diagram for the receiver module. There are four pins on the RF Receiver which are source pin, ground pin, and two pins of data. The source and ground pin is connected with the Vin and Gnd pin of Arduino Pro Mini. Pin A03 on Arduino Pro Mini is used to connect the data pin of RF Receiver. This connection is very important to make the communication between these two devices functioning well.

4.4 Application Flow Chart

The application flow chart in figure 2 shows the program flow. The Bluetooth module and connected relays are initialized first. The modem will now check for any data. If any data is received, it will identify the device and the mode in which it is to be controlled. If the received data suggests to controlling the fan in automatic mode, the modem will send data to the temperature sensors via controller. The controller is programmed to execute a particular action for a particular value of received data.

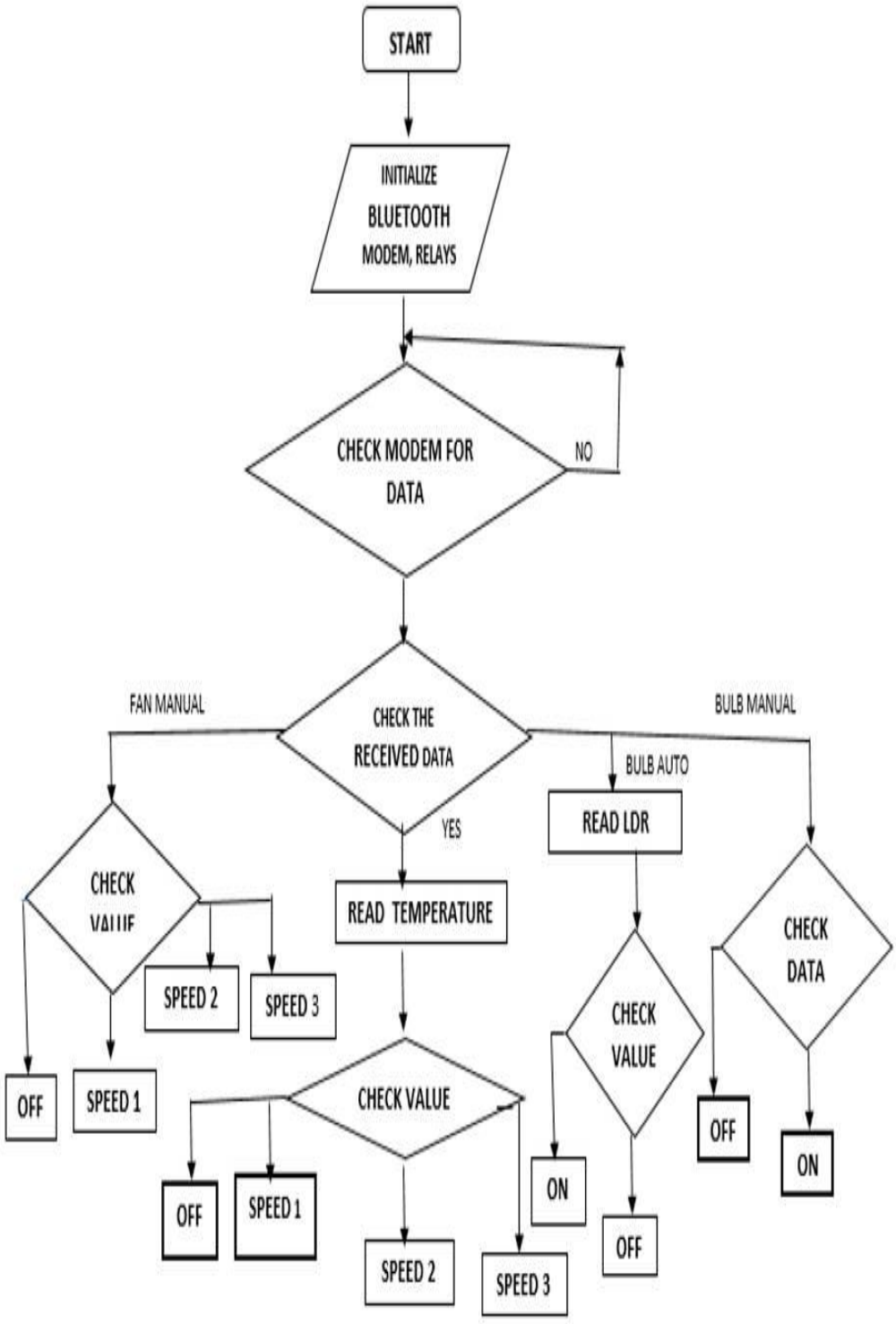


Figure 4-7 : Application flow chart

4.5 Software Design

Software design for this project involves training for speech processor as HM 2007 is ASIC processor and assembly programming for microcontroller to work on incoming signals from speech processor. It receives control commands from processor and switches ON/OFF relay connected to the particular appliance. Our project simultaneously works with MATLAB code, where speech recognition will be carried out using MFCC algorithm. If voice command is matched with the corpus stored in system then and then only code will generate matched waveform and appliance will be activated.

4.5.1 MFCC algorithm

Mel frequency Cepstral Coefficient (MFCC) is used to extract the features from voice and Vector quantization technique to identify the speaker. Voice has an infinitive amount of information, we have to determine who is the person speaking based on the features of the person´s voice. An analysis for the voice in time domain will be very impartial. So an analysis in the frequency domain can be a more viable option. Extract the parametric representation of voice signals is a vital process for the recognition performance. MFCC is a technique based on human hearing behavior that cannot recognize frequencies over 1Khz. MFCC are base on the difference of frequencies that the human ear can distinguish. The signal is expressed in the MEL scale, this scale is based on the perception of the pitches in an equally spaced intervals judged by observers. This scale uses a filter that is spaced linearly at frequencies below 1000 Hz.

4.5.2 MFCC algorithm follows following steps:

1) Automatically detects an isolated word from your speech (input utterance). It does this by calculating energy and the number of zero crossings on a frame-by frame basis, and compares these values to a threshold.
2) For each frame in a word, it applies a window function followed by a preemphasis filter. It then calculates MFCC and their delta and delta-delta coefficients for each frame, and uses these as feature vectors.
3) For each word's training data, we estimate the parameters of a Gaussian Mixture Model to fit the distribution of training vectors. We therefore train a model to represent each word.

4.6 Project Flow

Figure below shows the steps needed to accomplish the goals of this project in a sequential manner.

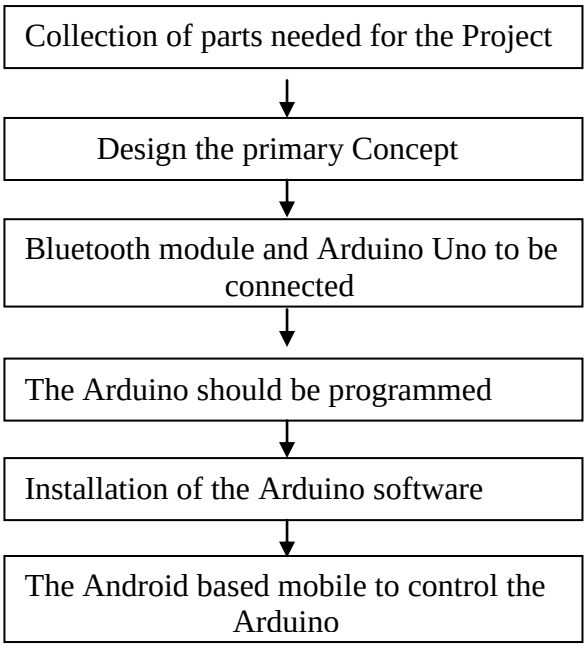


Figure 4-8 : Project flow

First, all the parts needed to design the project are collected and a primary concept is designed based on it. Next is the connection between the Arduino Uno and the Bluetooth via the Bluetooth module which is the most important part of the project. After all the connection is being done, the Arduino board needs to be programmed and the Arduino software has to be installed. At the end, the Android based mobile phone is used to control the Arduino Uno via.

5 IMPLEMENTATION & RESULT

5.1 Hardware Implementation

5.1.1 Programming the Arduino Uno

The Arduino-Uno board needs to be programmed with a code so that it is able to interact with the application. Arduino provides a flexible platform, which helps to write a code for any function to be performed by the Arduino Uno and upload to the board. APPENDIX A shows the full source code of the Arduino Uno. Interfacing the Atmega328 with Electrically Erasable Programmable Read Only Memory (EEPROM) is done using the Universal Synchronous Asynchronous Receiver Transmitter (USART) protocol. The code is written in Embedded C using Atmel studio 6.0. The code is then compiled and converted to HEXcode. Afterwards, the HEX code is then burned to the Atmega 328 microcontroller.

5.1.2 Integrating the Bluetooth Module to Arduino Uno

For the Arduino Uno to be controlled, a connection is required between the Bluetooth module and the Arduino Uno. The VCC port on the Arduino Uno board is connected to the VCC pin on the Bluetooth module (HC-06). The GND port on the Arduino Uno is connected to the GND pin on the Bluetooth module (HC-06). Finally the transmitter of the Bluetooth module is connected to the receiver of the Arduino Uno as well as the transmitter of the Arduino Uno to the receiver of the Bluetooth module need to be connected. Table 3 shows the connection between the Arduino Uno and the Bluetooth module.

Table 5-1 : Connection between Arduino Uno and the Bluetooth Module

Arduino Uno Board	Bluetooth Module
GND port	GND pin
VCC port	VCC pin
Transmitter Pin	Receiver Port
Receiver Pin	Transmitter Port

5.1.3 Connection between the Bluetooth Module and Arduino Uno

The connection between the Arduino Uno and the Bluetooth module is the fundamental connection in the circuit. The block diagram shows the connection between the Bluetooth module and the Arduino Uno.

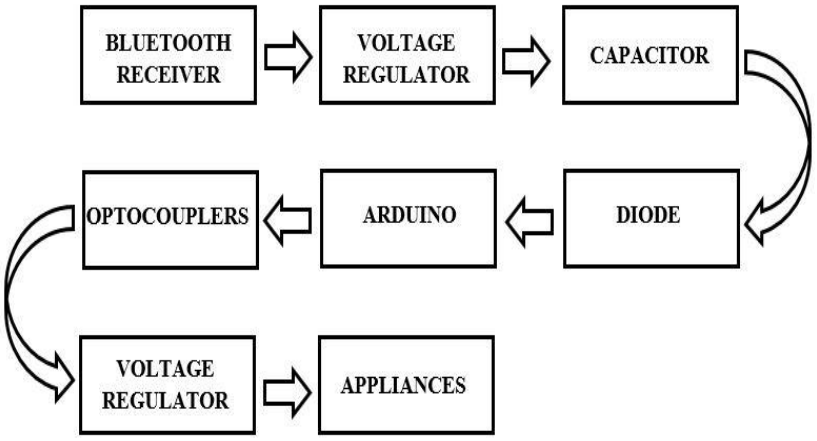


Figure 5-1: Connection between the Bluetooth module and the Arduino Uno.

The Bluetooth receiver transfers the signal to the voltage regulator, which then regulates the voltage and forwards it to the capacitor. Two capacitors are used in this circuit. One capacitor is of 1000 microfarad for appliances, that requires high power to operate and the other is of 10microfarad, which requires low power to operate. The signal from the capacitor goes to the diode that restricts the flow of current to one side and allows the current to flow only in a single direction. The Arduino board then receives the signal from the diode, which goes to the optocouplers. Afterwards, the optocoupler is connected to the voltage regulator before being connected to the appliances. This connection is due to the optocoupler having a maximum power of 9000 watts, which if directly connected to the appliances may cause damage. The optocoupler is connected to a voltage regulator that regulates the voltage and drives the appliances.

5.1.4 Communication between Android Phone and the Appliances

The application on a mobile phone is coded with an integer value of 49, 50, 51, 52, 53,54, 55, and 56. After opening the application, 1 and 49 are pressed and converted to the binary value as well as sent to the receiver of the Bluetooth module (HC-06) via the Bluetooth on a cell phone. The binary value from the Bluetooth module goes to

the Arduino. Arduino checks in its database the equivalent of the binary code. If it is HIGH, the light should be turned ON and if itis LOW, the light should be turned OFF.

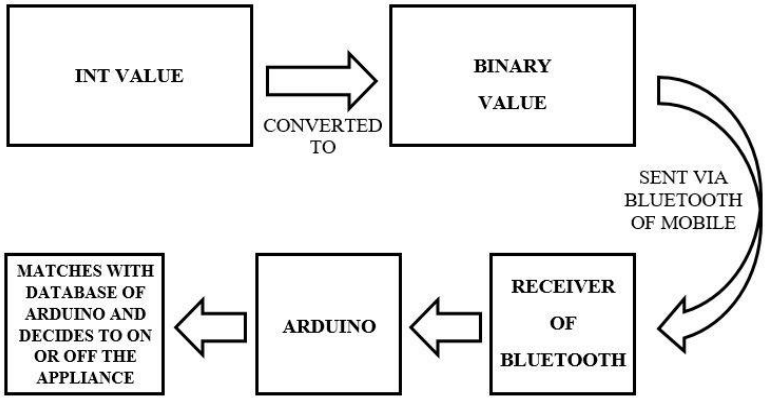


Figure 5-2 : Communication between Android Phone and the Appliances

5.1.5 How to Test the Connection

After the application is installed on the mobile phone and the Bluetooth module is connected to the Arduino Uno, the connection is to be tested to make sure that the phone is interacting with the Arduino Uno via the Bluetooth module (HC-05).The steps to test the connection are as follows:

1. Open the application installed on the mobile phone.
2. With the help of the application, search for the Bluetooth devices.
3. Connect to the Bluetooth module (HC-05).
4. If the blinking of the light stops in the Bluetooth module, then it is Working correctly, and the connection is established. If the light continues to blink, the connection needs to be checked.

5.1.6 Connecting the Appliance to the Arduino Board

After all the connections are done, the home appliances should be connected to then Arduino. The positive end of the home appliance has to be connected to the anode port of the optocoupler and negative end of the appliance has to be connected to the power source using wires. Using different optocouplers and Arduino ports, the connections is made for other appliances. Finally, with the help of a Bluetooth connected Android phone, all of the appliances in the house are controlled wirelessly.

Using the above cited additives [2] we implement our machine on a breadboard. The microcontroller device with the Bluetooth module and relay circuit needs to be connected with the transfer board. Then we need to release the android based software-"auto-mobile domestic" on our phone. Through the application we are able to instruct the microcontroller to exchange on/off equipment. Upon getting the guidance via the Bluetooth module the microcontroller gives the signal to the relay board. The software first searches for the Bluetooth de-vice. If it is to be had then it launches the voice recognizer. It reads the voice and converts the audio sign right into a string. It produces a fee for every appliance in order to accept to the microcontroller tool. The microcontroller makes use of the port in serial mode. After studying the facts it decodes the enter price and sends a sign to the parallel port thru which the relay circuit can be activated. on this paintings we use Bluetooth module. We also can connect a Blue-tooth module to do the work, the usage of which the utility can be used anywhere in which a cell network is available.

5.2 Software Implementation

5.2.1 Arduino Software (IDE)

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board.

5.2.2 Programming Language Used

- **Embedded C**

C is the language of choice for programming larger microcontrollers (MCU), those based on 32-bit cores. These parts are often derived from their general-purpose counterparts, and are both as complex and feature-rich. As a result, C (and C++) compilers are necessary and readily available for these MCUs. With a refined design in hand that takes into account the prospective hardware environment, you can begin coding. Starting to code an embedded project is not much different from coding a desktop application project. Most significantly, the only software environment present

is that which you establish, through device defaults, global declarations, and setup routines. The main() function is indeed the main function.

There are other practices that characterize embedded C development:

- in-line assembly language,
- device knowledge, and
- mechanical knowledge.

- **Java and XML**

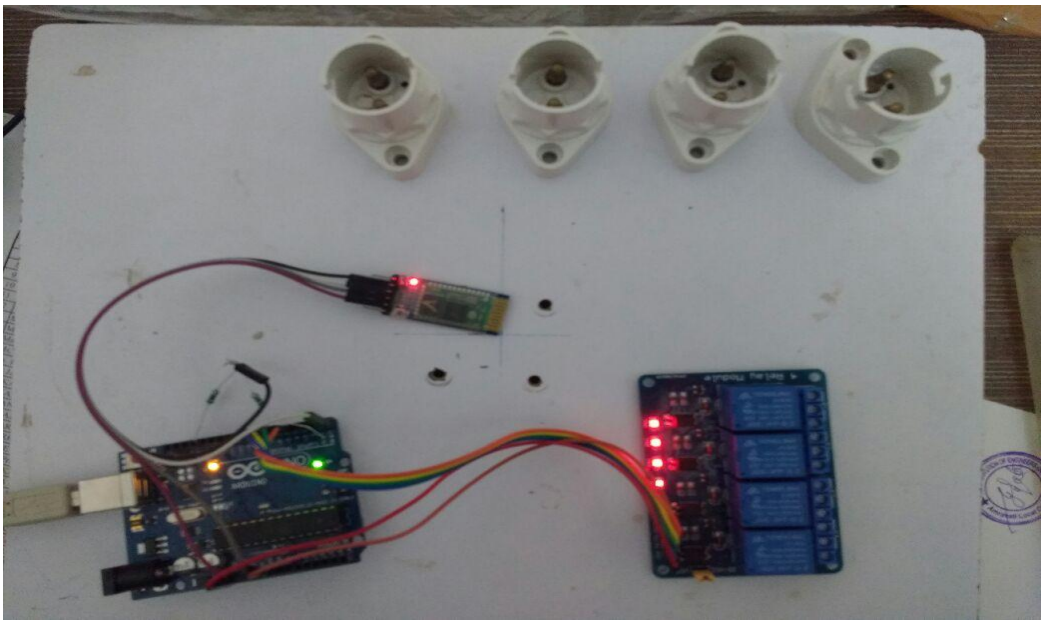
Java provides a broad functionality for dealing with XML data.Two main mechanisms to parse XML:

- To parse your data sequentially as a stream of events
- To build an object representation of it

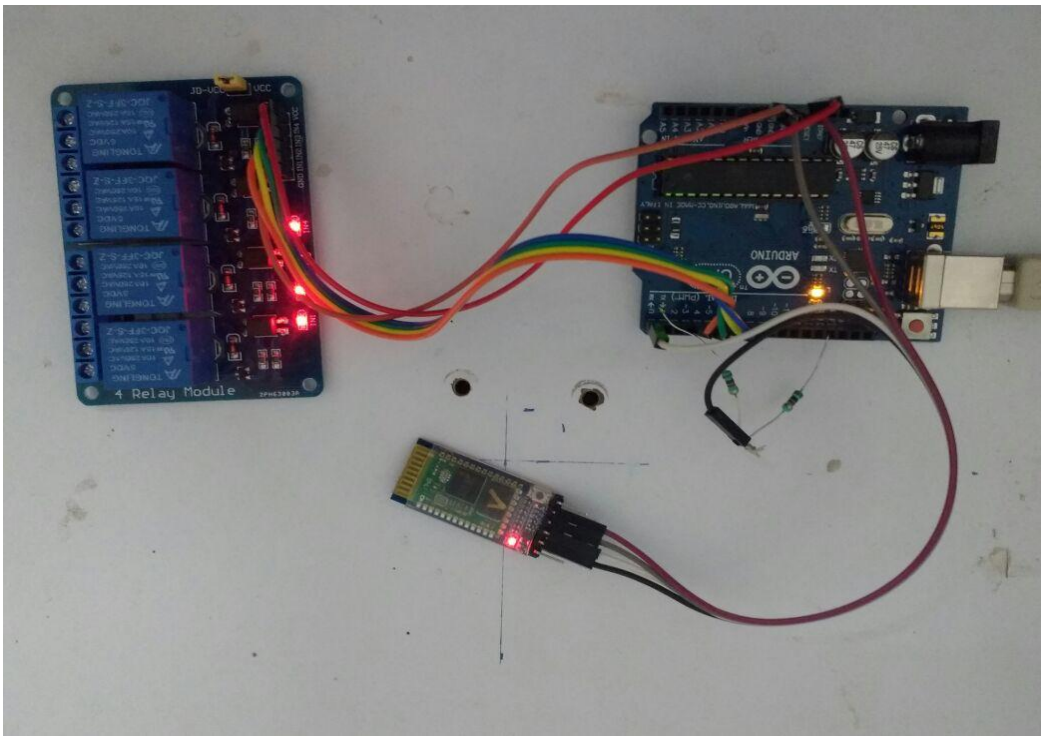
Several XML toolkits are available for Java, e.g.:

- JAXP is part of the Java platform
- JDOM is open source

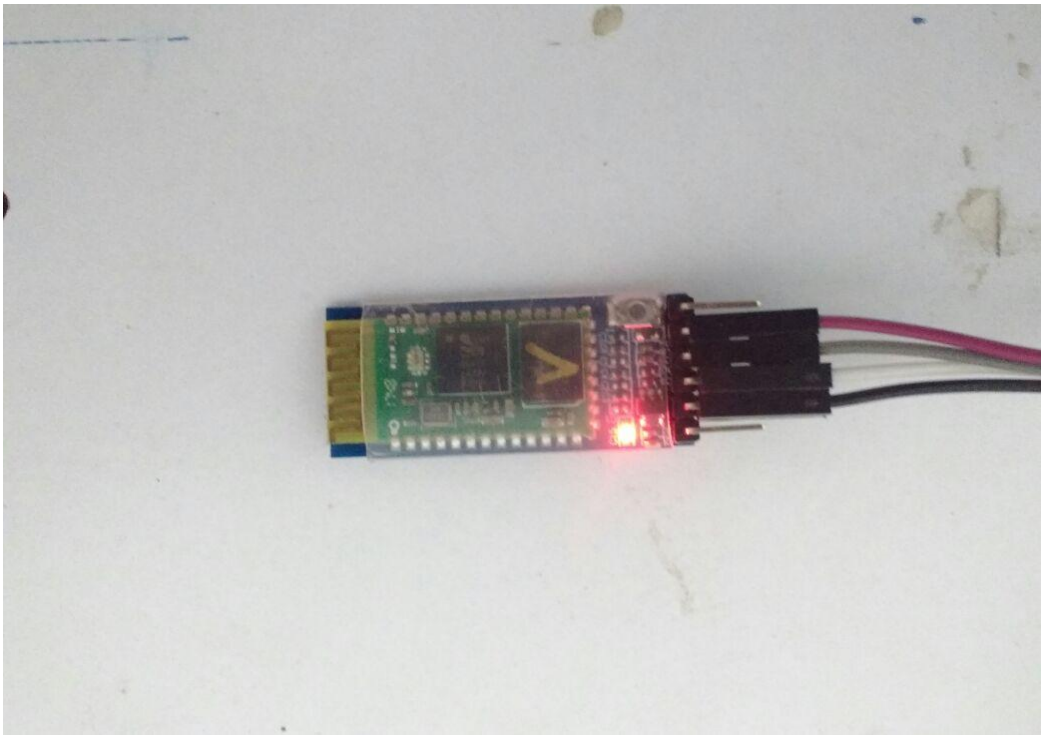
5.3 Screenshots



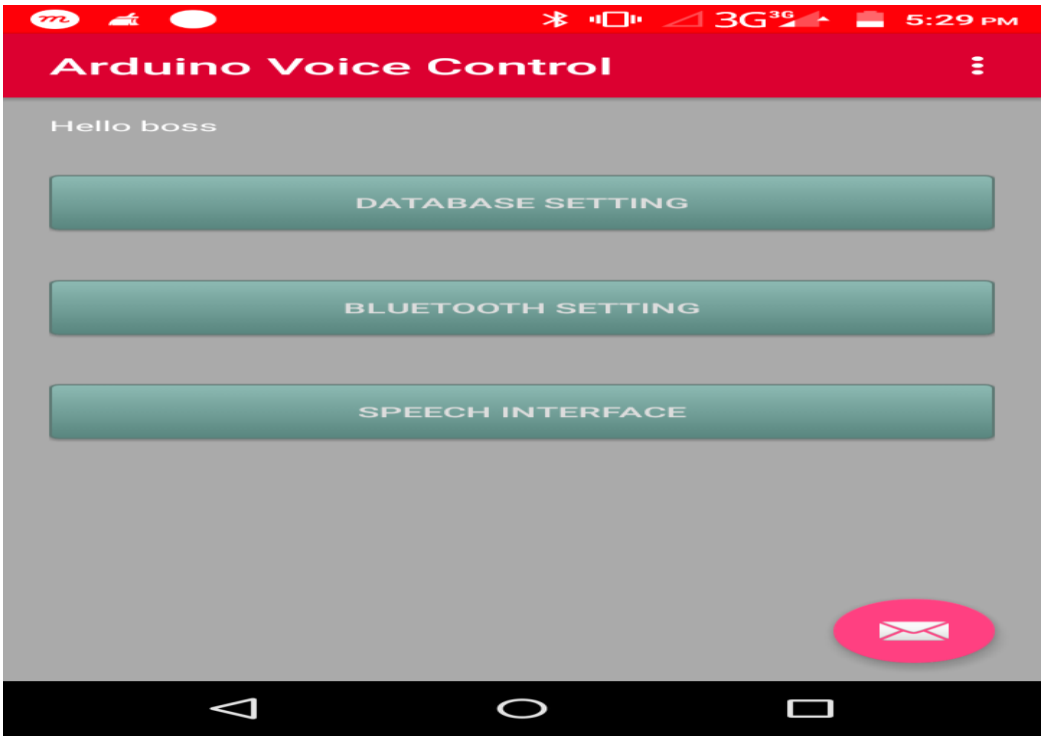
Screenshot 5-1 : Overall Project Interface



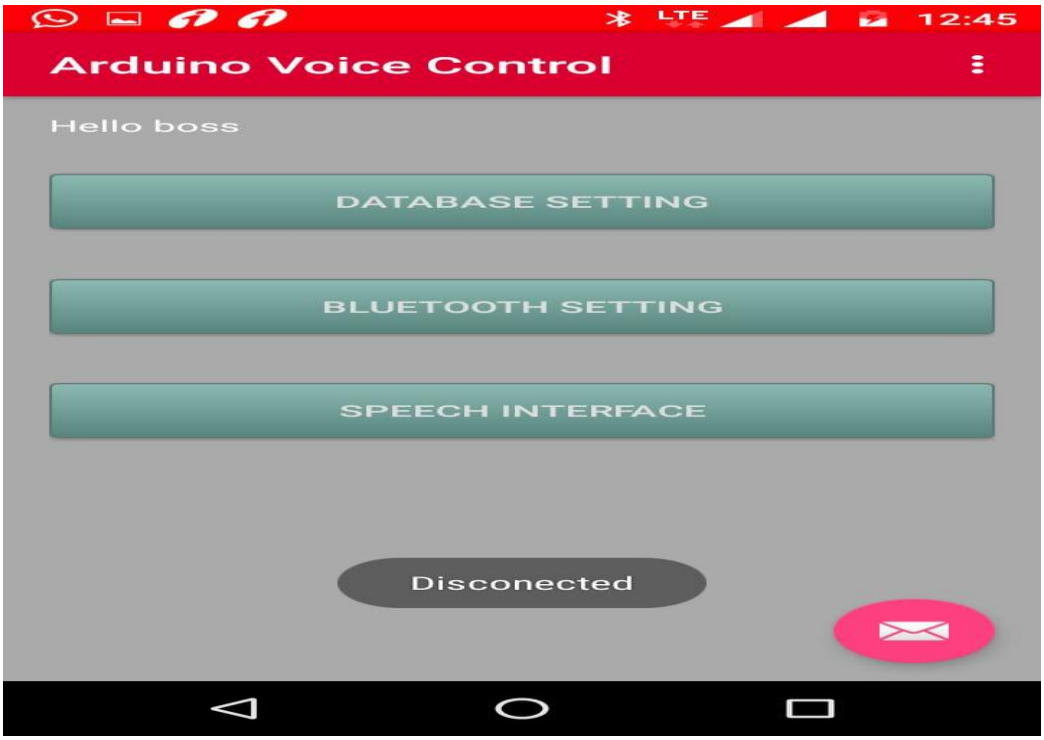
Screenshot 5-2 : Overall Hardware Interface



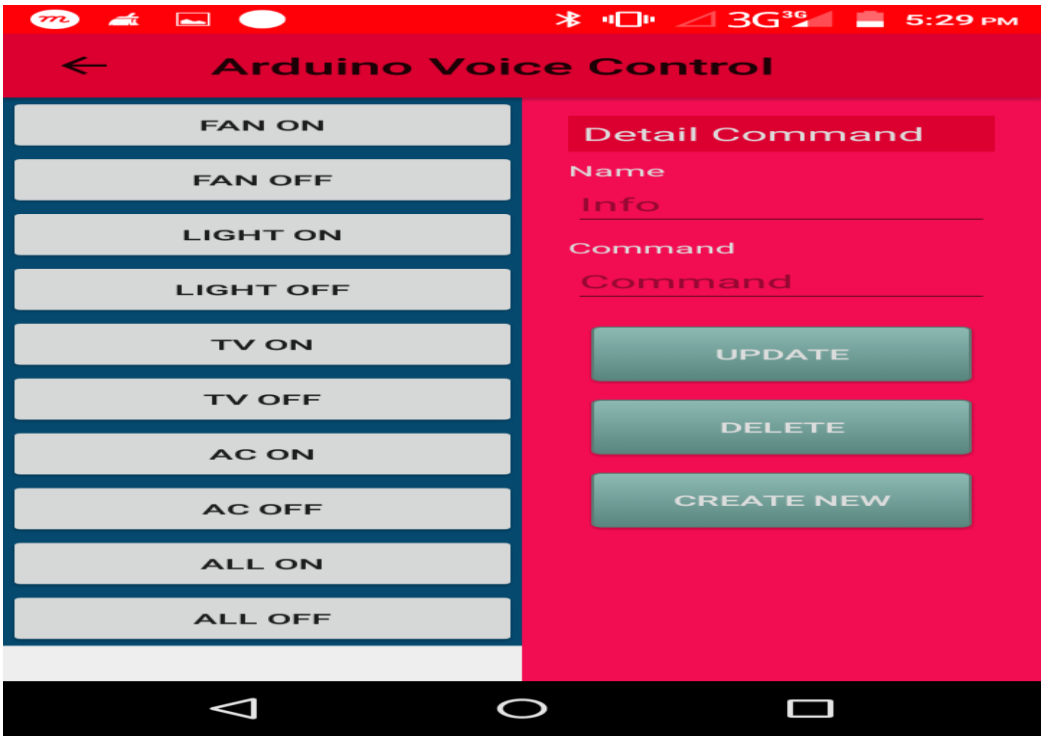
Screenshot 5-3 : Bluetooth Module



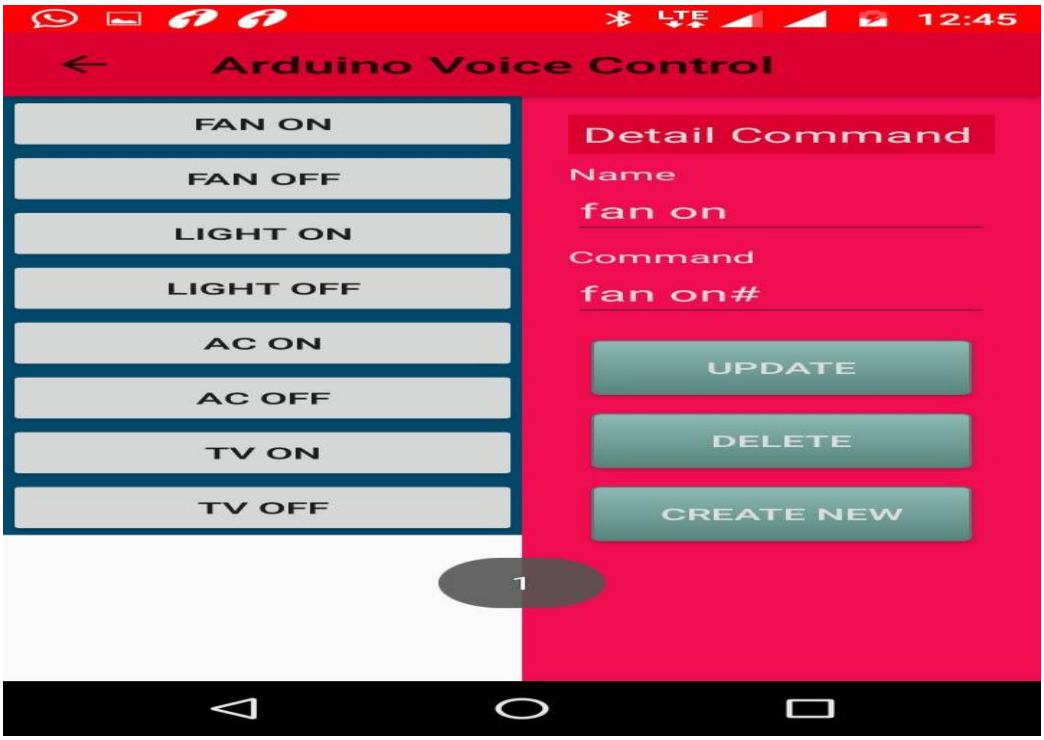
Screenshot 5-4 : Android Application Interface (Not Connected)



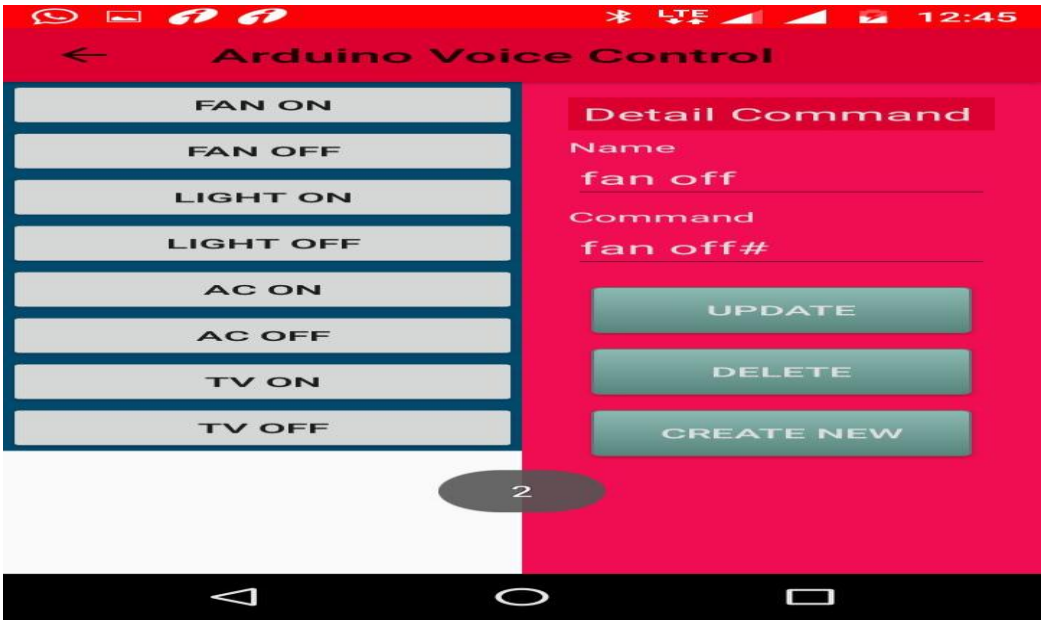
Screenshot 5-5 : Android Application Interface (Connected)



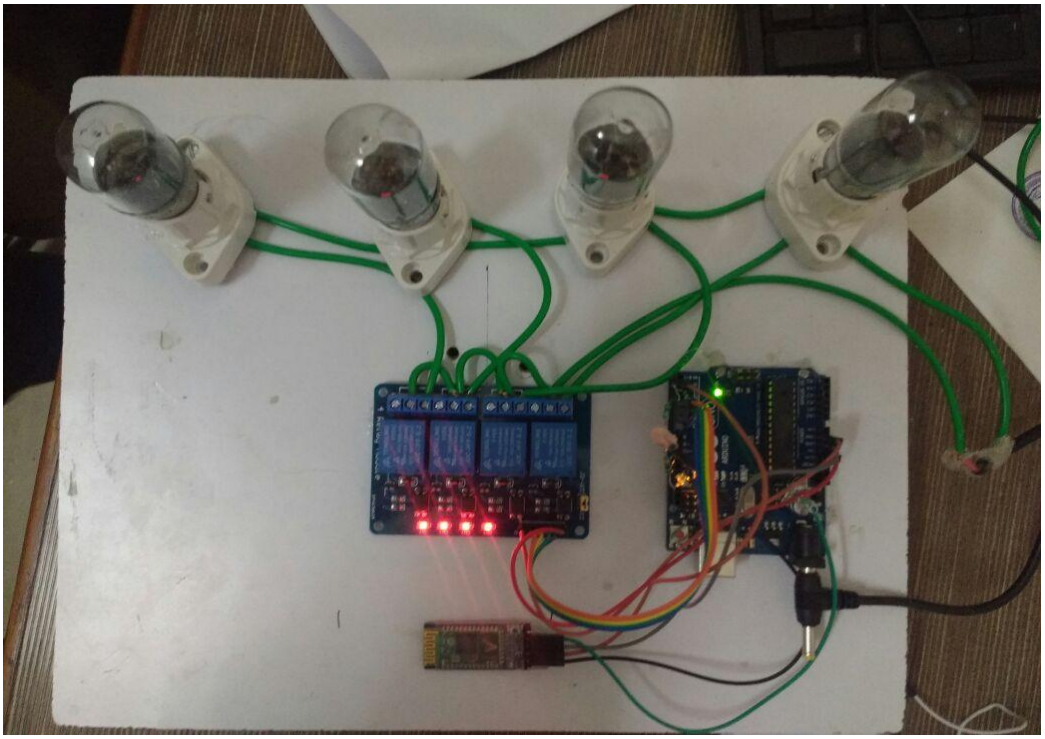
Screenshot 5-6 : Application Database Setting



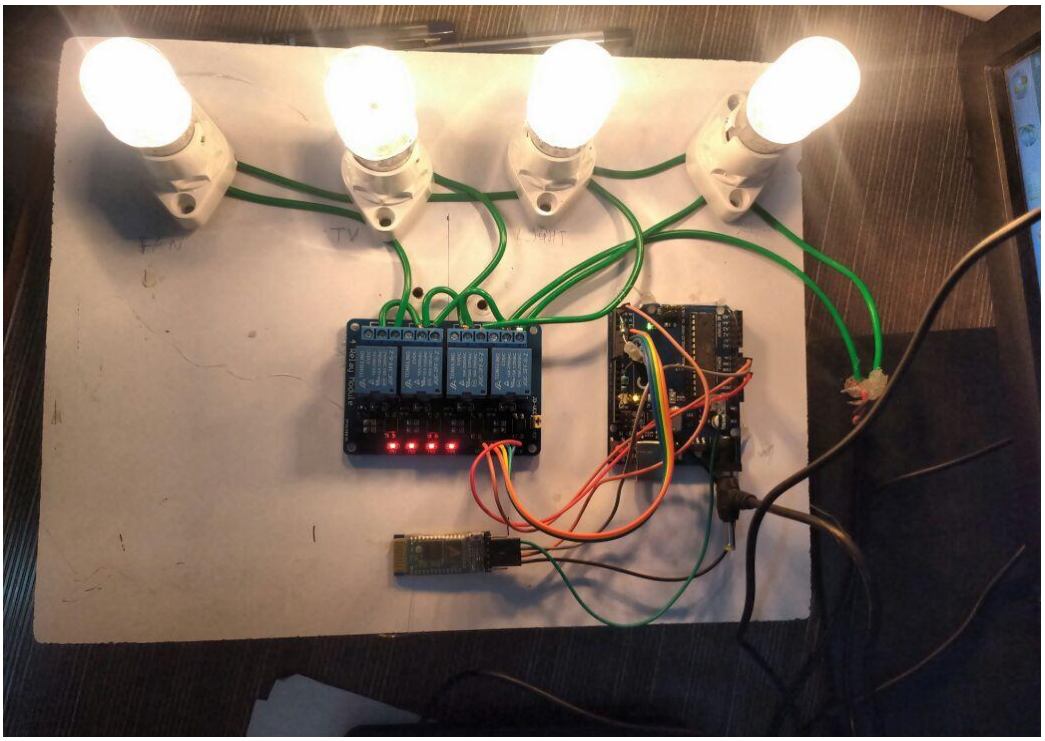
Screenshot 5-7 : Fan ON Control Option



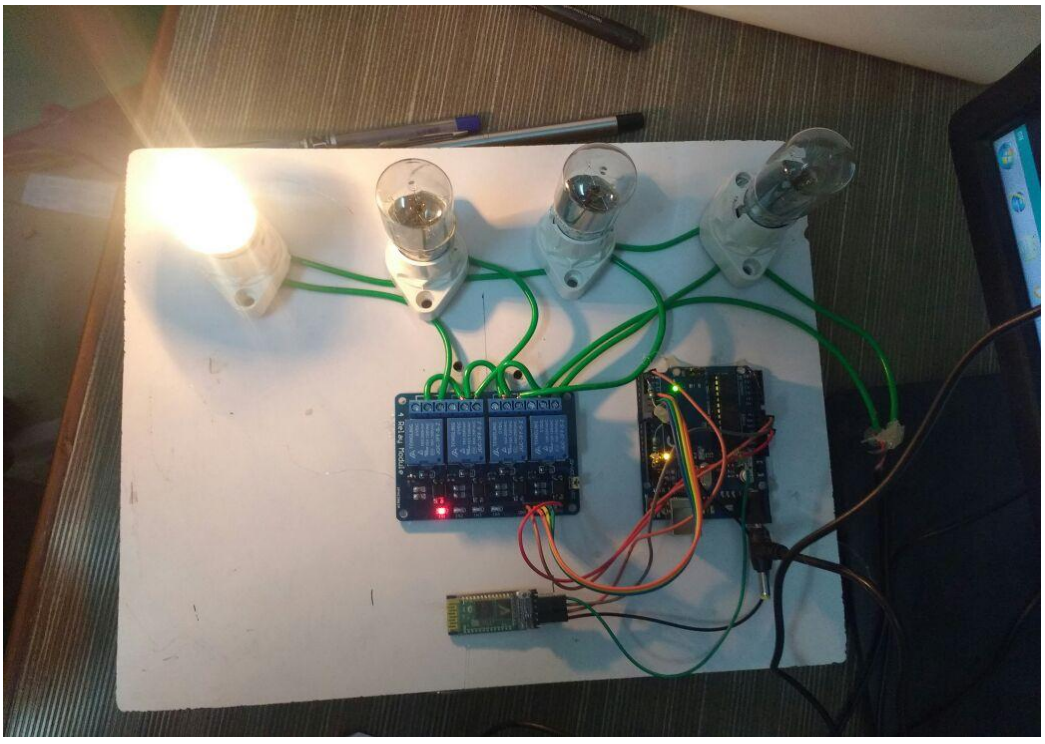
Screenshot 5-8 : Fan OFF Control Option



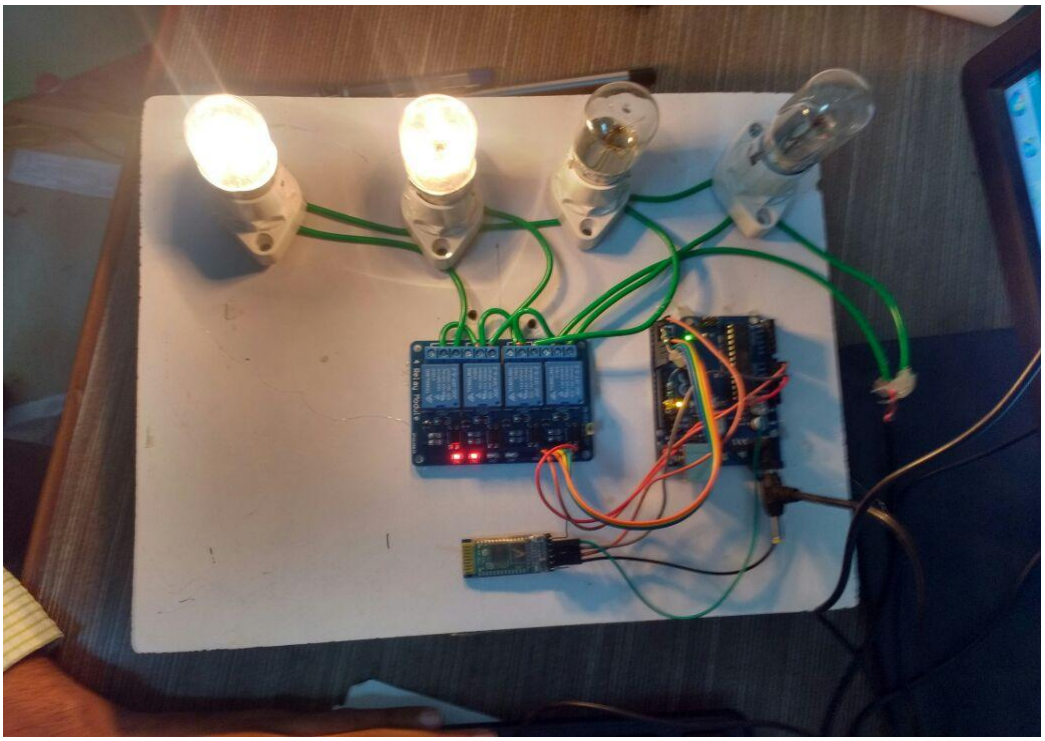
Screenshot 5-9 : Assembled H/W Kit



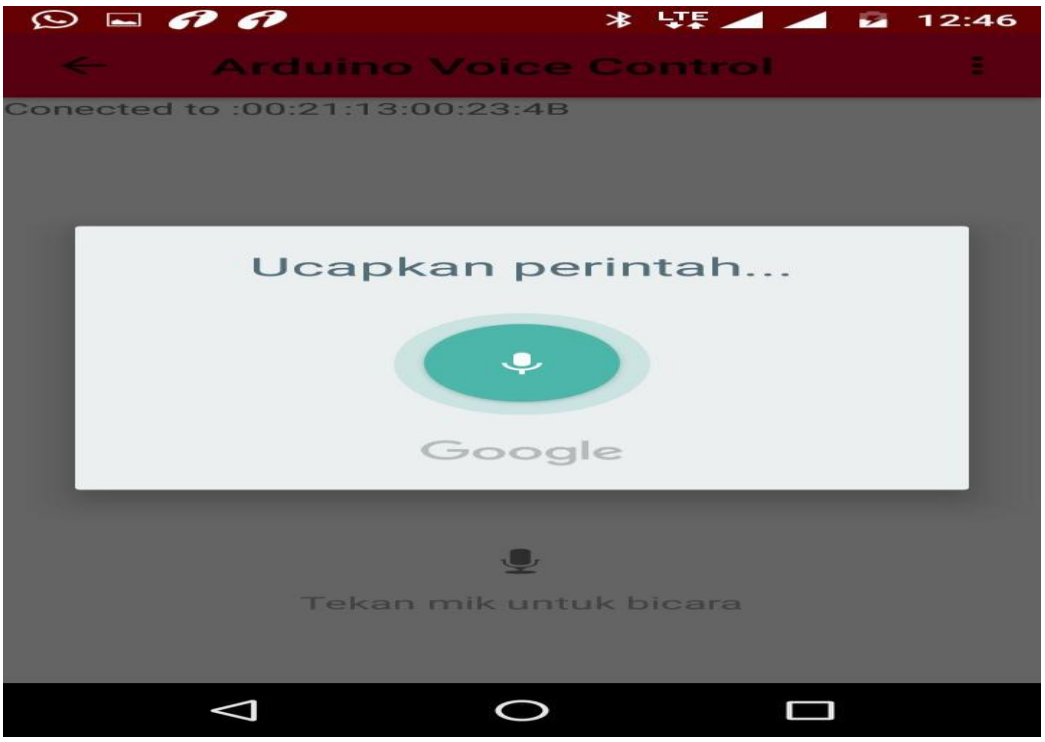
Screenshot 5-10 : Al Lights turned ON



Screenshot 5-11: Single Device Operation



Screenshot 5-12: Two Devices ON & OFF Control



Screenshot 5-13 : Software Connecting Screen

6 APPLICATION, ADVANTAGES & DISADVANTAGES

6.1 Applications

- Using this project, we can turn on or off appliances remotely i.e. using a phone or tablet.
- The project can be further expanded to a smart home automation system by including some sensors like light sensors, temperature sensors, safety sensors etc. and automatically adjust different parameters like room lighting, air conditioning (room temperature), door locks etc. and transmit the information to our phone.
- Additionally, we can connect to internet and control the home from remote location over internet and also monitor the safety.
- Home appliance controlling using handled devices through spoken commands.
- Implementing digital and computerized mobile home automation system for security system and electric appliances.
- Home automation and security system based on sensor.

6.2 Advantages

- It is a robust and easy to use system.
- There is no need for extra training of that person who is using it.
- All the control would be in your hands by using this home automation system.
- This project provides the facility of monitoring all the appliances with in the
- Communication range through Bluetooth.
- The schematic of Arduino is open source, for the future enhancement of the project
- Board can be extended to add more hardware features.
- Android ADK based home automation and security system

6.3 Disadvantages

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7 CONCLUSION AND FUTURE WORKS

7.1 Conclusion

The current project presented the implementation of an inexpensive home automation system, within the framework of assistive technology. The system implementation is based on the Arduino microcontroller, which has been programmed to control a range of home automation devices based on sensor signals and on direct commands by the user. The system has been programmed to have Bluetooth communication capability. Demonstrations of the system show that it facilitates the control of home-based devices such as electrical appliances, lights, heating, cooling systems and security devices by the intended users, i.e., the elderly and the disabled.

The implementation of this project overall is successful. The motive of making the project cost efficient and user friendly is taken into account and achieved. The project is comprised of components such as a Bluetooth module, an Arduino board, an Android mobile device, optocoupler, and an Android application (LMBT). Furthermore, with the discussions and objectives presented, it can be concluded that the objectives of the project have been achieved. Taking into consideration the target audience of elderly and handicapped people, the project developed is user friendly. Using an Android mobile phone, a Smart Home is created and controlled with a smart phone.

7.2 Future Works

Though overall the project is completed successfully, further study could be conducted to consider increasing the range of the signal to discover a method to amplify its range from the Bluetooth module. Furthermore, rather than using optocouplers and connecting them to the breadboard, further study could consider the use of a relay module to connect the modules.

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