DESIGN AND CONSTRUCTION OF MICROCONTROLLER BASED VOICE ACTUATED HOME AUTOMATION SYSTEM

BY

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, MODIBBO ADAMA UNIVERSITY OF TECHNOLOGY YOLA,

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY YOLA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF ENGINEERING

JANUARY, 2020

DECLARATION

I hereby declare that this project report was written by me and it is a record of my own research work. It has not been presented before in any previous application for a Bachelor's Degree. References made to published literature have been duly acknowledged.

_____ DATE: _____

Na'ason Nehemiah

(Student)

The above declaration is confirmed

_____ DATE: _____

ENGR. DR. S.Y. MUSA

(SUPERVISOR)

CERTIFICATION

This project entitled **"Design and Construction of Microcontroller Based Voice Actuated Home Automation System"** by **Na'ason Nehemiah (EE/14/2906)** meets the regulations governing the award of the bachelor's degree of the Modibbo Adama University of Technology, Yola and is approved for its contribution to knowledge and literary presentations.

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_____ Date: _____

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(External Examiner**)**

DEDICATION

I dedicate this work to Almighty God who gave me the knowledge and strength to partake in this project and to write the report successfully. I also dedicate the report to my beloved parents Mr. and Mrs. Na'ason Timon.

ACKNOWLEDGEMENTS

It is necessary to acknowledge my parents Mr. Na'ason Timon and Mrs. Justina Na'ason because without their mutual understanding this brain would have not came to existence.

My sincere gratitude goes to Engr. Dr. S.Y. Musa, my project supervisor for his time and effort at ensuring that the project worthwhile one. Again, I remain very much indebted to all the lecturers of Electrical and Electronic Engineering who have contributed in one way or the other to the success of this program.

Special thanks go to my siblings Miss. Nestha Na'ason, Miss. Neziah Na'ason, Miss Nerisa Na'ason, Mr. Naboth Na'ason and Miss. Na'arah Na'ason for their constant courage, prayers and moral support throughout our course. Will also like to appreciate my friends: Andrew Ishaya Mishelia, Obiabo Uja Kenneth, Mana Elisha, Collins Akujobi, Tosin Adebisi, Geoffrey Bitrus and lots more for their support. Believe me; any support that was given is highly appreciated.

Above all I give sincere thanks with every sense of humility to God Almighty from whom all knowledge, wisdom and intelligence come.

ABSTRACT

This project presents the design and construction of microcontroller based voice actuated home automation system. This is an advanced technology in the home automation, so houses are getting smarter. Usually conventional wall switches are located in different parts of the house and often require persons for their operations and, thus, manual pressing turn the on and off. It becomes very difficult for the elderly or physically handicapped people to operate them. This system is enhanced to control the home applications through an Android application of smart/ tablet phones by giving a voice command to corresponding loads. A Bluetooth is interfaced to the microcontroller (Atmega328p) using receiver (Rx) and transmitter (Tx) pins for communication. The electrical loads are controlled by the relay which is connected to the Amega328p, relay act as a switch operation. Then the respective device connected to the circuit will be turned on or off depending on the voice command given at the output side of home appliances controlling using Android Mobile via Bluetooth. This system can be helpful for elderly or disabled persons who are unable to go to the switch board to control the devices. The system has been designed for mobile phones having Android platform to automate an 8bit Bluetooth interface microcontroller which controls a number of home appliances using voice command at a distance of at least 10m.

TABLE OF CONTENTS

CHAPTER TWO: LITERATURE REVIEW

CHAPTER THREE: DESIGN AND CONSTRUCTION PROCEDURE

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

1.	Rx	Receiver
2.	Tx	Transmitter
3.	GSM	Global system for Mobile Communication
4.	RF	Radio Frequency
5.	IEEE	Institute for Electrical and Electronics Engineering
6.	LAN	Local Area network
7.	GUI	Graphical User Interface
8.	PC	Personal Computer
9.	USB	Universal Serial Bus
10.	AC	Alternating Current
11.	DC	Direct Current
12.	LED	Light Emitting Diode
13.	UHF	Ultra High Frequency
14.	TV	Television
15.	AC	Air Conditioner

CHAPTER ONE: INTRODUCTION

1.1 Background

Electronic control of home appliances is getting popular and widely used in a lot of household worldwide. It has tons of advantages to individual, which would help them to control their home appliances. Switching of home appliances can be categorized into two, which can either be wired or wirelessly connected. The difference between these two is one has a wired connection where home appliances are connected to a switch via cables. While the other one, home appliances are linked wirelessly to a central controller [1].

With the huge advancement in the communication sector, mobile phones have more advantages not only for making calls and sending SMS, but also for controlling home appliances with voice command using wireless means, example the Bluetooth Technology [2]. Mobile phones can be used for home appliances control using Bluetooth technology that effectively allows control within the range of 5 to 10meters. This system eliminates the need to manually switch ON/OFF the electrical appliances [3]. Many mobile phones come with an inbuilt application, the Bluetooth. Bluetooth technology uses ultra-high frequency radio waves (UHF) with a frequency range of 2.4 to 2.485 GHz for the purpose of wireless data transmission. Home automation research targeted many needs like applications that provide the luxury and smart requirements while some threw light on the special needs for elderly and disabled, our system is a computer based system that can accept voice to direct commands and process them. The system provides us switching any device ON/OFF [4].

This project demonstrates a system that can be integrated as a single portable unit and allows one to wirelessly control lights, fans (AC), television, etc., and turn ON or OFF any appliance that is plugged into a wall outlet through a voice command. This integrated

platform for home security, monitoring and automation by using microcontroller designed to be used by individuals especially handicapped and/or elderly people in controlling their electric home appliances with a voice command through Android application (BlueSay_TT).

1.2 Problem Statement

In the conventional mode, users have to manually switch ON or OFF various home appliances by moving around the house, office etc. This project would lower human stress in moving around just to switch ON/OFF home appliances by providing smart control of home appliances. This device offers a better way of life in which an individual gets to switch his/her home appliances using voice command from turning ON/OFF light to turning ON/OFF of TV.

The users prefer controlling the elements at their house remotely using a cell phone. So the system should support wireless communication. Another problem is that WIFI and Bluetooth and other high-speed type of communication cannot be available all the families in general.

The users should have the authority to check the status of the element. That requires a new window in UI design to display the status of any elements in the system. And a running log is also needed to assist the people taking care of the maintenance of the system to provide the better user experience.

1.3 Objectives

- To install android application on smart phone, this will communicate with Bluetooth module through voice command from the user.

- To instruct the microcontroller to switch ON/OFF home appliances through the android application.
- To Enable/disable voice control for specific power socket
- To test and process the circuit.
- To construct and package the circuit.

1.4 Significance of the Study

This study will be undertaken to construct an electronic home appliances control at lower cost. This will benefit individuals in reducing man power and energy usage and also offers a smart way of controlling home appliances using voice command especially for the handicapped and elderly people.

1.5 Scope of the Project

The connection between the mobile phone and the main controlling unit will be established through wireless connection, where each home appliance would have a particular command that will control it. This centralized electronics system would operate within a range of a maximum range of 10 meters.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter highlights the review of similar work done by our predecessor, and the fundamental concept of the project.

2.1 Review of Similar Works

A voice controlled home automation system has drawn considerable attentions in the recent years. Considering all the above mentioned advantages we have selected Bluetooth [5]. Initially, home automation system were designed for the people seeking luxury and sophisticated home. But there was always a need to develop home automation system for the people with special needs like elderly and disabled. According to the report published by the WHO, around 785 million people of 15 years and older live with disability of these, the world health survey reports that 110million people have significant difficulties in function [6]. In order to assist the old people and the people with disability, home automation technologies are adopting voice-controlled or voice recognition technologies. The main idea is to control and monitor home appliances by using speech recognition.

One of the experimental works on the android and Bluetooth based home automation system was presented here. The commands given through voice are conveyed to the control unit with switches on loads ON/OFF as desired. These voice commands sent are converted to binary sequence in microcontroller. The microcontroller unit takes decision and perform the required decision [7].

Finally the system generates some control factors to switch on/off the home appliances. A client-server based voice control system for home automation has been presented. Voice command is captured by the client. The server system converts the voice

commands into a form that is used to control the home appliances. Android mobile based voice command control and monitoring system have been implemented here, in which artificial intelligence has been used for voice recognition. Our work is different from other related works in the following ways: We use Bluetooth and android application here. The user interface is easier to design and implement. The system can be remotely controlled by a mobile or a computer and it can easily be extended to include more appliances. The system is easy to install and configurable. Unlike other related systems, no expertise skills are required to install and configure this system. Android's voice recognition library has been included in our work [8]. The system can recognize the voice commands independent of vocabulary size, noise, speaker characteristics or accent.

2.2 Review of the Fundamental Concepts

2.2.1 Microcontroller

A microcontroller is a computer present in a single integrated circuit which is dedicated to perform one task and execute one specific application. An inexpensive microcontroller ATmega32 is used to process the signal sent from core unit and send command to relay. Libraries are used to receive the data or implement the sampling, converting function by ourselves. After converting the data back to command, it sends signal to control the relay. A switch is added to enable and disable the voice control. In this work, I used Atmega328p microcontroller for giving signals to the relays and taking signal from the Bluetooth device HC 06. It takes 5 V dc power supply.

A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of

RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips [9].

Microcontrollers are very essential in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

2.2.2 Arduino

The Arduino Uno is a microcontroller board based on the ATmega328.The Arduino circuit acts as an interface between the software part and the hardware part of the project. It is simple, inexpensive, open source prototyping platform extensible to hardware and software. 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, and a reset button. It contains everything needed to support the microcontroller. It requires the connection to a computer using a USB cable or power it with an AC-to-DC adapter [10].

Figure 2.1: Arduino Uno Board

According to [10], there are numerous different microcontrollers and microcontroller platforms accessible for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's handy board, and numerous others offer comparative usefulness. These apparatuses take the chaotic subtle elements of microcontroller programming and wrap it up in a simple to-utilize bundle. Arduino additionally rearranges the methodology of working with microcontrollers; moreover it offers some advantages for instructors, students, and intrigued individuals:

i. Inexpensive
ii. Cross-platform
iii. Straightforward, clear programming method
iv. Open source and extensible programming
v. Open source and extensible hardware

2.2.3 Bluetooth Module

Bluetooth is a remote innovation standard for trading information over short separations. Bluetooth radio has a transmission between 2400–2480 MHz. It was developed by Telecom merchant Ericsson in 1994. 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 [11].

Modern mobile devices embed small, low-powered and cheap integrated chips functioning as short range radio transceivers for Bluetooth radio communications. Device pairing, authentication, encryption and authorization techniques have given recognition to Bluetooth technology due to its vital security mechanisms.

The Bluetooth utilized as a part of Home Automation System (HAS) Android cell phone application is the Bluetooth Serial Port Profile (BTSPP). RFCOMM is a connection-oriented protocol. It provides streaming communication between the devices. The btspp profile and RFCOMM protocol are used in the application to access the serial port and communicate using streaming data. All of the Bluetooth APIs is available in the android, bluetooth package.

Table 2.1: Bluetooth Module Specification

Bluetooth Protocol	Bluetooth Specification v2.0 + EDR
Frequency	2.4GHz ISM band
Modulation	GFSK (Gaussian Frequency Shift Keying)
Emission Power	≤ 4dBm. Class 2
Sensitivity	≤-8dBm at 0.1% BER
Speed	2.1Mbps (Max)/ 160kbps, Synchronous: 1Mbps/1Mbps
Security	Authentication and encryption
Profiles	Bluetooth serial port
Power Supply	+3.3V DC, 50Ma

Working Temperature	-20 - +75 ^{0}C
Dimension	26.9mm × 13mm × 2.2mm
Mode	Slave
Baud Rate	9600 baud rate
Pin Code	1234

According to [12], Bluetooth serial module's operation doesn't need driver, and can communicate with the other Bluetooth device that has the serial. But communication between two Bluetooth modules requires at least two conditions.

1. The communication must be between master and slave.
2. The password must be correct.

2.2.4 Light Emitting Diode (LED)

The light emitting diode (LED) is a semiconductor device that emits visible light when an electric current is passed through it. The LED is a very common, infinitely useful component that converts electrical current into light. LEDs come in various shapes, sizes, and colours. LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, smaller size, faster switching, and greater durability and reliability. Light-emitting diodes are used in applications as diverse as replacements for aviation lighting, automotive lighting (particularly brake lamps, turn signals and indicators) as well as in traffic signals [13].

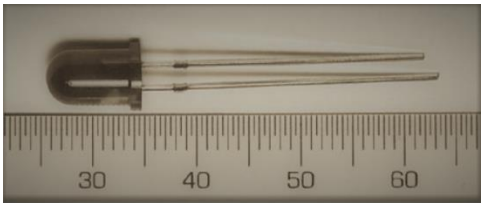


Figure 2.2: Light Emitting Diode (LED)

a) Current through LED b) LED Leads

Figure 2.3: Current flows through an LED and LED Leads

Table 2.2: Forward voltage for different types of LEDs

LED Colour	Forward Voltage (Vf) range		
	Minimum	Typical	Maximum
White	3.2 V	3.5V	3.8 V
Warm White	3.2 V	3.5V	3.8 V
Blue	2.8 V	3.2V	3.5 V
Red	1.7 V	2V	2.4V
Green	3.2 V	3.2V	3.8 V
Yellow	1.7 V	2V	2.2 V
Orange	1.8 V	2V	2.2 V

The level of resistance can be either fixed or variable. Resistance is measured in ohms (Ω) and can range from zero to thousands of ohms (kilo ohms, or kΩ) to millions of ohms (mega Ohms, or MΩ) [14].

2.2.5 Android

Android operating system is an open source focused around Linux kernel with Java programming interface planned fundamentally for touch screen contraptions. Gadget producers, remote transporters and fan engineers are permitted to adjust and distribute the product under the Apache License.

Android is also associated with a suite of proprietary software developed by Google called Google Mobile services (GMS) that very frequently comes pre-installed devices which usually includes the Google Chrome, web browser and Google search and always includes core apps for services such as Gmail, as well as the application store and a digital distribution platform Google play, and associated development platform. These apps are licensed by manufactures of Android devices certified under standards imposed by Google.

Google Play is Android essential application store. There were roughly 700,000 applications accessible for Android in October 2012 and created by a vast group of Android application designer [15].

Android building design comprises of a few layers as demonstrated in Figure 5. The applications need to go layer by layer to get to the hardware. A few libraries are accessible. ARM (Advanced RISC Machine) architecture is the principle equipment platform for Android.

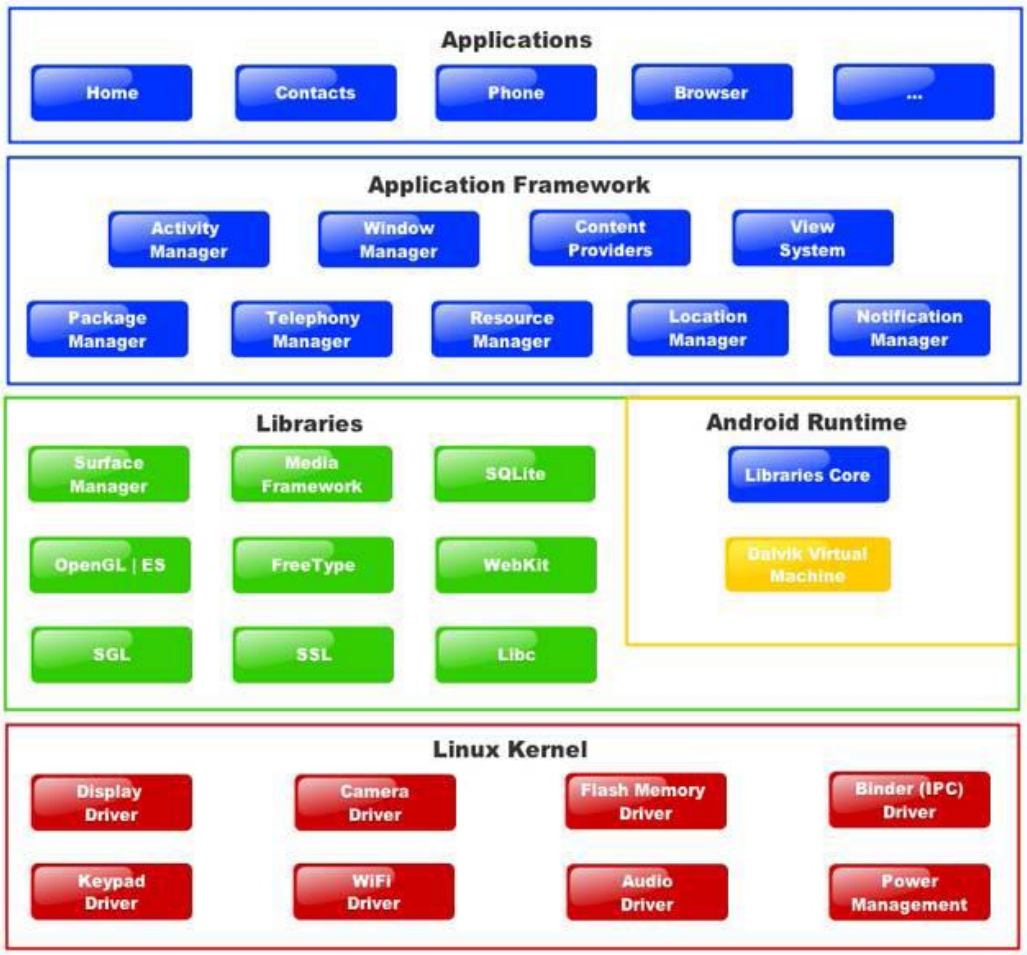


Figure 2.4: Android Architecture

Android applications are written in Java programming language. The Android SDK (Software Development Kit) provides tools for code compilation and packaging data and resource file into an archive file with ‘apk’ (Android Package Kit) extension. Android devices uses ‘apk’ file to install the application. Android framework allows for the creation of extremely rich feature and novel applications by using a set of reusable components. There are different version of android OS ranging from version 1.5 to version 7.0, below is the table that shows the name of the versions and there released date [16].

Table 2.3: Android Versions with released date

Android version	Name	Released Date
1.5	Cupcake	April, 30, 2009
1.6	Donut	September, 15, 2009
2.0,2.1	Éclair	October, 26, 2009
2.2	Froyo	May, 20, 2010
2.3	Ginger Bread	December, 6, 2010
3.0	Honey Comb	February, 22, 2011
4.0	Ice Cream Sandwich	October, 19, 2011
4.3	Jelly Bean	July, 9, 2012
4.4	Kit Kat	October, 31, 2013
5.0	Lollipop	November, 12, 2014
6.0	Marshmallow	October, 5,2015
7.0	Nougat	June, 30, 2016

2.2.6 Relay

A relay is an electromechanical device which is activated by a current or signal in one circuit to open or close another circuit. Relays are like remote control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability. Relays are used in a wide variety of applications throughout industry, such as in telephone exchanges, digital computers and automation systems. Highly sophisticated

relays are utilized to protect electric power systems against trouble of power blackouts, as well as to regulate and control the generation and distribution of power [17].

The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it). You can think of a relay as a kind of electric lever, switch it on with a tiny current and it switches on another appliance using a much bigger current. Why is that useful? As the name suggests, many sensors are incredibly sensitive pieces of electronic equipment and produce only small electric currents [18].

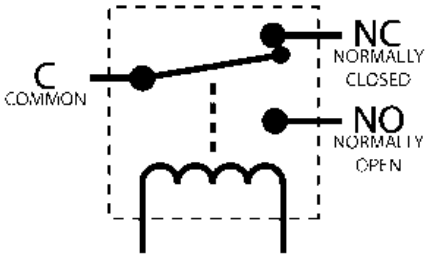


Figure 2.5: Relay Schematic Diagram

Figure 2.6: Picture of a relay

CHAPTER THREE: DESIGN AND CONSTRUCTION PROCEDURE

3.0 Design Concept

A user interface is provided by an application (BlueSay_TT) installed on an android smartphone through which voice commands can be issued by the end user. These voice commands are inputted by the user from the android application (BlueSay_TT) and send through Bluetooth connection to the home appliances controller with the aid of Bluetooth Module.

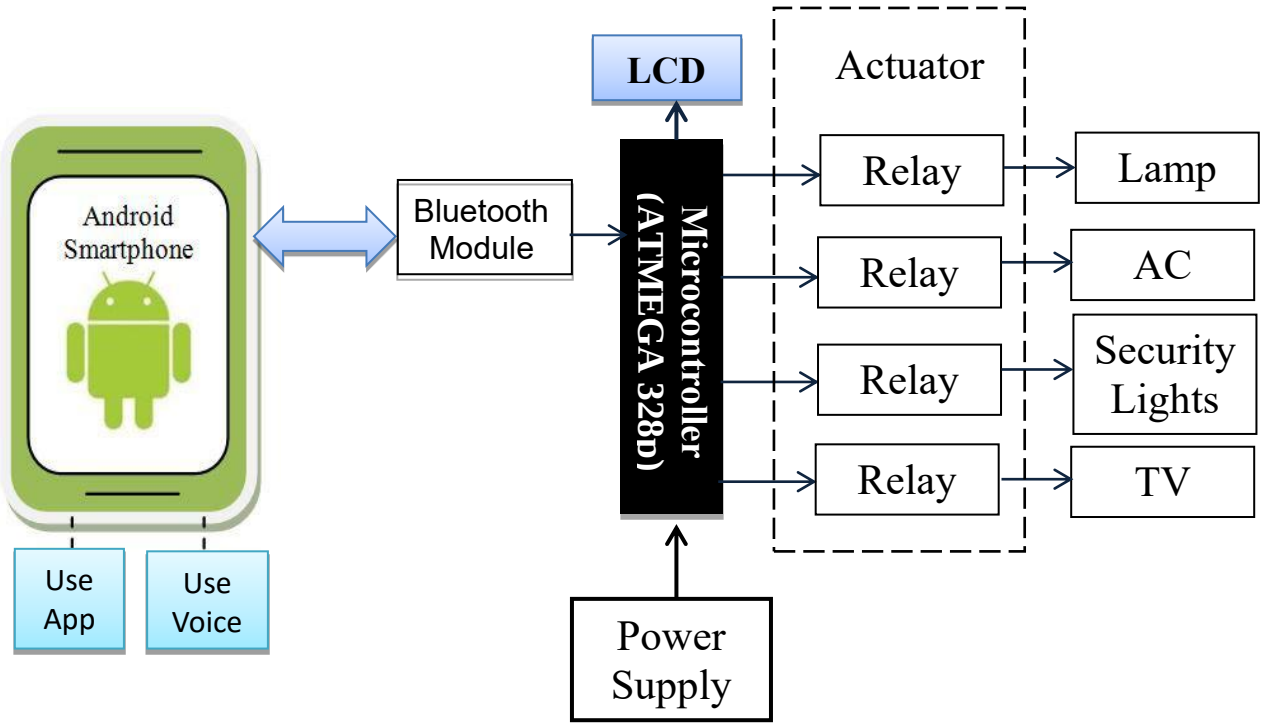


Figure 3.1: System block diagram

The Microcontroller processes the received voice command and act upon the request. The actuator (relays) these are used as switches to the loads (Lamps, AC, TV etc), according to the signal received by the Microcontroller. The request can either be switching

ON or switching OFF load. After processing the request, a feedback is generated by the controller and transmitted back to the android application via the same link.

3.1 Hardware Design

The circuit diagram used in this project is shown in Figure 3.14. The hardware design involves the design of the circuitry in each of the functional blocks. The following sections detailed the design of each blocks.

3.1.1 Power Supply Unit Design

The power requirement for the system was obtain by summing up all individual power requirement of the subsystem components.

Table 3.1: Power Supply Unit Design

LOAD	**MAX CURRENT DRAWN**
ATMEGA 328p	200mA
Bluetooth Module	300mA
LED	15mA x 12 = 180mA
DC motor	30mA
Total	710mA

The power supply can deliver 5V 1.5A

3.1.1.1 Step Down Transformer

STEP1: The transformer is a static piece of electrical apparatus by means of which electrical power in one circuit is transformed into electrical power of the same frequency into another circuit. It can be used to raise or lower the voltages. It does this by means of

inductive coils which are electrically isolated but are magnetically connected. A transformer that steps down 220V to 15V was used in this project.

3.1.1.2 Rectification

STEP2: Rectification is the process whereby an alternating voltage is converted into pulsating voltage by the use of diodes; any diode arrangement that is designed for this purpose is called a rectifier.

A full wave rectifier bridge uses four diodes when sourced by a two wire transformer as shown in Figure 3.2

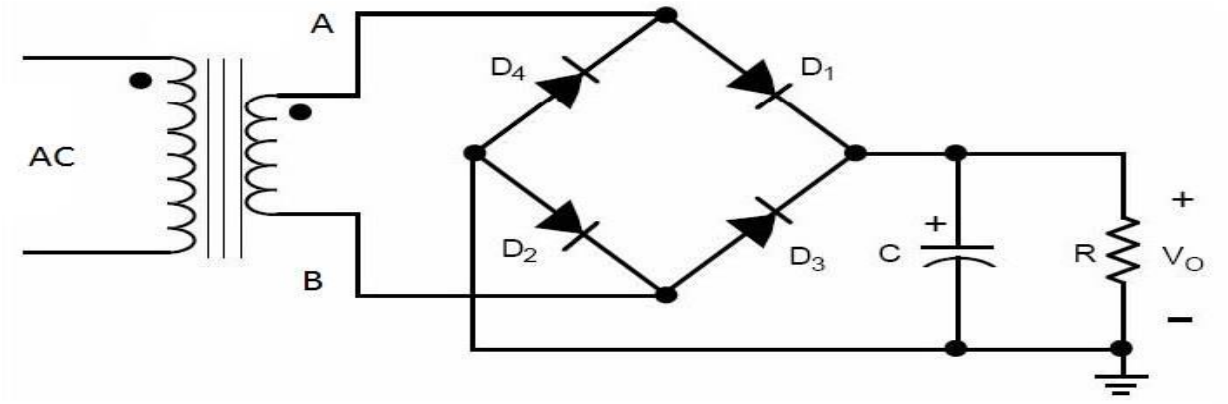


Figure 3.2: AC rectification with a bridge rectifier

During the positive half cycle, terminal A of the supply is positive while B is negative; diodes D1 and D2 become forward biased (ON) whereas D3 and D4 are reverse biased (OFF). During the negative half cycle, secondary terminal B becomes positive and A is negative making diodes D3 and D4 conduct. The total output DC output voltage is then the sum of the pulses for both half cycles. The maximum current that can be drawn by all loads is 1.1A, a 2A bridge rectifier (KBP210) was used. The frequency of the pulsating rectifier output voltage is twice the supply frequency as shown in figure 3.3

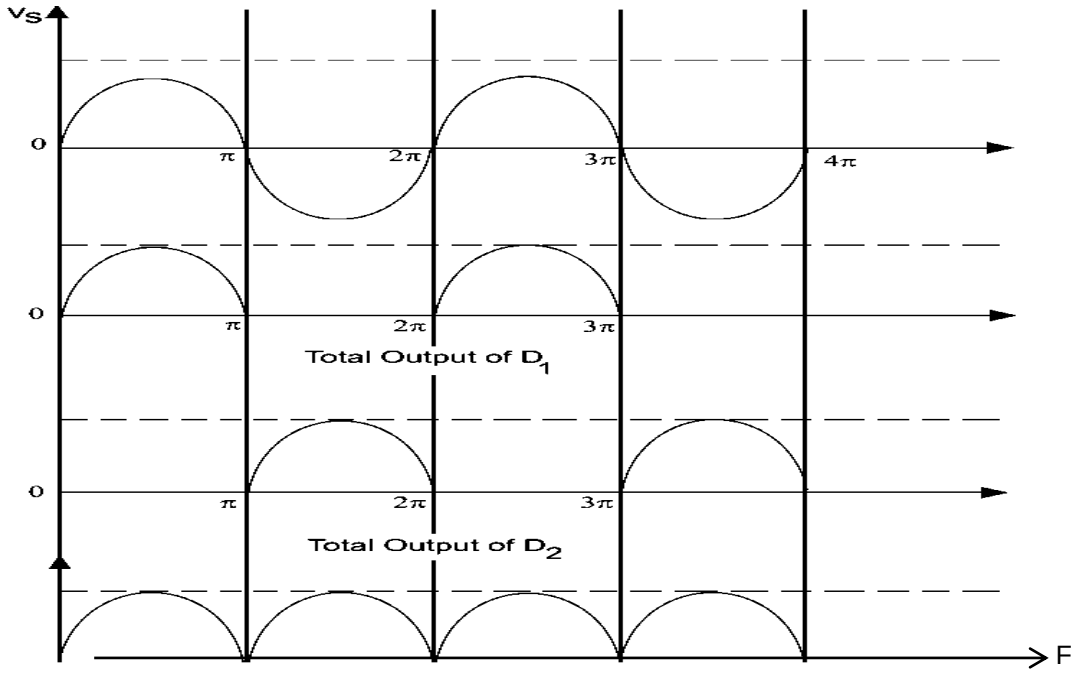


Figure 3.3: Individual and combined diode outputs of the rectifier

3.1.1.3 Filtering

STEP3: The output directly taken from the bridge rectifier is bumpy as seen above, at π, 2π, 3π and so on; the pulse amplitude is momentarily zero. A filter capacitor connected directly to the output as in the circuit in Figure 13 works to reduce the bumps as well as compensate for periods where the waveform would otherwise have been flat. This is illustrated in below in figure 3.5

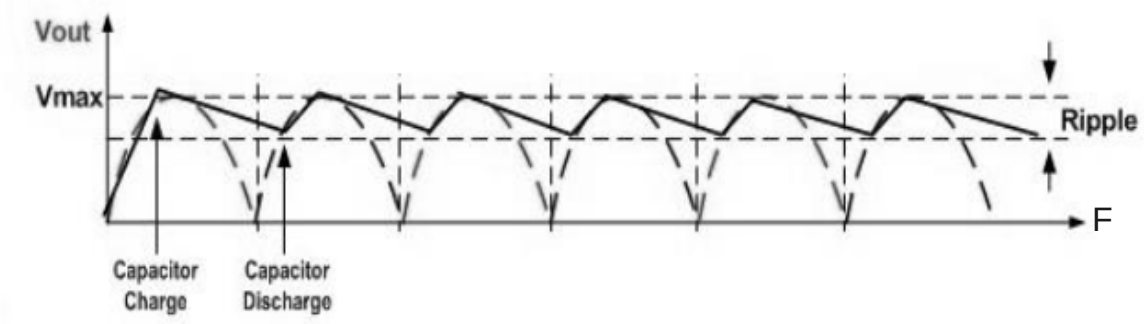


Figure 3.4: Filter capacitor‘s action on ripples

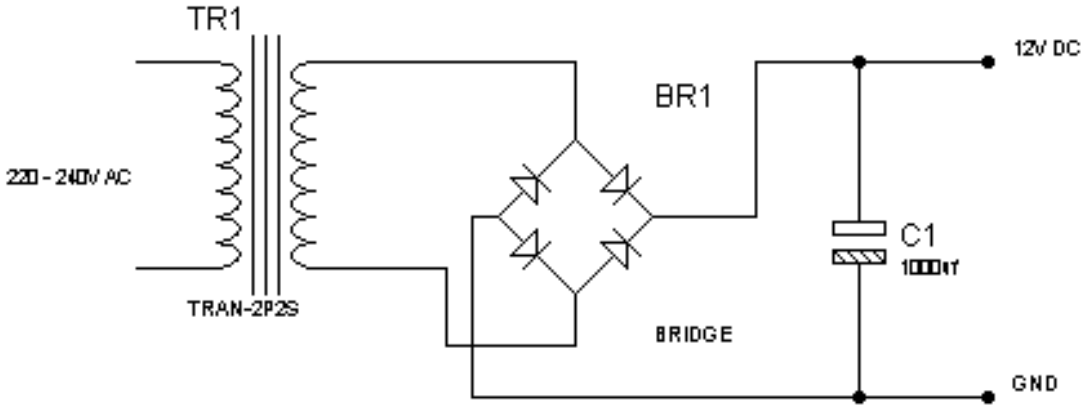


Figure 3.5: Unregulated DC supply

$Imax = 800mA$

$Vmax = 12V$

$Vmin = 7V$

(Because 7805at least need 2V more i.e. 7V to provide a 5V output)

$f = 50Hz$

$$C = \frac{Imax\ X\ dT}{V} \quad \ldots 3.1$$

Where,

Imax = maximum current

dT = discharge time

V = voltage

$$dT = \frac{T}{2} = \frac{1}{2f} \quad \ldots 3.2$$

$$dT = \frac{1}{2\ x\ 50} = 10ms$$

$$V = Vmax - Vmin \quad \ldots 3.3$$

$$V = 12 - 7 = 5V$$

$$Vp = VrmsX\sqrt{2} \quad \ldots 3.4$$

$$Vp = 12X\sqrt{2} = 17V$$

Now 1.4V will be dropped on 2 diodes (0.7 per diode) as 2 will be forward biased for half wave.

$$17 - 1.4 = 15.6V$$

When capacitor discharge into load circuit, it must provide 7V to 7805 IC to work so finally

$$V = 15.6 - 7 = 8.6V$$

Therefore,

$$C = \frac{Imax\ X\ dT}{V} \quad \ldots 3.5$$

$$C = \frac{800\ x\ 10^{-3} x 10\ x\ 10^{-3}}{8.6}$$

$$C = 9.302\ x\ 10^{-4} F$$

$$C = 930uF$$

Since there is no capacitor with that value, 1000uf will be used.

For the capacitor working voltage;

$$V_c \geq 2V_p \quad \ldots 3.6$$

Therefore Vc should be at least twice the peak voltage across it. Hence it is taken to be 50V.

3.1.1.4 Regulator Design

The regulated power supply was obtained using the circuit diagram of Figure 3.6. A 5V regulator IC (7805) and a 9V regulator IC (7809) voltage regulators was used to regulate the voltages: Liquid Crystal Oscillator (LCD), Microcontroller, Bluetooth Module etc and the Loads (Lamp, Fan (AC), Security lights etc) respectively. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator ICs maintain the output voltages at a constant value. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

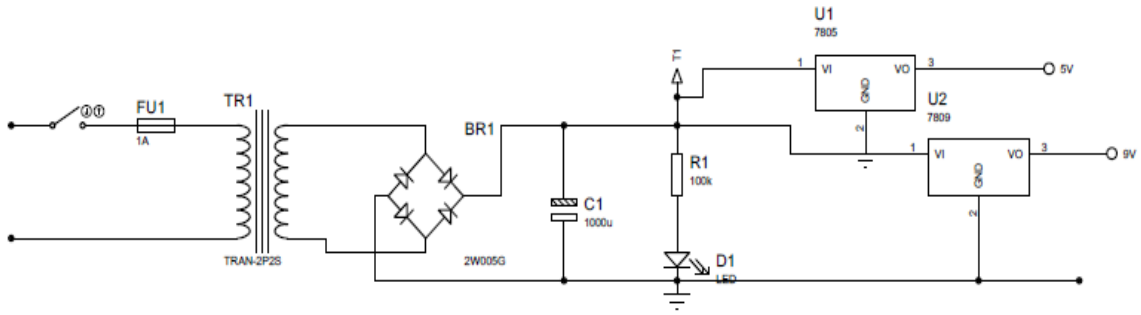


Figure 3.6: Regulated DC supply

3.1.2 Choice of Microcontroller

The microcontroller is the heart of the project; it controls all the activities of the entire system.

The criteria for choosing the microcontroller are:

- Meet the computation needs of task at hand efficiently and cost effectively.
- Availability of software development tools such as compiler, assemblers and debuggers and widely availability and reliable source of the microcontroller.

Table 3.2: Available microcontroller comparison

S/N	MCU	GPIO pins	SPI Bus	UART	Price
1	PIC 18F2620	25	1	1	2000
2	ATMEGA 328P	23	1	1	1500
3	18F4550	35	1	1	2500

For these reasons the ATMEGA 328P was used in this system and the following are the features/requirements for its design:

i. USB cable Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board.
ii. Inbuilt Universal Synchronous and Asynchronous Receive and Transmit (USART) Communication for communicating with the RF Transmitter/Receiver.
iii. External Oscillator (16MHz) with two (2) 22pf capacitors.

An oscillator is an electronic circuit that generates repeated waveforms. The exact waveform generated depends on the type of circuit that is used in generating them. For the high speed performance required for this project the crystal oscillator is used. The crystal oscillator is responsible for producing the clock signal required by the circuit (microcontroller).

To know the actual value of the crystal oscillator we have to look into some calculation. Using the relation below:

$$f_{int} = \frac{f_{quartz}}{4} \quad \ldots 3.7$$

Where:

f_{int} = is the internal frequency of microcontroller

f_{quartz} = is the frequency of crystal oscillator

From the data sheet of ATMEGA 328P f_{int} = 4MHZ (i.e. the internal frequency of the microcontroller).

$$f_{quartz} = f_{int} \times 4 \quad \ldots 3.8$$

$$f_{quartz} = (4 \times 10^6) \times 4$$

$$f_{quartz} = 16 \times 10^6 H_Z$$

The capacitor used with the oscillator is 22pf (from data sheet of 16MH$_Z$ crystal).

The microcontroller pins and its circuit connection are shown in fig. 3.8 and fig. 3.9

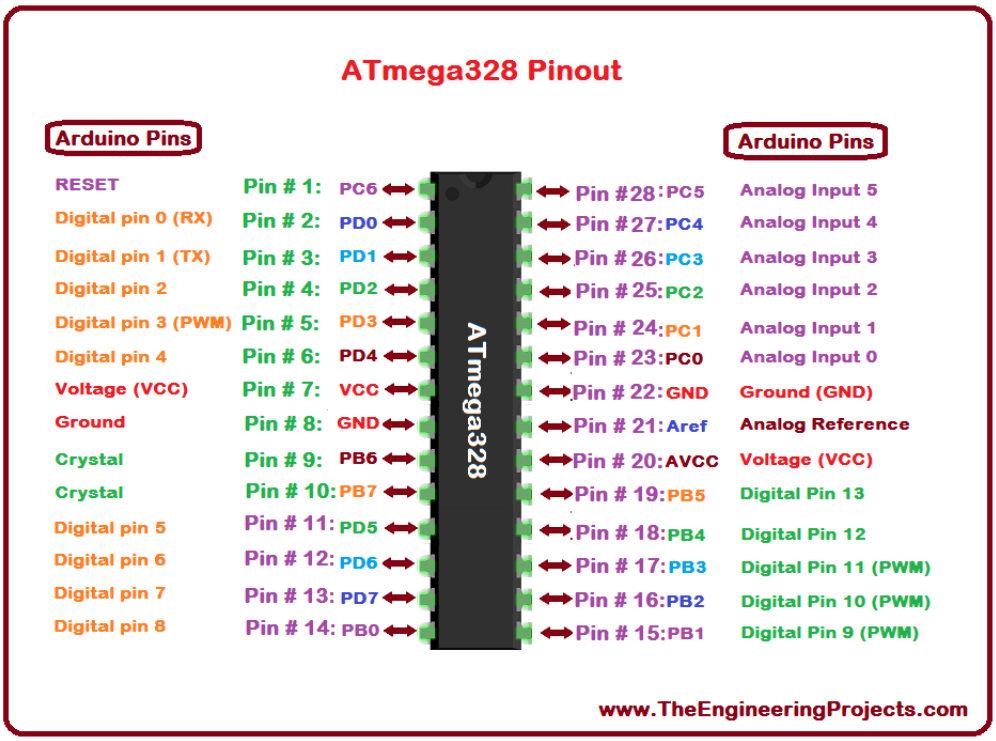


Figure 3.7: Controller circuit connection

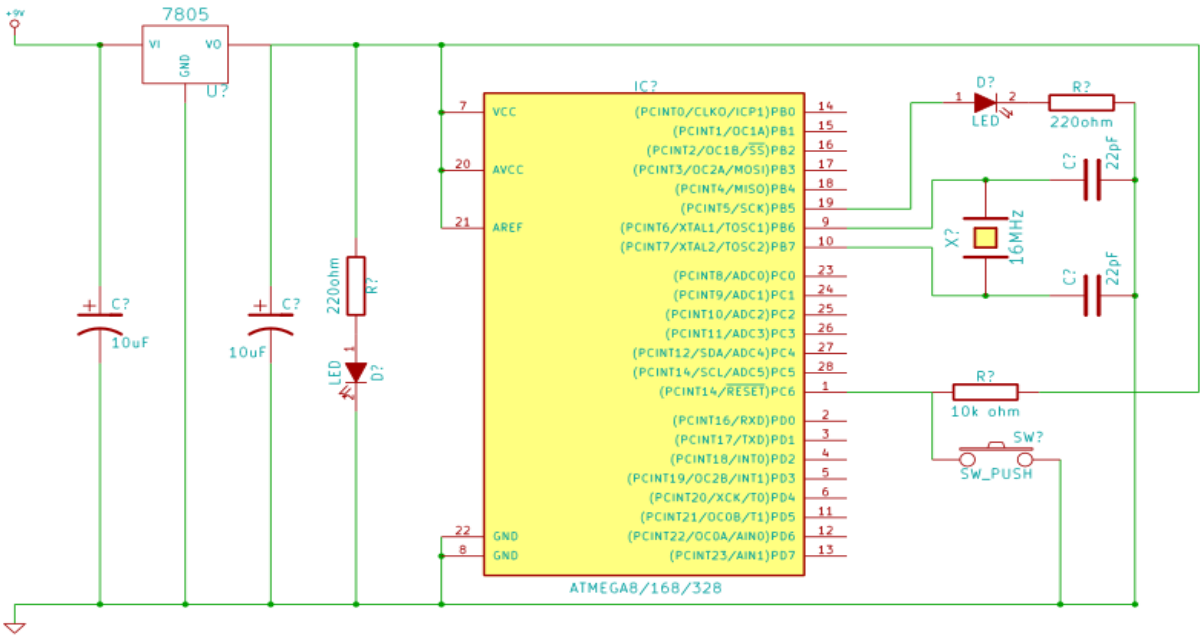


Figure 3.8: Controller circuit connection

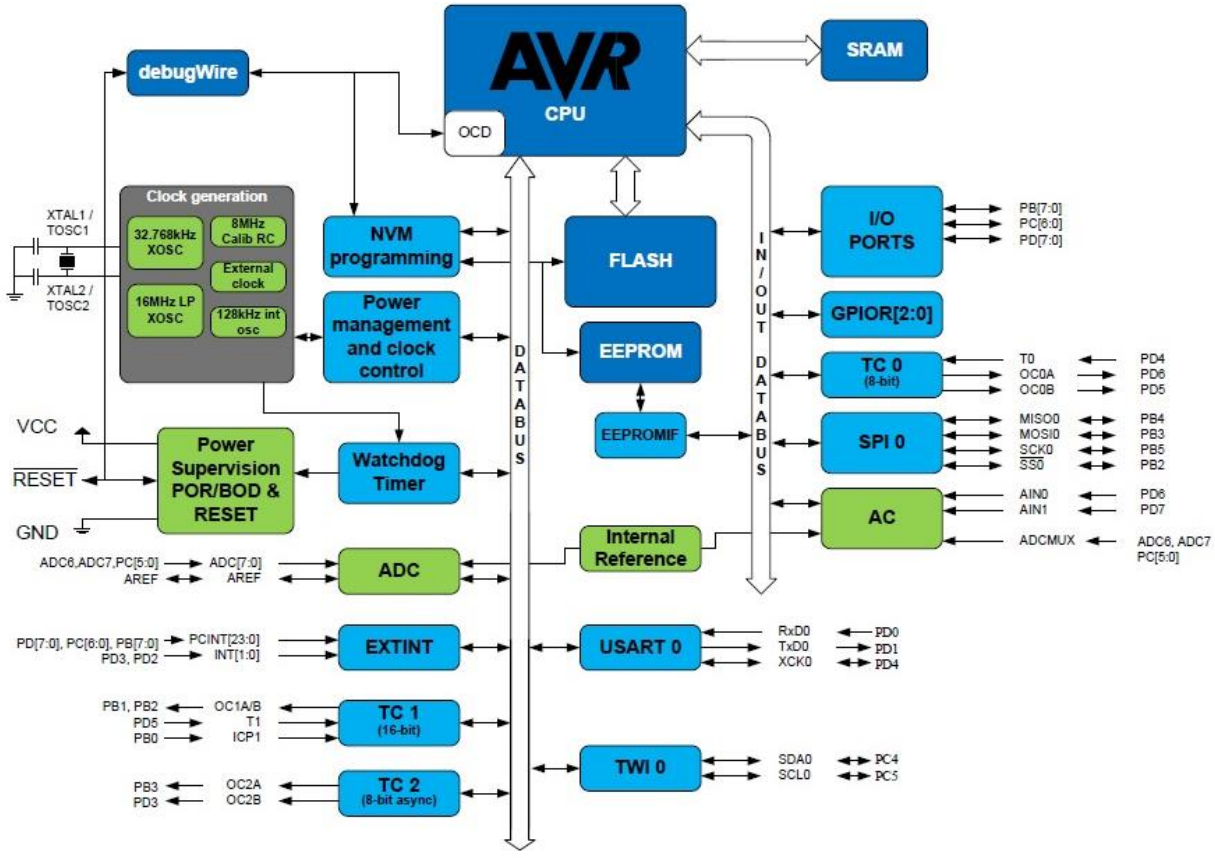


Figure 3.9: ATMEGA 328P Block Diagram

3.1.3 Actuator Design

The actuator unit consists relays that drives loads and motor (AC). The load drivers were used to switch the security lighting system, lamps, and TV AC while the motor driver controls the switching ON/OFF of the Air Condition (AC). LEDs were used as the lighting system.

The LED used in this project is a white type; it has a minimum forward voltage of 3.2V and maximum of 3.8V, to find the magnitude of the resistor that is connected to it. Equation 3.1 shows the formula for calculating the resistance

$$R = \frac{Vs - Vf}{I} \quad \ldots 3.9$$

Where

R is the current limiting resistor

V_s is supply voltage (Arduino outputs 5 V)

V_f is LED forward voltage drop

I is the current required the current required for the LED (5- 20 mA depending brightness required)

Therefore $R = \frac{5-3.5}{0.01} = 250\Omega$

But since 250Ω is not a standard resistor value, then 220Ω was chosen.

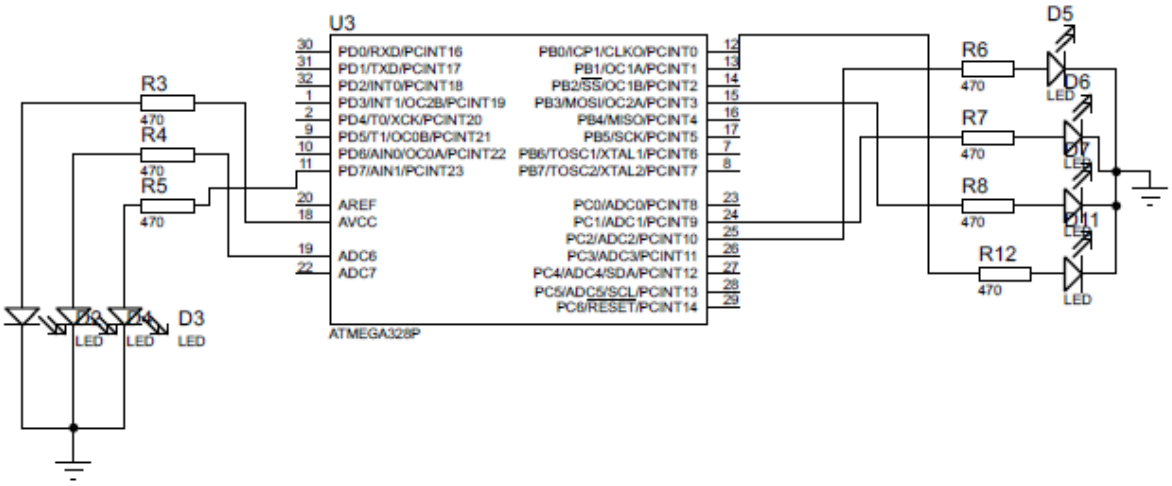


Figure 3.10: LED connection to the Microcontroller

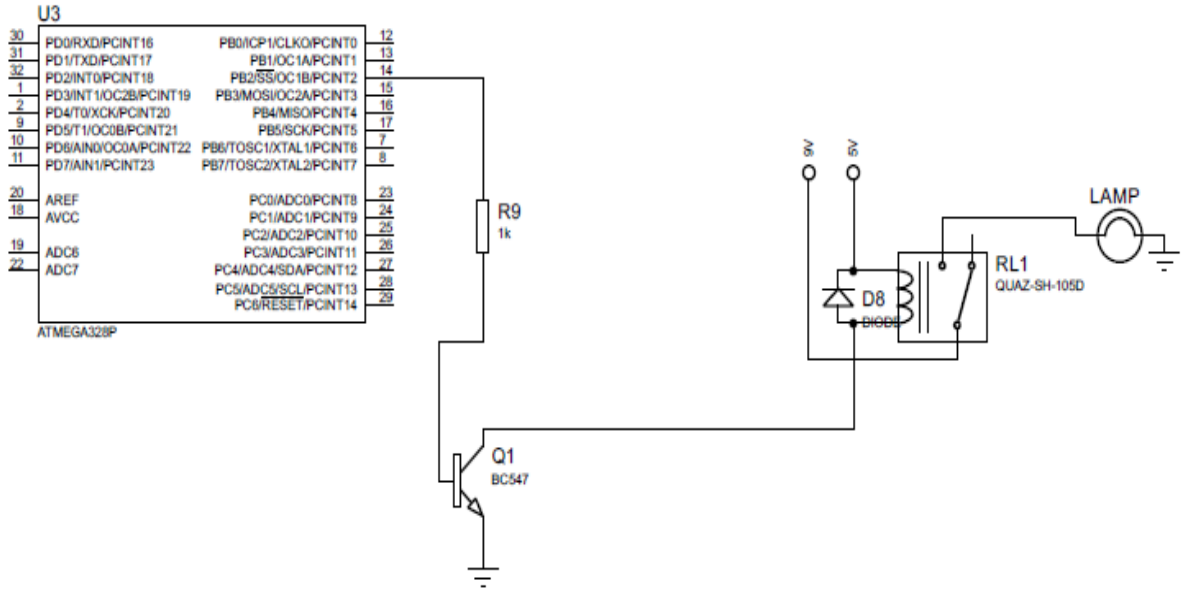


Figure 3.11: Lamp Driver Circuit

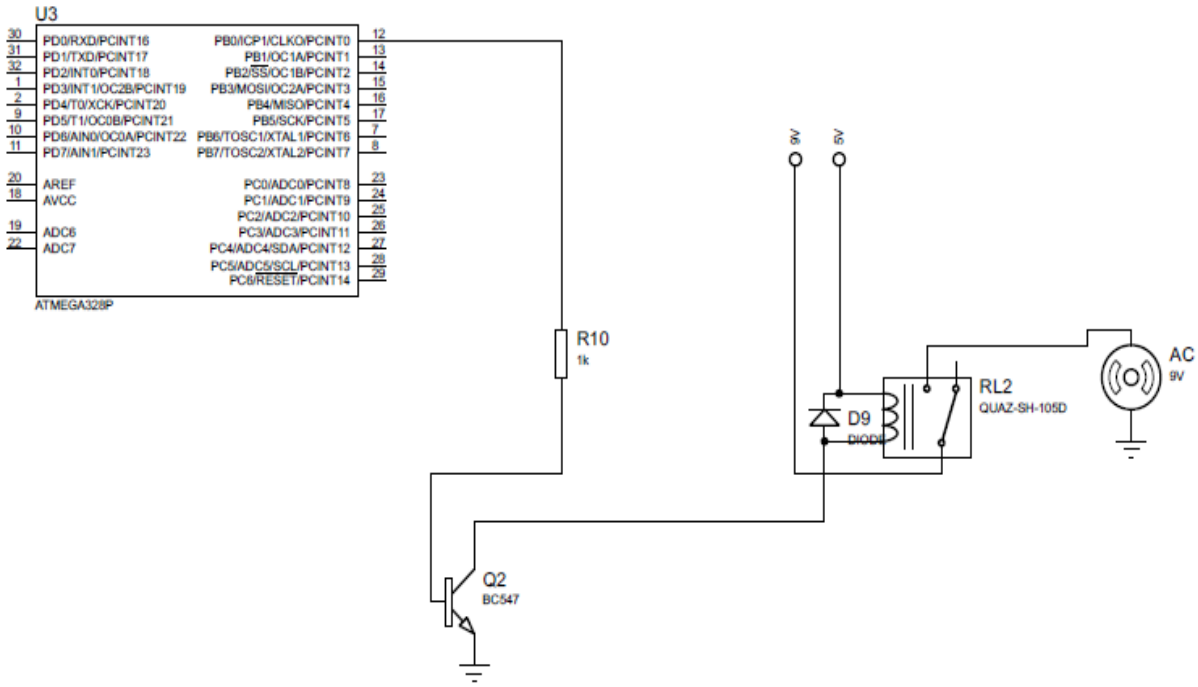


Figure 3.12: Motor (AC) driver circuit

3.1.4 Interface of Microcontroller and 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 transmitting and receiving signals. It receives the text from the Android phone and transmits it to the serial port of the ATMega328P. The Bluetooth module being used here is the HC-06 module, shown in figure 3.14. It is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The Bluetooth module HC-06 is a master/slave module.

Figure 3.13: HC06 Bluetooth module

By default the factory setting is slave. The Role of the module (Master or Slave) can be configured only by at commands. The slave modules cannot initiate a connection to another Bluetooth device, but can accept connections. Master module can initiate a connection to other devices. The HC-06 communicates with the ATMega328P via a serial connection. It has four pins that is VCC, GND, TXD and RXD. VCC is used to power the module, GND is the ground pin, TXD is used to send data from the module to the ATMega328P whereas RXD is used to receive data from the ATMega328P.

Table 3.3: Interfacing HC-06 with an ATMega328P

HC-06		ARDUINO UNO
VCC	Connected to	5V
GND	Connected to	Ground
TXD	Connected to	RX pin
RXD	Connected to	TX pin

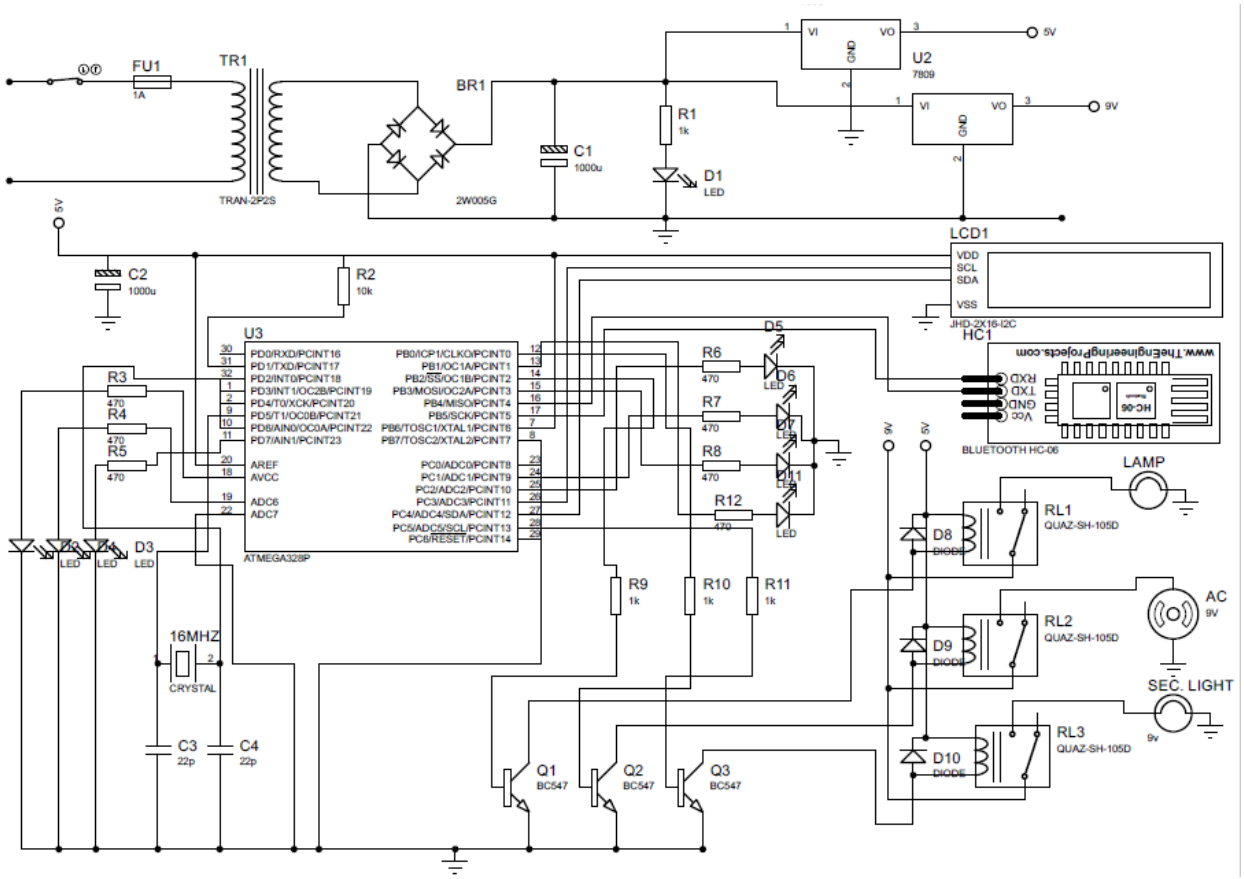


Figure 3.14: Functional Circuit Diagram

3.2 Software Design

This section discusses the software design of the microcontroller unit for the controller circuit.

3.2.1 System Flow Chart

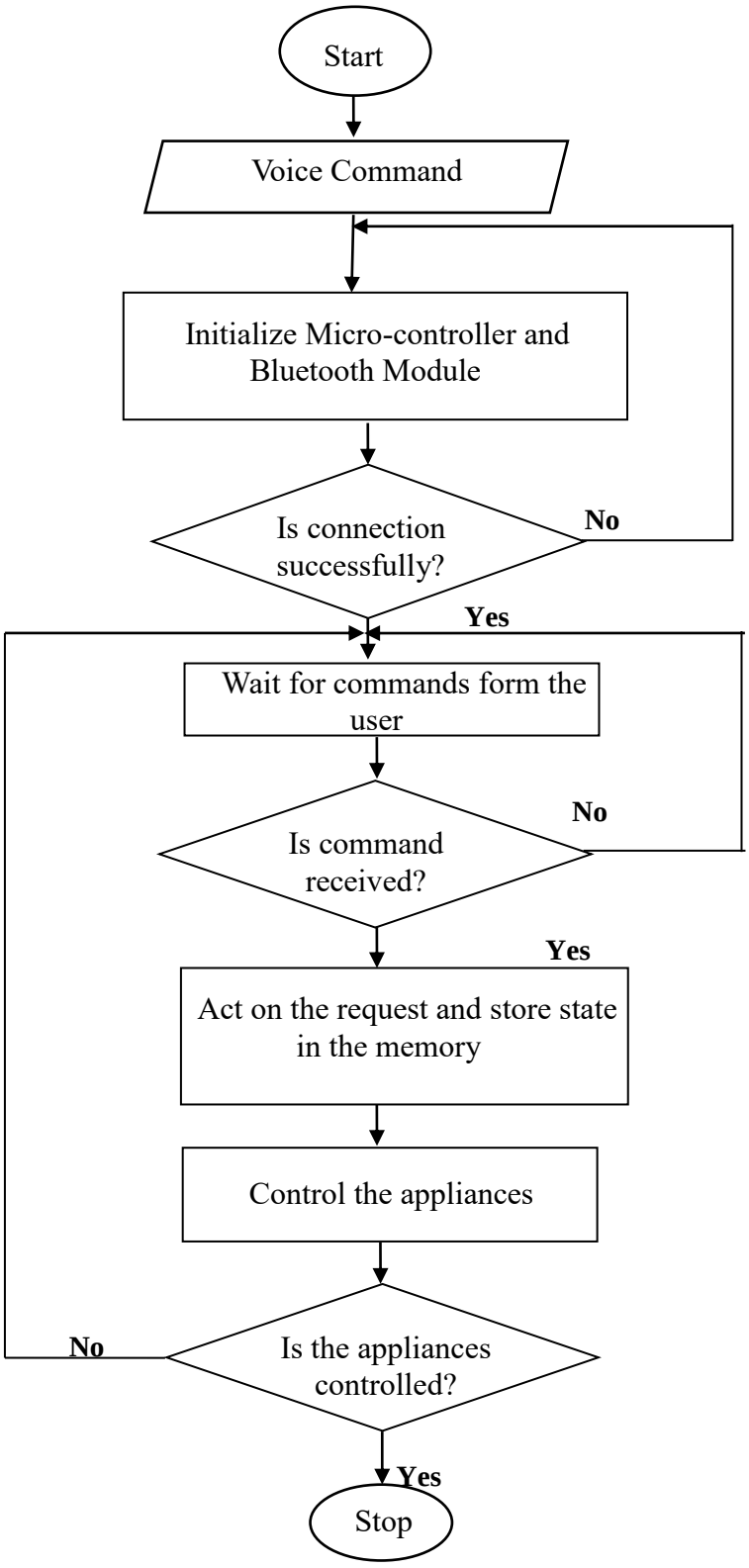


Figure 3.15: System Flowchart Diagram

3.2.2 Arduino Interface

The controller unit consists of microcontroller which required a program to function. The program can be written in various programming languages like Assembly, C, BASIC and so on. After writing the program, a complier converts the code into a Hexadecimal (.hex) file which is then burn into the flash memory of the microcontroller using a programmer. Arduino Uno board is used in this project. The Arduino UNO development board has ATMEGA 328 microcontrollers embedded in it. This microcontroller is typically programmed using dialect of features from the programming language C and C++. In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment (IDE) that is used to compile and upload program to the microcontroller via the Arduino Development board. Figure 3.16 shows a typical Arduino IDE interface.

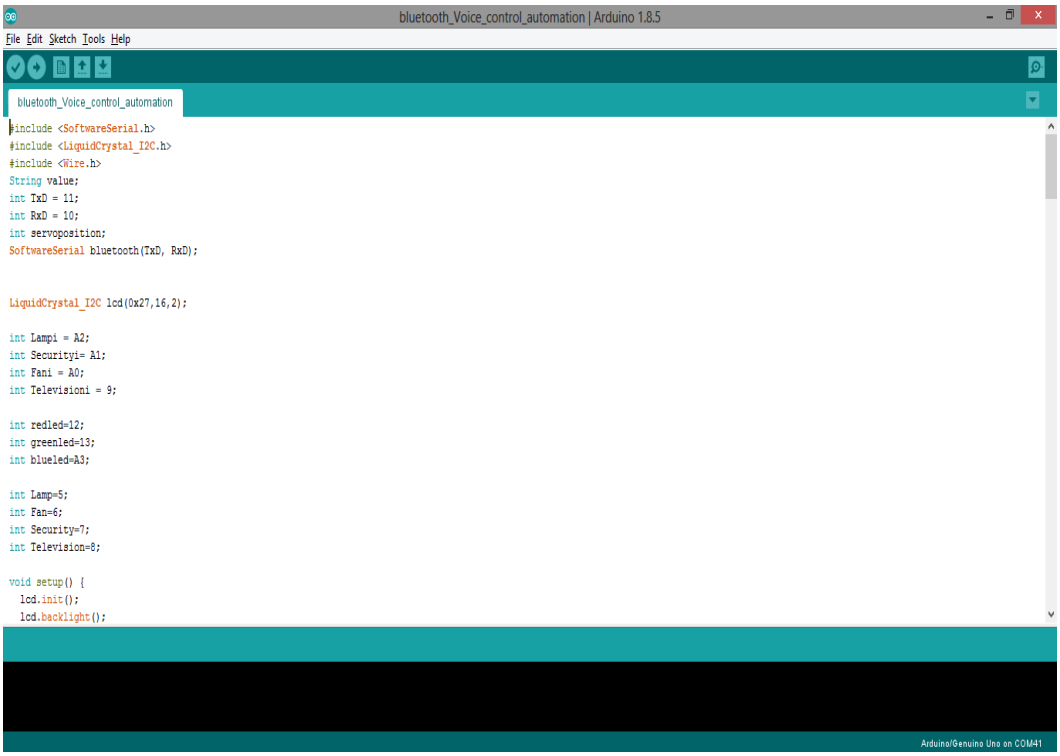


Figure 3.16: Arduino IDE interface

The code used in this project is clearly written in the appendix. Arduino codes are regarded as sketches. This sketch defines what the board will do. The buttons shown on the top left hand side of Figure 3.16, are used to operate the IDE. The two main features of the IDE are

1. VOID setup ():

   This feature of the Arduino IDE is only called once at the beginning of the program. One of the example found in the void setup () is: pinMode(Ledpin, OUTPUT);. This statement declares the Ledpin as the output in the program.

2. VOID loop ():

   This feature is called repetitively as long as the development board has power supply. DigitalWrite (Ledpin, HIGH);.this is an example of the statement used in the VOID loop. The statement implies that the ledpin which is the output is high at that instance.

The flowchart shown in figure 3.17 represents the program flow of the home appliances controller. The microcontroller initiates the Bluetooth module to scan for available smartphone and connect to it after authentication is made. The Bluetooth module communicates with the Arduino using serial communication having a baud rate of 9600 bits per second. To initialize serial communication in Arduino the command used is:

Serial.begin (9600);

This command states that serial communication will initiate with a baud rate of 9600 bits per second. Before beginning the serial communication, the output pins are defined and declared. After declaring the output pins and initializing serial communication it is checked for the data coming through serial transmission. When Bluetooth module receives serial

data from android phone it gives the data to Arduino for decoding and converting them into digital data for the output.

3.2.3 Android Commands Input

Android is software stack for mobile devices that includes an O.S, middleware and key applications. Android O.S is based on Linux and applications are made in java like a language running on virtual machine called “Dalvik” created by Google [20]. For this system, an open source android platform will be used. The Android application has a terminal mode which allows easy typing of command. First user has to start application, and then ask for making Bluetooth ON. After that he will be having list of available devices in range for serial connection. For safety purpose password is given for authorized user. Once the application is connected to HC-06, the user can then type in a command. Figure 3.18 shows the snap shot of the app user interface.

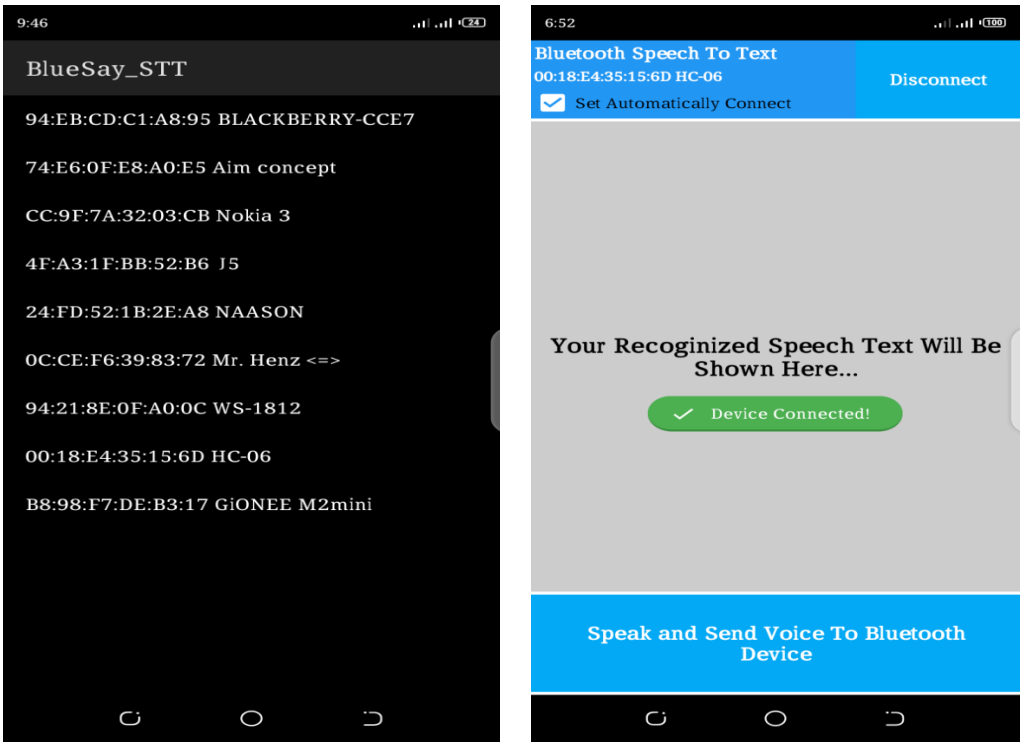


Figure 3.17: Android Application Interface

3.3 Construction Procedure

This section details the stages involved in the construction, including PCB production, soldering, and packaging.

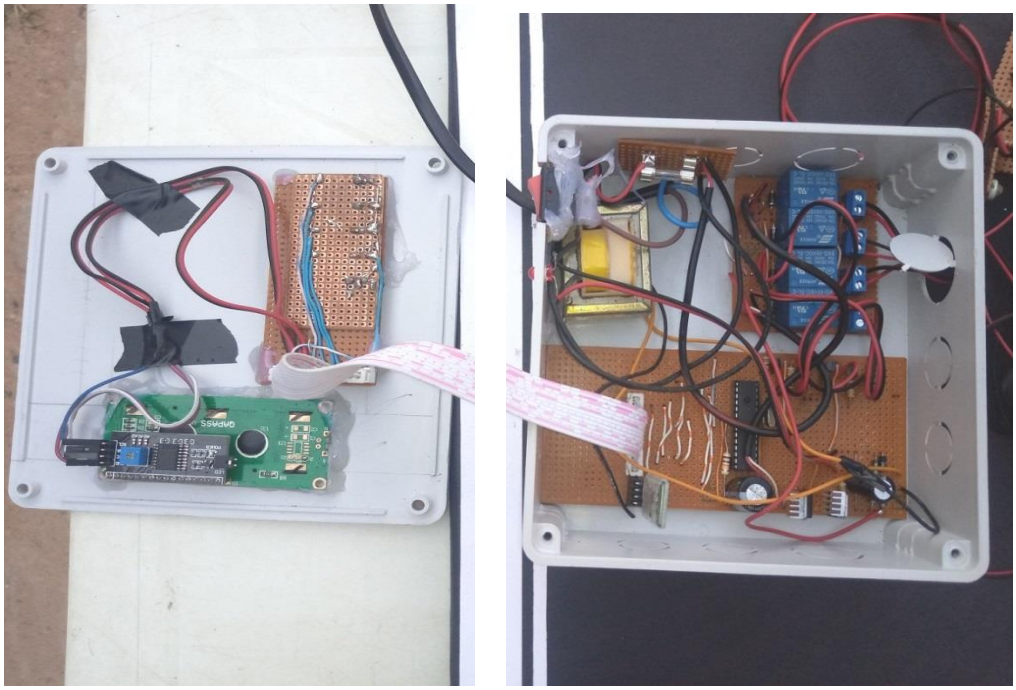
3.3.1 Vero Board

The project components were assembled on the Vero-board with the use of soldering iron and solder. It has rows of parallel copper strips with holes spaced at 0.1” to accept most through-hole components Vero board is a simple PCB with lots of copper dots with small holes available. One can build circuits by soldering components on the vero-boards. Routing is done by wires in the direction desired by the layout. Vero-board is a brand of strip-board, a pre-formed circuit board material of copper strips on an insulating bonded paper board which was originated and developed in the early 1960s by the Electronics Department of Vero Precision Engineering Ltd (VPE). It was introduced as a general-purpose material for use in constructing electronic circuits - differing from purpose-designed printed circuit boards (PCBs) in that a variety of electronic circuits may be constructed using a standard wiring board.

Figure 3.18: Vero Board layouts

3.3.2 Component Soldering

Soldering was done using soldering Work Station and soldering lead. This process involved appropriate mounting of various components on the board (Vero-board) with reference to components' layout. Plate 2 shows the pictures of the components side of the finished circuit board.



(a) (b)

Plate 1: Component on finished circuit board: (a) Display and (b) Main circuit

3.3 Packaging

The system components are implemented in a plastic casing. This is to protect the system against mechanical damage, exposure to weather and dirt, electromagnetic interference and also for ventilation.

Plate 2: Packaged Hardware

CHAPTER FOUR: PERFORMANCE AND TEST EVALUATION

4.0 Performance Evaluation

The first step in testing the system is to install the android application. After installing the application on the phone and connecting the ATMega328P with the Bluetooth module a test to make sure that the phone is interacting with ATMega328P via a voice command (say security lights ON). The test is highlighted below:

1. Open the application in the android device.
2. Search for Bluetooth devices via the application.
3. Connect to the Bluetooth module.
4. If the light in the Bluetooth module stopped blinking then the device is functioning properly, otherwise trouble shooting is required on the wiring.

After the connection was achieved, system performance was demonstrated by given a task (voice command) from the android device and the execution of that task was seen in the prototyped home. The system replied by executing the task, if the voice command is wrong there will be no response in the prototyped home. Table 4.1 shows the result of the performance test.

Table 4.1: Performance Test Result I

S/N	Task	Command	Result	Feedback
1	Switch ON Fan (AC)	AC ON	AC ON	“ac on”
2	Switch OFF Fan (AC)	AC OFF	AC OFF	“ac off"
3	Switch ON TV	TV ON	TV ON	“tv on”

4	Switch OFF TV	TV OFF	TV OFF	“tv off”
7	Switch ON Room Light	LAMP ON	Room Lamp ON	“lamp on”
8	Switch OFF Room Light	LAMP OFF	Room Lamp OFF	“lamp off”
11	Switch ON Security Lights	SECURITY LIGHTS ON	Security Lights ON	“security lights on”
12	Switch OFF security Lights	SECURITY LIGHTS ON	Security Lights OFF	“security lights off”

4.1 Discussion of Result

The results obtained after testing show high precision, reliability, and acceptable tolerance using this system in any home where physically challenge or elderly persons.

Plate 3: Tested system

4.2 Cost Evaluation

The cost estimate of this project is summarized in Table 4.2. The analysis mainly considers the physical cost of implementing this project, such as components/materials costs and transportation cost. However, other expenses such as programming/application development, construction, consultancy and miscellaneous expenses were not included.

The cost estimate here assumes a unit production cost of this system. However, producing the same system at large scale may reduce cost of production, as transport cost per unit item, design cost, labour cost, consultancy cost, etc., may reduce for each unit. This will provide a cost-effective production, thus, making the system affordable. It will also offer a reduced cost for institutions that may intend to implement this system for various research purposes.

Table 4.2: System Cost

Components description	**Quantity**	**References**	**Value**	**Unit Cost(₦)**	**Cost (₦)**
Resistors	7		470R	10	70
	5		1k	10	50
	1		10k	10	10
Capacitors	2		1000uf/50V	200	400
	2		22pf	50	100
Relay	4		5V	250	1000
Voltage regulator	1		7805	200	200
Voltage regulator	1		7809	200	200
Microcontroller	1	ATMEGA328P	8Bit AVR	1500	2500
Crystal oscillator	1		16MHz	30	50
Transformer	1		220/12V	700	2000
Bridge Rectifier	1			100	100
Transistor	4		BC547	50	200
LED	6			10	60
Socket	1			300	500
AC Fan	1			500	700

Diodes	4		1N4001	10	40
Bluetooth Module	1	HC-06	5V	2000	2000
Power Switch	1			100	100
Miscellaneous			Jumper	300	300
	10		Glue Stick	300	300
			Wiring Cable	500	500
			Lead	1000	1000
			House modeling	10000	10000
			Casing	6000	6000
			Transportation	5000	5000
TOTALS					**33,380**

CHAPTER FIVE: CONCLUSIONS

5.0 Summary

The purpose of undertaking this research work is to design and implement a Home Appliances Control using Android Application via voice command. The system would lower human stress involve in manually switching ON/OFF home appliances by providing smart control of home appliances that can cover a distance of 10m. The problem that leads to the development of this system has been properly discussed and relevant literatures were reviewed. The system was designed and constructed around ATMEGA 328P, Bluetooth Module, Transistors etc. Performance evaluation was carried out and revealed that the system is capable of performing the required task and satisfactory results were obtained during the test period as anticipated, with negligible errors. Conclusively the performance indicates that the system becomes necessary in any home where physically challenged or elderly persons live.

5.1 Conclusions

The system has been experimentally proven to work satisfactorily by connecting model appliances to it and the appliances were successfully controlled from android phone. The Bluetooth application was successfully tested on a multitude of different mobile phones, thus proving its portability and wide compatibility. This low cost system was designed to improve the standard of living in home. The remote control function using android phone provides help and assistance especially to disabled and elderly persons. A low voltage activating switches were used to replace the manual electrical switches, as such, the system can provide safety protection to the user. Moreover, implementation of wireless Bluetooth connection in control board allows the system install in more simple

way. The control board can be directly installed beside the electrical distribution board whereby the switching connection is controlled by relay. Therefore, the aim and objectives of the project has been successfully achieved.

5.2 Recommendations

Based on observations, results and satisfactions displayed in this work, the following recommendations are made for further development on this work:

i. The system can be connected to the internet to provide remote control and data acquisition over the internet.
ii. The consumed energy of the house can be sent to the electricity distribution company for the purpose of billing. Therefore, perform the purpose of energy metering in the house.

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APPENDIX I

Source Code

```
#include <SoftwareSerial.h>

#include <LiquidCrystal_I2C.h>

#include <Wire.h>

String value;

int TxD = 11;

int RxD = 10;

int servoposition;

SoftwareSerial bluetooth(TxD, RxD);


LiquidCrystal_I2C lcd(0x27,16,2);


int Lampi = A2;

int Securityi= A1;

int ACi = A0;

int Televisioni = 9;


int redled=12;

int greenled=13;

int blueled=A3;


int Lamp=5;

int AC=6;

int Security=7;
```

```
int Television=8;


void setup() {
  lcd.init();
  lcd.backlight();
  pinMode(Lamp, OUTPUT);
  pinMode(AC, OUTPUT);
  pinMode(Security, OUTPUT);
  pinMode(Television, OUTPUT);
  pinMode(Lampi, OUTPUT);
  pinMode(ACi, OUTPUT);
  pinMode(Securityi, OUTPUT);
  pinMode(Televisioni, OUTPUT);
  pinMode(redled, OUTPUT);
  pinMode(greenled, OUTPUT);
  pinMode(blueled, OUTPUT);
  Serial.begin(9600);
  bluetooth.begin(9600);
  digitalWrite(redled, HIGH);
  delay(3000);
  digitalWrite(redled, LOW);


  lcd.setCursor (5, 0);
lcd.print ("System");
lcd.setCursor(0, 1);
```

```
lcd.print("Initializing...!");
delay(6000);

for(int i=1; i<=6; i++){
   digitalWrite(greenled, HIGH);
   delay(500);
   digitalWrite(greenled, LOW);
   delay(500);}

lcd.clear();
lcd.setCursor(1, 0);
lcd.print("VOICE ACTUATED");
lcd.setCursor(0,1);
lcd.print("HOME  AUTOMATION");
delay(3000);

lcd.clear();
lcd.setCursor(5, 0);
lcd.print("SYSTEM");
lcd.setCursor(7,1);
lcd.print("BY");
delay(3000);

lcd.clear();
lcd.setCursor(0,0);
```

```
lcd.print("NEHEMIAH NAASON");
lcd.setCursor(1,1);
lcd.print("EE/14/2906");
delay(3000);

lcd.clear();
lcd.setCursor(1,0);
lcd.print("SUPERVISED BY:");
lcd.setCursor(0,1);
lcd.print("ENGR DR S Y MUSA");
delay(3000);
digitalWrite(redled, HIGH);
delay(2000);
lcd.clear();
lcd.setCursor(0,0);
lcd.print("System Active!!!");
digitalWrite(redled, LOW);
digitalWrite(blueled, HIGH);
delay(1000);
}

void loop() {
  Serial.println(value);
 if (bluetooth.available())
  {
```

```
value = bluetooth.readString();

if (value == "all on"){
digitalWrite(Lamp, HIGH);
digitalWrite(AC, HIGH);
digitalWrite(Security, HIGH);
digitalWrite(Television, HIGH);
digitalWrite(Lampi, HIGH);
digitalWrite(ACi, HIGH);
digitalWrite(Securityi, HIGH);
digitalWrite(Televisioni, HIGH);

lcd.setCursor(0,1);
lcd.print("AC=1");

lcd.setCursor(7,0);
lcd.print("Sec.=1");

lcd.setCursor(0,0);
lcd.print("Lamp=1");

lcd.setCursor(7,1);
lcd.print("TV=1");
}
```

```
if (value == "all off"){
  digitalWrite(Lamp, LOW);
  digitalWrite(AC, LOW);
  digitalWrite(Security, LOW);
  digitalWrite(Television, LOW);
  digitalWrite(Lampi, LOW);
  digitalWrite(ACi, LOW);
  digitalWrite(Securityi, LOW);
  digitalWrite(Televisioni, LOW);

lcd.setCursor(0,1);
lcd.print("AC=0");

lcd.setCursor(7,0);
lcd.print("Sec.=0");

lcd.setCursor(0,0);
lcd.print("Lamp=0");

lcd.setCursor(7,1);
lcd.print("TV=0");

  }

if (value == "lamp on"){
```

```
digitalWrite(Lamp, HIGH);
digitalWrite(Lampi, HIGH);

lcd.setCursor(0,0);
lcd.print("Lamp=1");

  }

if (value == "ac on"){
  digitalWrite(AC, HIGH);
  digitalWrite(ACi, HIGH);
     lcd.setCursor(0,1);
lcd.print("AC=1");

  }

if (value == "security lights on"){
  digitalWrite(Security, HIGH);
  digitalWrite(Securityi, HIGH);

lcd.setCursor(7,0);
lcd.print("Sec.=1");
  }

if (value == "tv on"){
```

```
  digitalWrite(Television, HIGH);
   digitalWrite(Televisioni, HIGH);
   lcd.setCursor(7,1);
lcd.print("TV=1");
  }

if (value == "lamp off"){
digitalWrite(Lamp, LOW);
  digitalWrite(Lampi, LOW);
    lcd.setCursor(0,0);
lcd.print("Lamp=0");
  }

if (value == "ac off"){
  digitalWrite(Fan, LOW);
  digitalWrite(Fani, LOW);
      lcd.setCursor(0,1);
lcd.print("AC=1");
  }

if (value == "security lights off"){
digitalWrite(Security, LOW);
 digitalWrite(Securityi, LOW);
  lcd.setCursor(7,0);
lcd.print("Sec.=0");
```

```
  }


if (value == "tv off"){
  digitalWrite(Television, LOW);
  digitalWrite(Televisioni, LOW);
    lcd.setCursor(7,1);
lcd.print("TV=0");
  }
} }
```