PROJECT REPORT

ON

"HOME AUTOMATION USING DTMF"

Submitted in partial fulfilment of the requirements for the completion of

MINI PROJECT [19EC5PWMP2]

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

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Department of Electronics and Communication Engineering

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DECLARATION

We undersigned students of fifth semester B.E in Electronics and Communication Engineering, BMS College of Engineering, Bangalore, hereby declare that the dissertation entitled "HOME AUTOMATION USING DTMF", embodies the report of my project work carried out independently by us under the guidance of Prof.Shaila V Hegde,Assistant Professor, E&C Department, BMSCE, Bangalore in partial fulfilment for the award of Bachelor of Engineering in Electronics and Communication from Visvesvaraya Technological University, Belgaum during the academic year 2020-2021.

We also declare that to the best of our knowledge and belief, this project has not been submitted for the award of any other degree on earlier occasion by any student.

Place: Bangalore
Date: 24-02-2021

Sukshith B Jain
Sumukha K S
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B.M.S COLLEGE OF ENGINEERING

(Autonomous College under VTU)

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CERTIFICATE

This is to certify that the project entitled **""HOME AUTOMATION USING DTMF"** is a bonafide work carried out by **Sukshith B Jain** (USN:1BM18EC156), **Sumukha K S** (USN:1BM18EC158) **Suraj S** (USN:1BM18EC160) and **Vaishakh M S**(USN:1BM18EC173) in partial fulfillment for the completion of MINI PROJECT [19EC5PWMP2] during the academic year 2020-2021.

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External Examination: **Signature with date:**

1.

2.

ABSTRACT

The objective of our mini project is to develop an automated control system for home appliances. Automation is the use of control systems and information technology to control equipment, industrial machinery and processes, reducing the need for human intervention. Automation plays an increasingly important role in the global economy and in daily experience. Automation has had a notable impact in a wide range of highly visible industries beyond manufacturing.

Home automation includes all that a building automation provides like climate controls, door and window controls, and in addition control of multimedia home theatres, pet feeding, plant watering and so on.

This system is designed to provide control of home appliances through mobile phone by dialling the designated number. Dialling can be done from the home phone or a call made to the number from outside. This system is designed by ARDUINO UNO but is based on digital logic using DTMF technology (Dual Tone multiple frequency) which receives the command from the phone to develop digital output. This digital signal is further processed to actuate switching mechanism through relay driver to turn on/off the loads/appliances. It can be used to switch appliances from anywhere, overcoming the limited range of other infrared and radio frequency type controls. This proposed system gives a new direction to the development of home automation.

ACKNOWLEDGEMENT

Any achievement, be it scholastic or otherwise does not depend solely on the individual efforts but on the guidance, encouragement and cooperation of intellectuals, elders and friends. A number of personalities, in their own capacities have helped us in carrying out this project work. We would like to take this opportunity to thank them all.

We express profound gratitude to respected principal **Dr. B. V. Ravishankar,** BMS College of Engineering for providing a congenial environment to work in. Our sincere gratitude to **Dr. Arathi R Shankar,** Head of the Department, Electronics and Communication Engineering for encouraging and providing this opportunity to carry out the project in the department.

We would like to thank our guide **Shaila V Hegde,** Assosiate Professor, Department of ECE who helped us in all the ways to carry out the project work. He stood beside and guided us in every step.

We would like to share the joy completing the project to all the team members of NXP lab**.** We thank all our professors for providing the basic knowledge without which this project wouldn't have been possible. Last but not the least we thank our family and friends, who made their valuable support compelled us to maintain a standard throughout our endeavour.

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1.1 INTRODUCTION:

Conventionally, electrical appliances in a home were controlled via switches that regulate the electricity to these devices.The present and the future of the world we live in is automation. Everything from household work to manufacturing and distribution centres are or will be using autonomous based lifestyle.

Home automation or domotics is building automation for a home, called a smart home or smart house. A home automation system will control lighting, climate, entertainment systems, and appliances. It may also include home security such as access control and alarm systems.Home automation is a network of hardware, communication, and electronic interfaces that work to integrate everyday devices with one another.

In this project, we propose a unique System for Home automation utilizing Dual Tone Multi Frequency (DTMF) that is paired with a wireless module to provide seamless wireless control over many devices in a house. We can operate our system from any distant or remote area.

It is a wireless system but instead of using a separate wireless module (transmitter and receiver) we are using the cell phones for this purpose. Cell-phone operated systems have a wide range (service provider range), less fear of interference as every call is having a unique frequency and moreover it has more control keys. The principle used for cell-phone controlled systems is the decoding of DTMF tone.

1.2 PROBLEM DEFINITION:

Let's say we forget to turn off some appliances before leaving home, we either have to travel back all the way or let the energy waste as is. This could be a national resource waste and could also sometimes be hazardous if an electrical appliance burns out which could lead to a disaster. The chances of forgetting the lights, door locks at night, temperature controlling thermostats are high which can lead to some or the other problems. For disabled and old age people some of the daily tasks would be near to impossible. The power wastage due to inefficient use of electricity and less safety measures in houses.

PROBLEM SOLUTION:

● This wireless remote control system is developed to control home appliances from any place by using a communication network and a mobile phone or a telephone to automate a home or office. The major purpose behind this proposed idea is to make the lives of people easy.

● Even from long range, some of the appliances can be accessed. This leads to efficient energy consumption. Owners don’t have to worry about security since they can be accessed by them using a password.

● For disabled and old age people, they can control anything and everything using the mobile phone connected to the network.

● Home automation has made it possible to have what is often referred to as a 'smart home', a home that can detect and identify you, automatically adjust the lighting to your predefined taste, play your favourite music, water your flowers in the morning, switch on the security lights at night and switch them off in the morning, heat water for bathe and tea, stream to you anywhere in the world via the internet a live video of what is happening in and around your house. This allows you to make your house an active partner in managing your busy life.

1.3 Project Objective:

The objective of this mini project is to implement automation in home which can be used for switching ON and OFF the household appliances and the system is to be of low cost, reliable and scalable. We are using a microcontroller to achieve hardware simplicity, low cost short message service (SMS) for feedback and voice dial from any phone to toggle the switch state.

Area of Application:

The versatility of home automation allows it to be used in multiple environments. Our project can be utilised in people's homes as well as industrial environments such as schools and offices.

It eases the burden of having to manage and control every single appliance by providing us control over multiple of them right at the palm of our hands. It saves time and effort and also assists people with disabilities to have easier control of their surroundings.

We use home automation to control house lighting systems, secure and lock doors, control irrigation systems for the garden , remotely control air-conditioning, microwave or geyser, all over the local area network. Applications can be made to automatically turn on and off based on our convenience. It can also be installed in public places to enable auto lighting , water taps, hand dryers and more.

2 LITERATURE SURVEY:

● Phone to microcontroller interfacing with DTMF by Mayank Magoo. The objective of the author's article is to make the lives of aged people easy by making the homes automated and hence we need a smart device or system to achieve this goal. This article is basically based on Dual-Tone MultiFrequency(DTMF) and how to employ it to automate the home or office. This article also tells us how to interface a microcontroller to the phone line. Using this interface any device can be controlled using a telephone or cell phone. Some of the key features of the author's article are1.The use of ATMEGA-8 microcontroller. Using ATMEGA-8 makes the system cost efficient since it's low cost and easy to program and implement. 2. Another key feature is the use of MT8870 as DTMF decoder IC, since it is a low cost IC hence reduces the cost factor. 3. The system controls the electrical devices and appliances through the available communication network, hence it is very simple to use and adaptable. 4. Since it employs only cell phones to control the appliances, therefore there is no need for any extra effort to teach people how to use this system. Every system has some drawbacks or limitations so does this system, some of them are1. Limited range of infrared and radio remote control, with the aid of available cellular communication systems. 2.Used an amplifier IC to amplify the current from the decoder will only increase the complexity and cost factor, which can be avoided by avoiding the use of amplifier IC. 3. Since some extra components are used therefore the required voltage would be high to operate all those components.[1]

● Implementation of home automation and security system using touch screen, remote control and web based operation: by Dhiraj Sunehra This research paper by the author presents the implementation details of a Home Automation and Security System (HASS) that uses a RF remote controller, temperature sensor, humidity sensor and touch screen to control electrical devices. The user can conveniently control the devices in the home by using this System. Touch screen control panels can be attractive compared to conventional switch boards. A camera is also interfaced for surveillance purposes. The image of the intruder is uploaded onto a web server. A web page is developed using PHP and HTML for controlling the devices as well as to monitor the home environment when the user is away from home. A few desirable features of this Home Automation System are1. It provides an additional security feature along with the required automation. 3. The operation/implementation process is highly user friendly, especially for the younger population which is required in a country like India where the majority of the population belongs to the youth. The project also has a few minor issues which can be improved1. It is a highly complex arrangement of devices which requires skill as well as time. 2. It requires prerequisite knowledge of languages like HTML, PHP, and C/C++. 3. The Automation System might not be feasible with all groups of people, especially the elder ones. Home automation control using gateway: by Peter M.Corcoran, Ferenc Papai and Arpad Zoldi Features of the project1. In this paper the better thing is that it is using gateway architecture. 2. They prevail in the three tier architecture for implementing the home gateway. 3. The third software tier is essentially a user interface layer which supports remote client access to the home gateway. [2]

● Bluetooth based home automation system: by H.Kanma This paper shows the implementation of the home automation system using Bluetooth that can be accessed through GPRS. The researchers use a cellular phone, Bluetooth communication adapters for the appliances and the cellular phone separately .The home appliances and cellular phone can be connected by using Bluetooth as a communication medium. The cellular phone with Bluetooth connectivity works as a host controller and a GSM modem that provides an internet connectivity which is used to update the services by the cellular phone therefore, it is useful for the appliances which usually will be used for many years. They use cellular phones as a remote control for the various home appliances to set up the parameters starting and stopping the operation. The paper discusses controlling and updating home devices with fault diagnostics and detection. Issues of using Bluetooth for home automation1. Bluetooth communication has high power consumption so the batteries of devices need to be charged frequently. 2. Bluetooth has a limited communication range within the home environment and does not allow the user to control home appliances remotely. 3. Bluetooth communication has serious security concerns as there is no password protection so anyone can access the devices. [3]

● Mobile based home automation system: by M. Van Der Werff, X.Gui and W.L.Xi.This paper explains a type of home automation system which consists of a java-based mobile phone, a cellular modem and a controller board containing a microcontroller. The researchers use a mobile phone as a remote control which provides the interface between the user and the home automation system. User friendly graphical user interface (GUI) is provided on the mobile phone through an application developed by using Java programming language. The work shows GUI running the developed java application which allows users to input commands for turning on or off home appliances. The user inputs are processed by the java application and then sent to the home server via SMS, where the home server communicates with the remote control via cellular modem. The researchers provide a secure environment with password protection to make this a safe and user friendly application so only allowed users can log in to the application using their username and password . This project consists of a microcontroller(Atmel butterfly) for the designing of home server and the software that runs on the microcontroller handles the communication to and from the cellular modem the communication to the attached external devices, the processing of SMS messages and the sending of response to commands/errors. Issues regarding the project1. High cost as compared to other technologies like DTMF based automation systems. 2. Number of appliances is limited. 3. If a user forgets his/her password then there is no way to retrieve it. [4]

3.1 Project Setup and Connections:

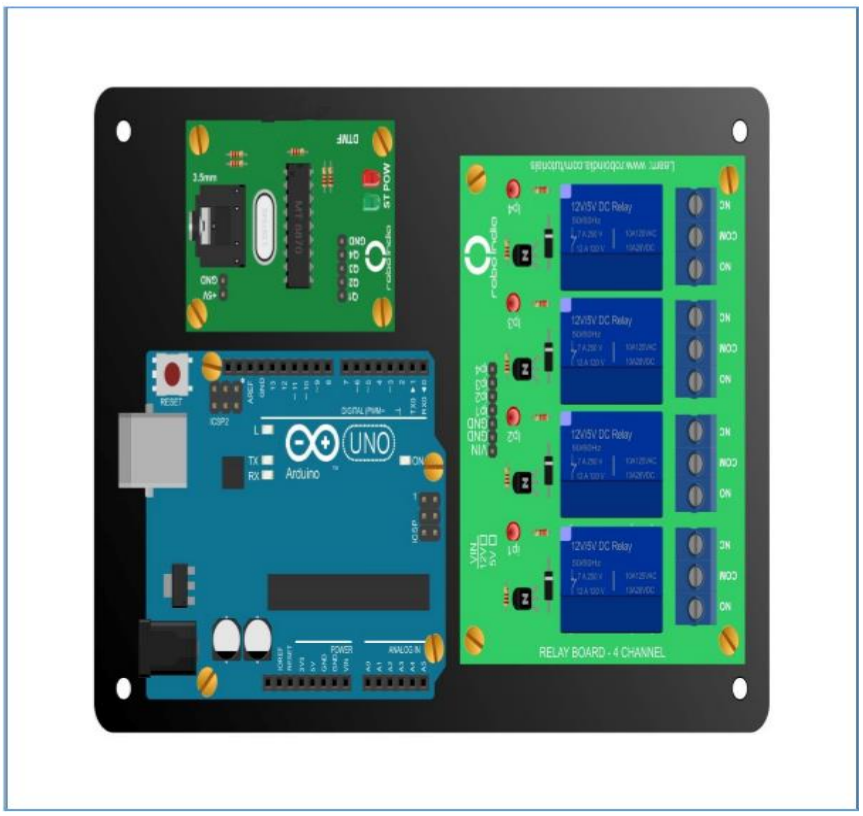


Figure:1 Project Setup

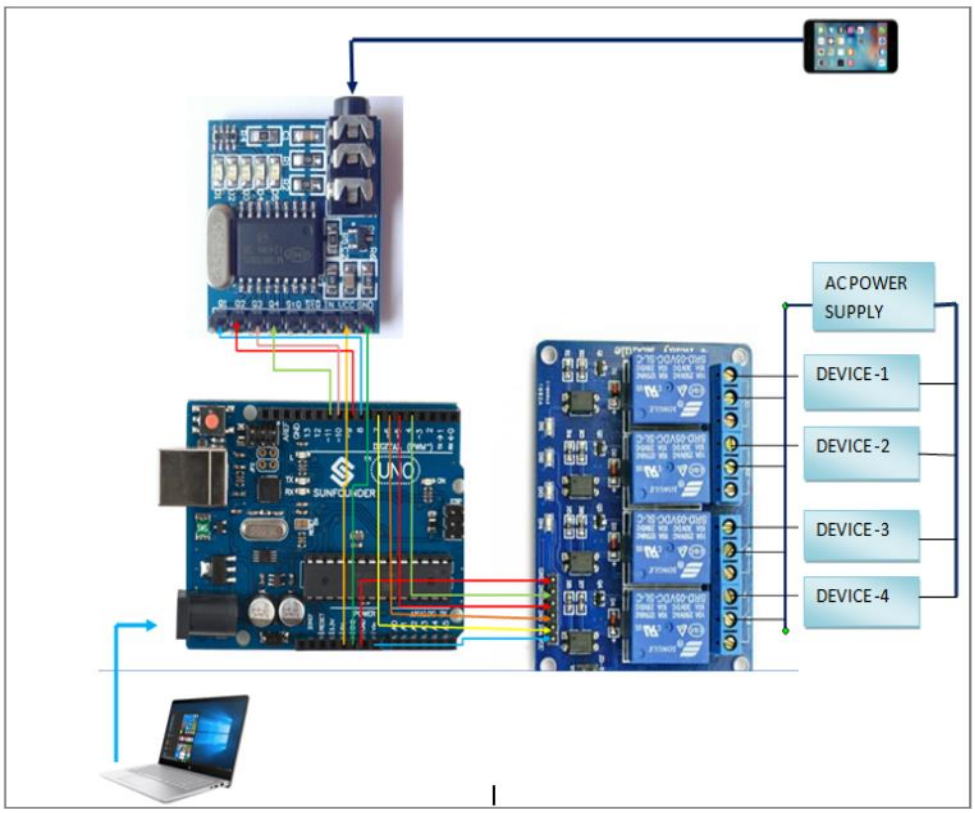


Figure:2 Circuit Connection

Components Used:

- Microcontroller – Arduino UNO
- DTMF Decoder – MT8870 IC
- Four Channel Relay – ULN 2003 IC

1.Microcontroller:

A microcontroller is designed to govern the operation of embedded systems in motor vehicles, robots, office machines, complex medical devices, and various other devices. A typical microcontroller includes a processor, memory, and peripherals. The simplest microcontrollers facilitate the operation of the electromechanical systems found in everyday convenience items. In recent years, microcontrollers have found their way into common items such as ovens, refrigerators, toasters, Microcomputers are also common in office machines such as photocopiers, scanners, and printers. The most sophisticated microcontrollers perform critical functions in aircraft, spacecraft, oceangoing vessels, life-support systems, and robots of all kinds. Medical technology offers especially promising future roles. For example, a microcontroller might regulate the operation of an artificial heart, artificial kidney, or other artificial body organ. Microcomputers can also function with prosthetic devices (artificial limbs). A few medical-science futurists have suggested that mute patients might someday be able, in effect, to speak out loud by thinking of the words they want to utter, while a microcontroller governs the production of audio signals to drive an amplifier and loudspeaker.

Arduino UNO:

Arduino Uno is basically based on ATmega328 microcontroller (MCU). It consists of 14 digital input/output pins, six analogue inputs, a USB connection used for programming the on board MCU, a power jack, an ICSP header and a reset button. Arduino is an open source electronics prototyping platform that is flexible, easy-to-use hardware and software. The crystal oscillator which is used in this is of frequency 16MHz and it supports MCU. It can be easily connected to a computer by using the USB (Universal Serial Bus) cable or power it with an AC-to-DC adaptor or battery to get started. The MCU on board is programmed in Arduino programming language using Arduino IDE.

Figure:3 Arduino UNO

Arduino UNO Specifications:

Microcontroller	Atmel ATmega328
Operating Voltage	5V (DC)
Input Limit	6-20 V
Recommended input	7-12 V
Number of I/O pins (digital)	14
Number of I/o pins (analog)	8
DC current	40mA
RAM	SRAM of 2KB
ROM	EEPROM of 1KB
Flash Memory	32KB with 0.5KB bootloader
Clock Speed	16MHz
Dimensions	0.73'' x 1.70''

Table:1 Arduino UNO Specification

Pin Diagram of Arduino UNO:

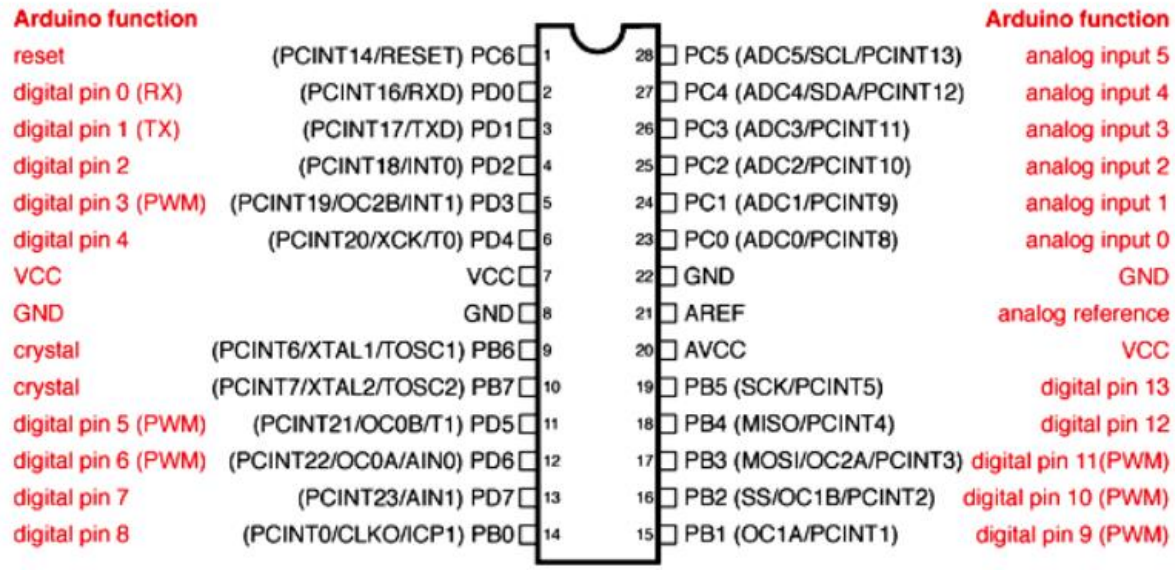


Figure:4 Pin Diagram of Arduino UNO

Input and Output:

The 14 digital input/output pins can be used as input or output pins by using pin Mode(), digital Read() and digital Write() functions in arduino programming. Each pin operates at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 kilo 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 analog Write() 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.

Memory:

The ATmega328 has 32 KB (with 0.5 KB occupied by the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Communication:

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.

2.DTMF Decoder:

The DTMF Decoder (MT8870) is a device which is used to decode the DTMF tones generated by the dialer keys of a cell-phone. It integrates both the band split filter and digital decoder functions. The decoder utilizes the digital counting techniques to detect and decode all 16 DTMF tone-pairs into a 4-bit binary code. For e.g. - if a user dials '1' in his keypad the output generated by the decoder is 0001 and so on. The output of the DTMF decoder can be used to drive home appliances.

DTMF tones are sometimes used in caller ID systems to transfer the caller ID information, but in the United States only Bell 202 modulated FSK signalling is used to transfer the data

- DTMF is a system for identifying number dialed on a pushbutton or DTMF keypad.
- DTMF keypad is a 4×4 matrix of push buttons.
- DTMF is sum of two sine waves one from 697 to 940Hz and other from 1209 to 1663 Hz.
- Each group contain 4 individual tones which form 16 combinations.
- By using band pass filter we can decode in receiver section.

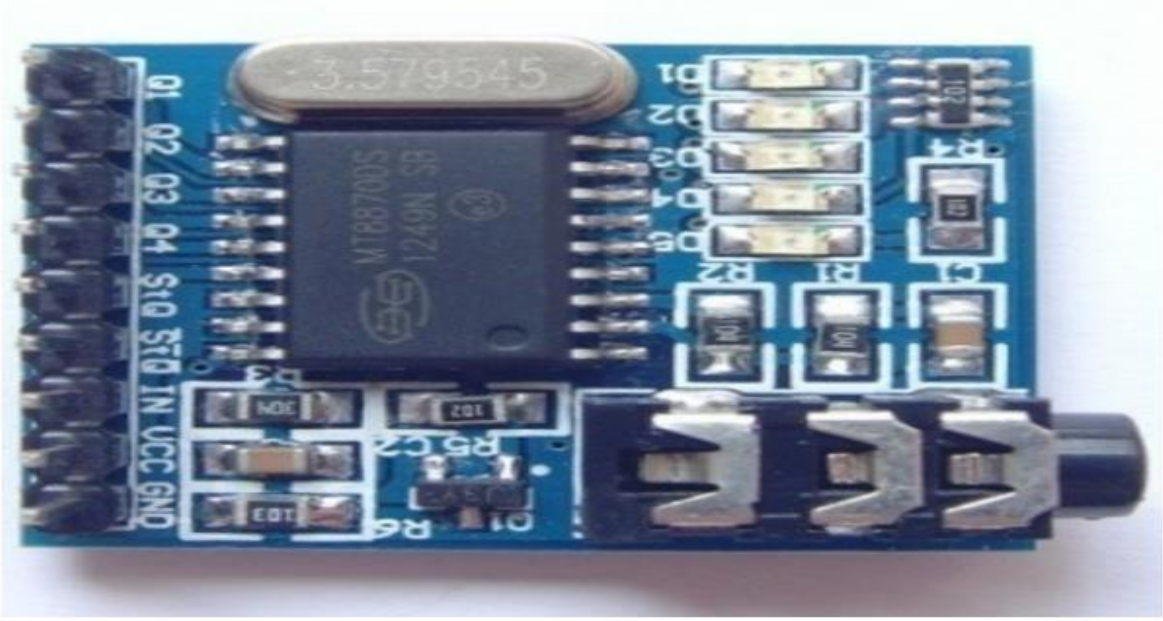


Figure:5 DTMF Decoder

MT8870 IC:

There is an inbuilt Op amp present inside the M-8870 decoder IC.The electrical signals from microphone pin are fed to inverting input of the Op Amp via a series of resistance (100kΩ) and capacitance (0.1 µF).

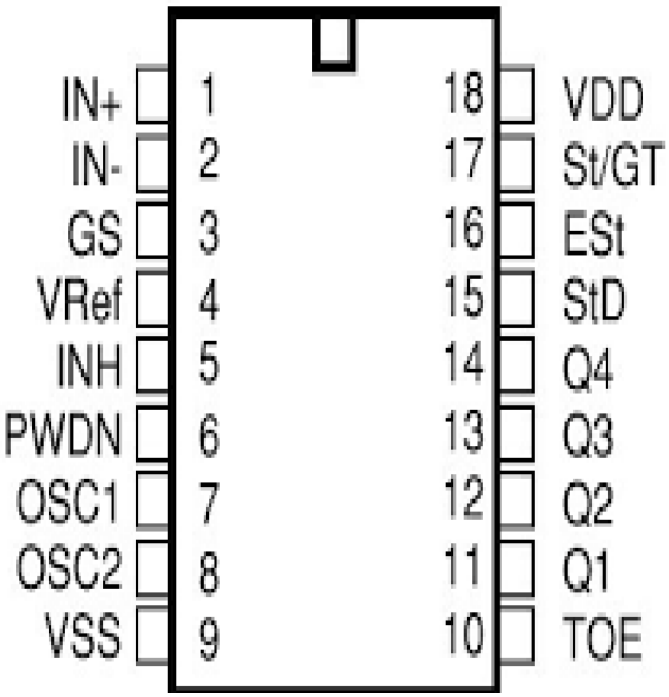


Figure:6 Pin Diagram of MT8870 IC

- The non-inverting input of Op-amp is connected to Vcc/2.
- Pin 3 is the output of internal Op Amp, the feedback signal is given by connecting the output pin to inverting input pin through a resistor (270kΩ).
- 5th Pin, INH is an active high pin, inhibits detection of A, B, C, D tones of character.
- 6th Pin, PWDN is an (active high), inhibits the working of oscillator thus stops the working of our circuit.
- 10th pin TOE is the output enable pin which is active high logic and enables the latching of the data on the data pins Q0, Q1, Q2, and Q3.
- 15th Pin StD is the Data valid pin, turn out to be high on detection of valid DTMF tone or else it remains low.

Features

• Complete DTMF Receiver
• Low power consumption
• Internal gain setting amplifier
• Adjustable guard time
• Central office quality
• Power-down mode
• Inhibit mode
• Backward compatible with MT8870C/MT8870C-1

Decoded Output of DTMF Decoder:

Button	Low DTMF Frequency	High DTMF Frequency	Binary Coded Output			
	(Hz)	(Hz)	Q1	Q2	Q3	Q4
1	697	1209	0	0	0	0
2	697	1336	0	0	0	1
3	697	1477	0	0	1	0
4	770	1209	0	0	1	1
5	770	1336	0	1	0	0
6	770	1477	0	1	0	1
7	852	1209	0	1	1	0
8	852	1336	0	1	1	1
9	852	1477	1	0	0	0
0	941	1209	1	0	0	1
*	941	1336	1	0	1	0
#	941	1477	1	0	1	1

Table:2 Decoded Output of DTMF Decoder

3.Relay:

The relay is usually provided with 4 terminals, two of which are connected to relay winding and other two are connected to the circuit to be controlled. It has following characteristics:

- Sensitivity
- Speed
- Selectivity

Types of Relays:

- Electromagnetic Attraction Type
- Electromagnetic Induction Type
- Thermal Relay
- Distance Relay

Electromagnetic Relay:

These relays are electromagnetically operated. The parts of these relays are an iron core & its surrounding coil of wire. An iron yoke provides a low reluctance path for magnetic flux, the yoke being shaped so that the magnetic circuit can be closed by a movable piece of iron called the armature, and a set of contacts. The armature is hinged to the yoke and is held by a string in such a way that there is an air gap in the magnetic circuit. Figure shows the principle of operation of this relay. When an electric current flows in the coil, the armature is attracted to the iron core. Electrical switching contacts are mounted on the armature. When the armature coil is energized, these movable contacts break their connections with one set of fixed contacts and close a connection to a previously open contact. When electric power is removed from the relay coil, spring returns the armature to its original position.

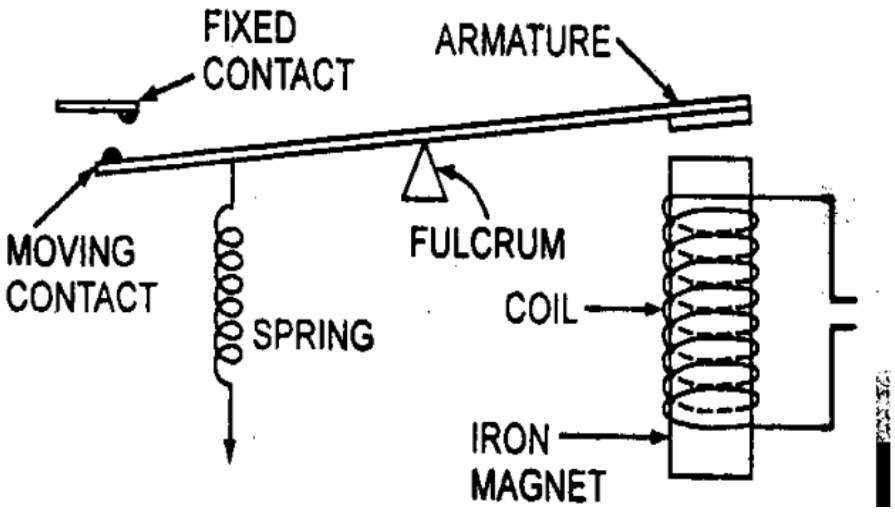


Figure:7 Operating Principle of Relay

Four Channel Relay:

A relay is a device which allows us to turn on or turn off a circuit with voltage and which is much higher than what Arduino could handle. Relay provides complete isolation between the low-voltage circuit placed on the Arduino side and the high-voltage side which is connected to the load. For this project we have used a 4 channel, 5V relay. This 5V 4-channel relay interface board and each channel needs a 15-20mA driver current. It can be used to control various home appliances and equipment with large current. It has a standard interface that can be controlled directly by microcontroller

Figure:8 Four Channel Relay

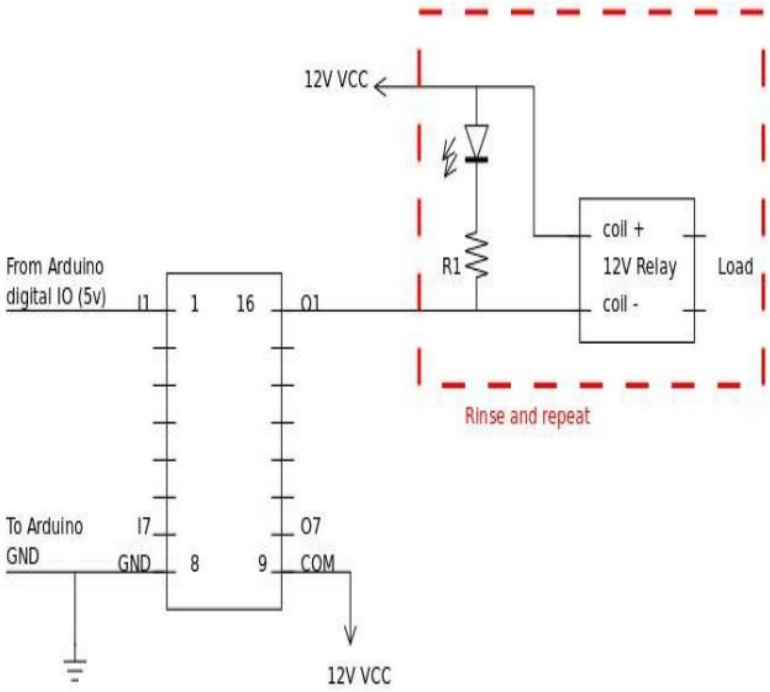


Figure:9 Connection between Relay and Arduino

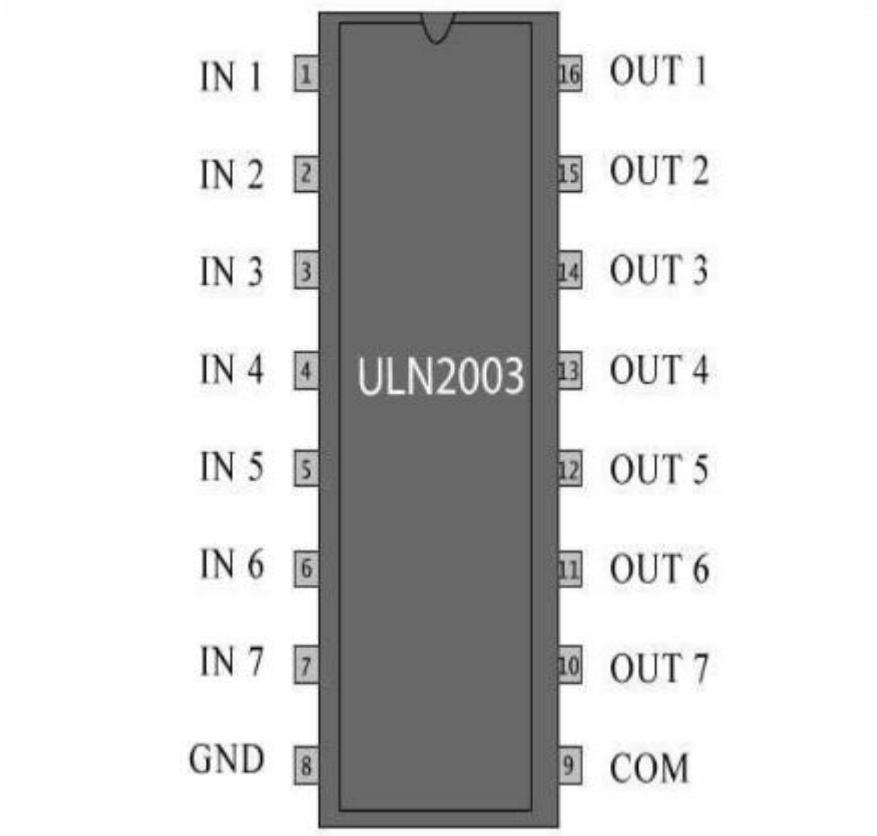


Figure:10 Pin Diagram of ULN2003 IC

Working of the Circuit:

DTMF SIGNALLING:

In telecommunication, a caller needs to dial the number of the callee. The earlier versions of telephones used to have rotary type dials which are now obsolete. Almost all the landline and mobile phone handsets now use pushbutton keypads. DTMF is a signalling system for identifying the keys or better say the number dialled on a pushbutton or DTMF keypad. The early telephone systems used pulse dialling or loop disconnect signalling. This was replaced by multi frequency (MF) dialling. DTMF is a multi frequency tone dialling system used by the push button keypads in telephone and mobile sets to convey the number or key dialled by the caller. DTMF has enabled the long distance signalling of dialled numbers in voice frequency range over telephone lines. This has eliminated the need of telecom operator between the caller and the called and evolved automated dialling in the telephone switching . DTMF (Dual tone multi frequency) as the name suggests uses a combination of two sine wave tones to represent a key. These tones are called row and column frequencies as they correspond to the layout of a telephone keypad.

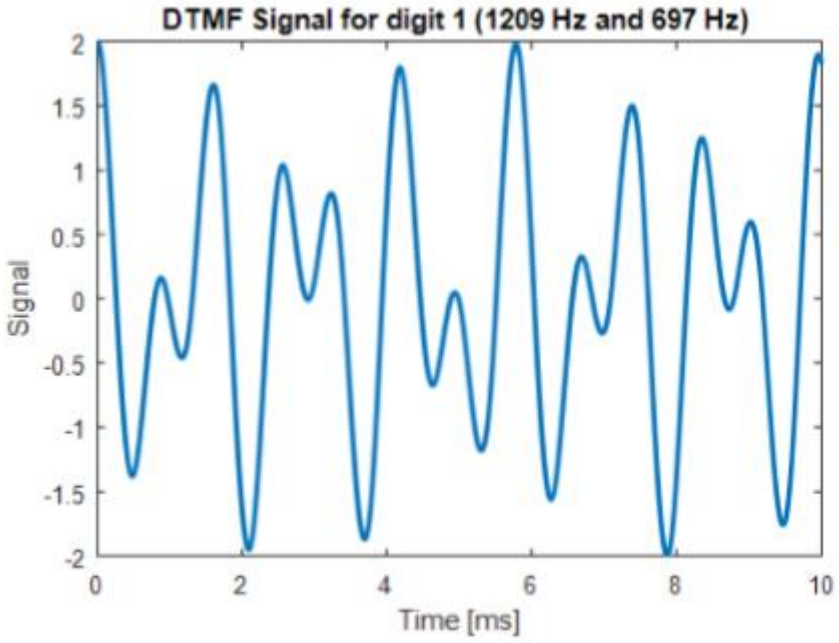


Figure:11 DTMF Signal

DTMF Keypad:

A DTMF keypad (generator or encoder) generates a sinusoidal tone which is mixture of the row and column frequencies. The DTMF Keypad is laid out in a 4×4 matrix of push buttons. The row frequencies are low group frequencies. The column frequencies belong to high group frequencies. This prevents misinterpretation of the harmonics. Also the frequencies for DTMF are so chosen that none have a harmonic relationship with the others and that mixing the frequencies would not produce sum or product frequencies that could mimic another valid tone. The high-group frequencies (the column tones) are slightly louder than the low-group to compensate for the highfrequency roll off of voice audio systems. Pressing a key sends a combination of the row and column frequencies.

For example, the key 1 produces a superimposition of tones of 697 and 1209 (Hz). Initial pushbutton designs employed levers, so that each button activated two contacts. The tones are decoded by the switching centre to determine the keys pressed by the user.

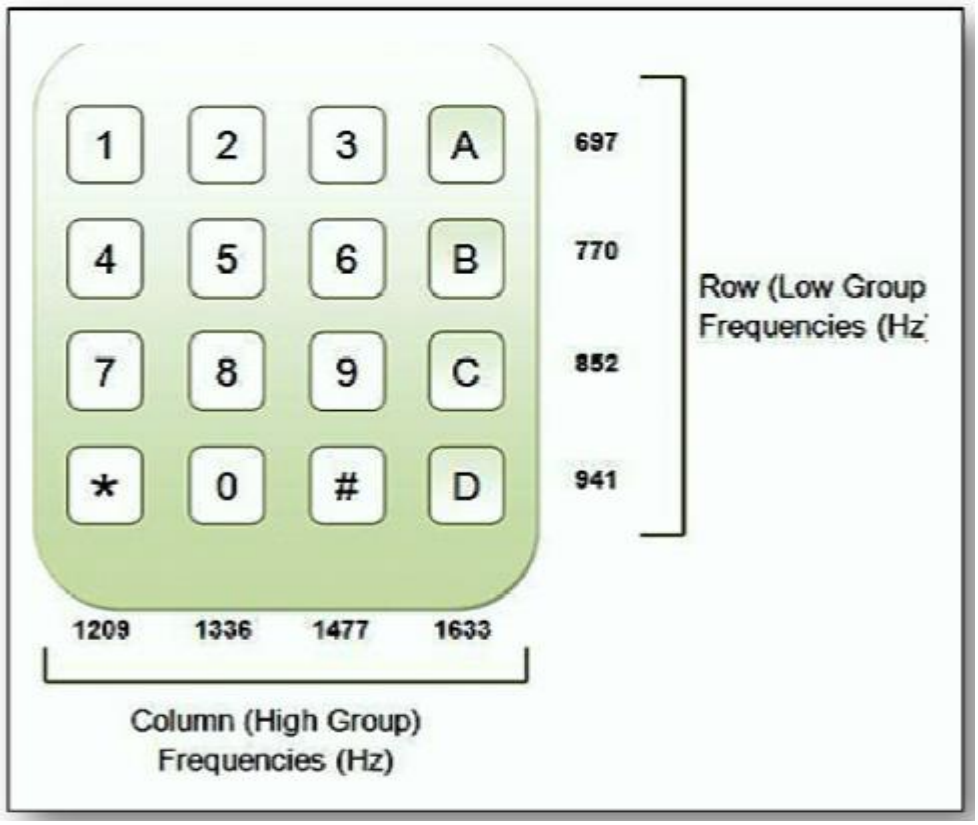


Figure:12 DTMF Keypad

DTMF decoder generates a binary output which is given to the microcontroller. Here a program code is fed to the microcontroller which activates the relay module according to the key pressed by the user. At the output of the microcontroller the
devices are connected to a 4-channel relay module. It is a driver which drives the appliances based on the microcontroller output. Thus, when the relay drive is activated by the microcontroller, the device either gets ON or is switched OFF as per the requirement The DTMF Decoder, Arduino UNO and the relay module gets the DC supply from the power supply unit. The DTMF decoder (MT8870) is connected to the Arduino UNO which in turn is connected to the relay module. The output of the relay module is connected to various loads. In our project we have used four loads (bulbs) for demonstration. The entire connection is made through jumper wires.

Arduino UNO Code:

```
const int Q1 = 8; //Defining Digital Input pins from DTMF Module
const int Q2 = 9;
const int Q3 = 10;
const int Q4 = 11;

const int D1 = 4;  //Defining Digital Ouput pins for Relay board
const int D2 = 5;
const int D3 = 6;
const int D4 = 7;

int SoQ1 = 0;      //Defining variable to store the status(HIGH/LOW) of above
int SoQ2 = 0;
int SoQ3 = 0;
int SoQ4 = 0;
int oldCOn = 0;   //Variable to know what was the last button pressed.

void setup() {
  pinMode(Q1, INPUT);  //Defining pins as input.
  pinMode(Q2, INPUT);
  pinMode(Q3, INPUT);
  pinMode(Q4, INPUT);

  pinMode(D1, OUTPUT);  //Defining pins as output.
  pinMode(D2, OUTPUT);
  pinMode(D3, OUTPUT);
  pinMode(D4, OUTPUT);

}

void loop(){
```

```
  SOQ1 = digitalRead(Q1); //Reading status of Input pins. It can be low or high.
  SOQ2 = digitalRead(Q2);
  SOQ3 = digitalRead(Q3);
  SOQ4 = digitalRead(Q4);


  if(SoQ4==LOW && SoQ3==LOW && SoQ2==LOW && SoQ2==HIGH) //Condition for
Button 1. Its equivalent to 0001
  {
    if(oldCon!=1){
      digitalWrite(D1, HIGH);
    }
    oldCon=1;
  }


  else if(SoQ4==LOW && SoQ3==LOW && SoQ2==HIGH && SoQ1==LOW)
//Condition for Button 2. Its equivalent to 0010
  {
    if(oldCon!=2){
      digitalWrite(D1, LOW);
    }
    oldCon=2;
  }
  else if(SoQ4==LOW && SoQ3==LOW && SoQ2==HIGH && SoQ1==HIGH)
//Condition for Button 3. Its equivalent to 0011
  {
    if(oldCon!=3){
      digitalWrite(D2, HIGH);
    }
    oldCon=3;
  }
  else if(SoQ4==LOW && SoQ3==HIGH && SoQ2==LOW && SoQ1==LOW) //Condition
for Button 4. Its equivalent to 0100
```

```
  {
    if(oldCon!=4){
      digitalWrite(D2, LOW);
    }
    oldCon=4;
  }
  else if(SoQ4==LOW && SoQ3==HIGH && SoQ2==LOW && SoQ1==HIGH)
////Condition for Button 5. Its equivalent to 0101
  {
    if(oldCon!=5){
      digitalWrite(D3, HIGH);
    }
    oldCon=5;
  }


  else if(SoQ4==LOW && SoQ3==HIGH && SoQ2==HIGH && SoQ1==LOW)
//Condition for Button 6. Its equivalent to 0110.
  {
    if(oldCon!=6){
      digitalWrite(D3, LOW);
    }
    oldCon=6;
  }
  else if(SoQ4==LOW && SoQ3==HIGH && SoQ2==HIGH && SoQ1==HIGH)
//Condition for Button 7. Its equivalent to 0111
  {
    if(oldCon!=7){
      digitalWrite(D4, HIGH);
    }
    oldCon=7;
  }
```

```
  else if(SoQ4==HIGH && SoQ3==LOW && SoQ2==LOW && SoQ1==LOW) //Condition for Button 8. Its equivalent to 1000
  {
    if(oldCon!=8){
      digitalWrite(D4, LOW);
    }
    oldCon=8;
  }
  else if(SoQ4==HIGH && SoQ3==LOW && SoQ2==LOW && SoQ1==HIGH) //Condition for Button 9. Its equivalent to 1001
  {
    if(oldCon!=9){
      digitalWrite(D1, LOW);
      digitalWrite(D2, LOW);
      digitalWrite(D3, LOW);
      digitalWrite(D4, LOW);
    }
    oldCon=9;
  }
delay(50); //Debounce Delay.
}
```

4.Result:

In our testing we found that our system is operating successfully. When the call is initiated and the keys are pressed upon the cell-phone, the DTMF decoder decodes the signal into binary form. This is further processed by the microcontroller to generate the specific signal to drive the relay module for driving the output devices connected to it. The key pressed by the user, the binary code output by the DTMF decoder and the resulting action performed by the driving circuit is shown in TABLE 3

Number	Binary Output of DTMF Decoder				Action
1	0	0	0	1	Device 1 will be ON
2	0	0	1	0	Device 1 will be OFF
3	0	0	1	1	Device 2 will be ON
4	0	1	0	0	Device 2 will be OFF
5	0	1	0	1	Device 3 will be ON
6	0	1	1	0	Device 3 will be OFF
7	0	1	1	1	Device 4 will be ON
8	1	0	0	0	Device 4 will be OFF
9	1	0	0	1	All devices ON
0	1	1	0	0	All devices OFF

Table:3 Observation Table

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
• One can control home appliances from anywhere.
•It reduces wastage of electricity if someone forgets to switch off any appliance connected to the system if we were away.
• It is very low cost compared to other technologies like GSM.

Disadvantages:

• Lack of security. Anyone can control the appliances by connecting to the mobile connected to DTMF module.
• Number of appliances is limited as our mobile can generate only 16 tones.
• One mobile phone should always be connected to the system

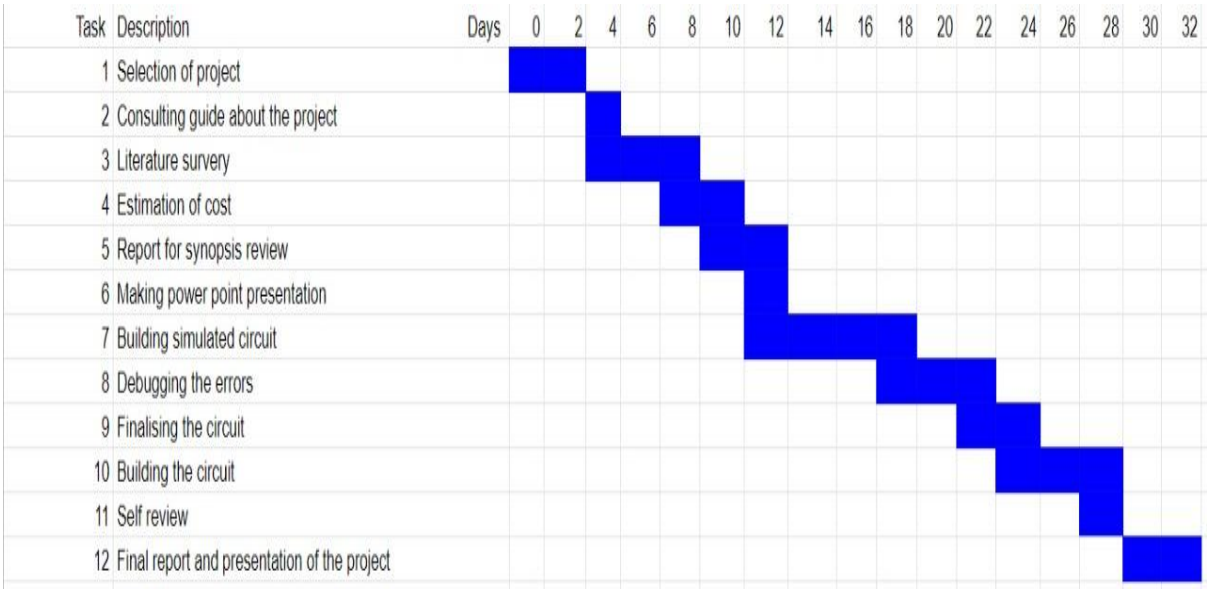
Future Work:

• Memory can be used to store the appliance status during power failure.
• Appliance scheduler/timer can be implemented using RTC (Real Time Clock) .
• Can be converted to an IoT device using Wi-Fi connectivity.

Conclusion:

DTMF Based Home Automation has been designed and setup. It has been possible to control all home appliances automatically using our own mobile phones. The control of all appliances is possible even from a wide range.

Project Planning:



Estimated Budget:

1	Components required	Cost in Rs.
2	Microcontroller Arduino Uno	400
3	DTMF Decoder (MT8870)	120
4	Relays	400
5	Darlington Transistor Arrays(ULN2003)	80
6	DTMF Keypad	300
7	MIscellaneous	400
8	**Total**	**1700**

References:

1.https://www.uchobby.com/index.php/2007/09/30/phone-to-microcontroller-interfacing-with-dtmf/
2. https://www.ijltet.org/pdfviewer.php?id=921&j_id=3980
3. https://pdfs.semanticscholar.org/9420/0718d283d19df88b90eca6fff33bd86094b2.pdf
4. M. Van Der Werff, X. Gui, and W.L. Xu, “A mobile based home automation system,” 2nd International Conference on MobileTechnology, Applications and Systems, Guangzhou, 15-17 Nov. 2005.
5. https://en.wikipedia.org/wiki/Home_automation

THANK YOU