

DTMF BASED HOME AUTOMATION

Title of the Project Report

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A comprehensive project report has been submitted in partial fulfillment of the requirements for the degree of

Bachelor of Technology

in

ELECTRONICS & COMMUNICATION ENGINEERING

Under the supervision of

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This is to certify that the project titled "DTMF BASED HOME AUTOMATION" carried out by

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for the partial fulfillment of the requirements for B.Tech degree in **Electronics and Communication Engineering** from **Maulana Abul Kalam Azad University of Technology, West Bengal** is absolutely based on his own work under the supervision of Mrs. **TIYA DEY MALAKAR**. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

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ABSTRACT

The aim of this project is to develop a home automation system that can be controlled remotely using mobile phone. The home automation is one of the most emerging trends in modernization of home appliance control. Presently, conventional wall switches are located in different parts of the house and one has to physically go near them and press them to turn the loads on/off. It becomes very difficult for the elderly or physically handicapped people to do so. The another advantage of this project is that, some time we forget to switch off the home appliances and by this DTMF based home automation system we can switch on or off from any part of the world.

This system is designed to provide control of home appliances through mobile phone by dialing the designated number. Dialing 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.

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Introduction

Conventionally, electrical appliances in a home were controlled via switches that regulate the electricity to these devices. Today, we have entered the era of technology. Gone are the days where manual operation were performed. Home automation is becoming more popular around the world and is becoming a common practice. Smart home automation becomes important, because it provides the user the comfort and easy access to the home appliances. The process of home automation works by making everything in the house automatically controlled, using technology to control and do the jobs that we would normally do manually. Home automation takes care of a lot of different activities in the house. 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 system is having 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 system is the decoding of DTMF tone. DTMF stands for Dual Tone Multi Frequency. The main components used here are the DTMF Decoder, Arduino UNO and the relay module. With the inter-connection of these components and with use of a cell phone as a remote we were successful in controlling various home appliances. For this the system we have used lamps to demonstrate AC loads and a 12V transformer to power the system. The advantages of using this technology are many. One can control home appliances from anywhere in the world. It helps in reducing the wastage of electricity. The cost for this system is also less as compared to other technologies like GSM.

PROJECT SETUP:



Fig. 1: SETUP

Project Description

Imagine how helpful it will be to be able to switch on your air conditioning system ten minutes before you get home on a hot afternoon in June. How about having a security system that will detect smoke, excessive electrical power usage, burglar attempts and unauthorized movements in your house and alert you? This is what home automation is about and there is no end to its application. In fact, sophisticated home automation systems are now being developed that can maintain an inventory of household items and prepare a shopping list or automatically order replacements.

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, open doors automatically, 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. It makes it possible to link lighting, entertainment, security, telecommunications, heating, and air conditioning into one centrally controlled system. This allows you to make your house an active partner in managing your busy life. Nowadays in foreign land, you can hardly find a house without a home automation system which can range from the remote for the television, burglar alarm and hi-tech security gates, to an automated air conditioning system that maintains the temperature at a predefined value.

AUTOMATION

Automation is the use of control systems and information technology to control equipment, industrial machinery and processes, reducing the need for human intervention. In the scope of industrialization, automation is a step beyond mechanization. Mechanization provided human operators with machinery to assist them with the physical requirements of work while automation greatly reduces the need for human sensory and mental requirements as well.

Automation plays an increasingly important role in the global economy and in daily experience. Engineers strive to combine automated devices with mathematical and organizational tools to create complex systems for a rapidly expanding range of applications and human activities. Many roles for humans in industrial processes presently lie beyond the scope of automation. Human-level pattern recognition, language recognition, and language production ability are well beyond the

capabilities of modern mechanical and computer systems. Tasks requiring subjective assessment or synthesis of complex sensory data, such as scents and sounds, as well as high-level tasks such as strategic planning, currently require human expertise.

Automation has had a notable impact in a wide range of highly visible industries beyond manufacturing. Once ubiquitous telephone operators have been replaced largely by automated telephone switchboards and answering machines. Medical processes such as primary screening in electrocardiograph or radiography and laboratory analysis of human genes, blood plasmas, cells, and tissues are carried out at much greater speed and accuracy by automated systems. Automated teller machines have reduced the need for bank visits to obtain cash and carry out transactions. In general, automation has been responsible for the shift in the world economy from agrarian to industrial in the 19th century and from industrial to services in the 20th century.

Home Automation

Home automation may designate an emerging practice of increased automation of household appliances and features in residential dwellings, particularly through electronic means that allow for things impracticable, overly expensive or simply not possible in recent decades. 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. But there exists a difference in that home automation emphasizes more on comforts through ergonomics and ease of operation.

DTMF Home Automation lets you operate your home appliances like lights and water pump from your office or any other remote place. So if you forgot to switch off the lights or other appliances while going out, it helps you to turn off the appliance with your cell phone. Your cell phone works as remote control to your **home appliances**. **You can control the desired appliance by presenting the corresponding key.**

PROJECT OBJECTIVE:

The objective of this project is to implement a low cost, reliable and scalable home automation system that can be used to remotely switch on or off any household appliance, 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.

Components used:

1. MICROCONTROLLER

A microcontroller is a compact microcomputer 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. Originally, such use was confined to large machines such as furnaces and automobile engines to optimize efficiency. 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.

MICROCONTROLLER USED: ARDUINO UNO

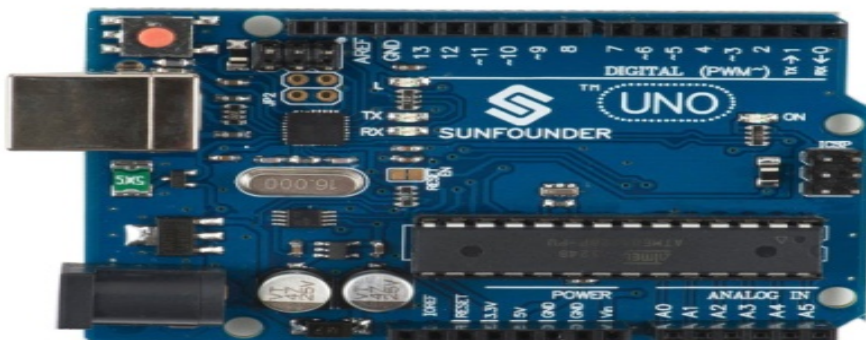


Fig. 2: Arduino Uno

Arduino is an open source electronics prototyping platform that is flexible, easy-to-use hardware and software. It is designed for artists, designers, hobbyists and anyone interested in creating interactive objects or environments. 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 onboard MCU, a power jack, an ICSP header and a reset button. It is operated with the help of a 16MHz crystal oscillator and contains everything needed to support the MCU. It is very easy to use as we simply need to connect it to a computer using a USB cable, or power it with an AC-to-DC adaptor or battery to get started. The MCU onboard is programmed in Arduino programming language using Arduino IDE.

ARDUINO UNO SPECIFICATION:

Microcontroller	Atmel ATmega328
Operating Voltage (logic level)	5 VDC
Input Voltage (recommended)	7-12 V
Input Voltage (limits)	6-20 V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	8
DC Current per I/O Pin	40 mA
Flash Memory	32 KB (ATmega328) of which 2 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz
Dimensions	0.73" x 1.70"

Differences with other boards

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Power

The Arduino/Genuino Uno board can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector. The board can operate on an external supply from 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may become unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are as follows: Vin. The input voltage to the Arduino/Genuino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. 5V. This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it. 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA. GND. Ground pins. IOREF. This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.

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).

Input and Output

See the mapping between Arduino pins and ATmega328P ports. The mapping for the ATmega8, 168, and 328 is identical.

Each of the 14 digital pins on the Uno can be used as an input or output, using `pinMode()`, `digitalWrite()`, and `digitalRead()` functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller.

In addition, some pins have specialized functions

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- External Interrupts: 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. See the `attachInterrupt()` function for details.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the `analogWrite()` function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

- LED: 13. There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED

is on, when the pin is LOW, it's off.

- TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library. The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though it is possible to change the upper end of their range using the AREF pin and the `analogReference()` function. There are a couple of other pins on the board:
- AREF. Reference voltage for the analog inputs. Used with `analogReference()`.

- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

communication on pins 0 and 1).

COMMUNICATION

A SoftwareSerial library allows serial communication on any of the Uno's digital pins. Arduino/Genuino Uno has a number of facilities for communicating with a computer, another Arduino/Genuino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 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 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an .inf file is required. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial

2. DTMF Decoder

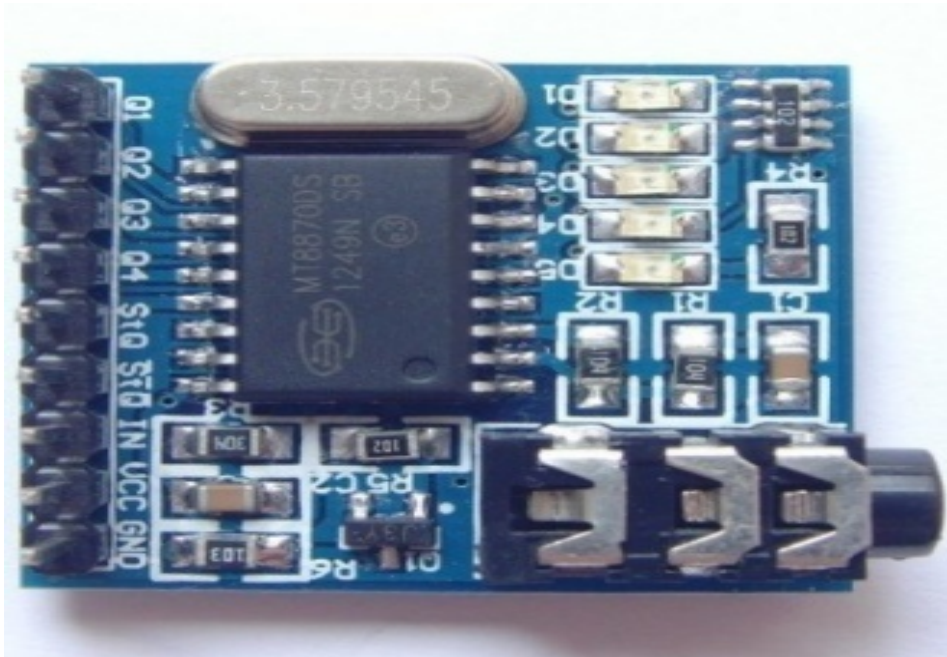


Fig. 3: DTMF Decoder

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.

Ac register signalling is used in dtmf telephones, here tones rather than make/break pulse are used for dialling, and each dialled digit is uniquely represented

by a pair of sine waves tones. These tones (one from low group for row and another from high group from column) are sent to the exchange when a digit is dialled by pushing the key, these tone lies within the speech band of 300 to 3400 Hz, and are chosen so as to minimize the possibility of any valid frequency pair existing in normal speech simultaneously. Actually, this minimisator is made possible by forming pairs with one tone from the higher group and the other from the lower of frequencies.

A valid dtmf signal is the sum of two tones, one from a lower group (697-940 Hz) and the other from a higher group (1209-1663 Hz). Each group contains four individual tones. This scheme allows 10 unique combinations. Ten of these code represent digits 1 through 9 and 0. Tones in DTMF dialling are so chose that none of the tones is harmonic of are other tone. Therefore, there is no change of distortion caused by harmonics. Each tone is sent as along as the key remains pressed. The dtmf signal contains only one component from each of the high and low group. This significantly simplifies decoding because the composite dtmf signal may be separated with band pass filters into single frequency components, each of which may be handled individually.

The underlying principle mainly relies up on the ability of DTMF (Double Tune Multi Frequency) ICs to generate DTMF corresponding to a number or code in the number pad and to detect the same number or code from its corresponding DTMF. In detail, a DTMF generator generates two frequencies corresponding to a number or code in the number pad which will be transmitted through the communication networks, constituting the transmitter section which is simply equivalent to a mobile set. In the receiver part, the DTMF detector IC, for example IC MT 8870 detects the number or Fig 3.3.1 Code represented by DTMF back, through the inspection of the two transmitted frequencies.

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 (100k Ω) and capacitance (0.1 μ F).

- The non-inverting input of Op-amp is connected to a reference voltage (pin4 -VREF). The voltage at VREF pin is $V_{cc}/2$.
- Pin 3 (GS) is the output of internal Op Amp, the feedback signal is given by connecting the output pin (pin3- GS) to inverting input pin (pin2- IN-) through a resistor (270k Ω).
- The output of Op Amp is passed through a pre filter, low group and high group filters (filter networks). These filters contain switched capacitors to divide DTMF tones into low and high group signals (High group filters bypass the high frequencies whereas low group filter pass low frequencies).
- Next processing sections inside the IC are frequency detector and code detector circuits. Filtered frequency passed through these detectors.
- At last the four digit binary code is latched at the output of M-8870 DTMF decoder IC.
- The entire process from frequency detection to latching of the data, is controlled by steering control circuit consisting of St/GT, Est pins, resistor (390k Ω) and a capacitor (0.1 μ F).
- 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.
- The 10th pin 10; 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.

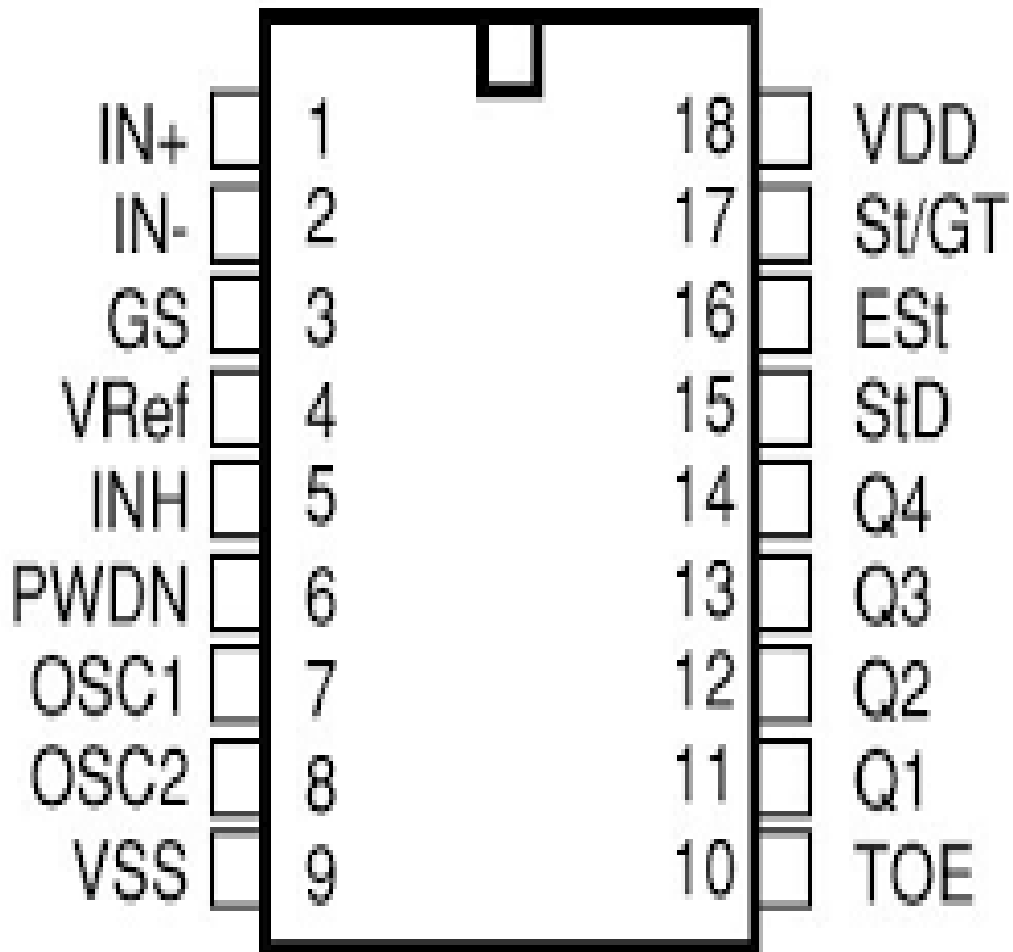


Fig 4: Pin Diagram of MT8870 IC

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

Applications

- Receiver system for British Telecom (BT) or CEPT Spec (MT8870D-1)
- Paging systems
- Repeater systems/mobile radio
- Credit card systems
- Remote control
- Personal computers
- Telephone answering machine

A miniature 3.579545 MHz quartz crystal enclosed in a hermetically sealed HC-49/US package, used as the resonator in a crystal oscillator. Pins 7 (OS1) and 8 (OS2) are used to connect crystal oscillator.

A crystal oscillator is an electronic circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. This frequency is commonly used to keep track of time (as in quartz wristwatches), to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters/receivers.

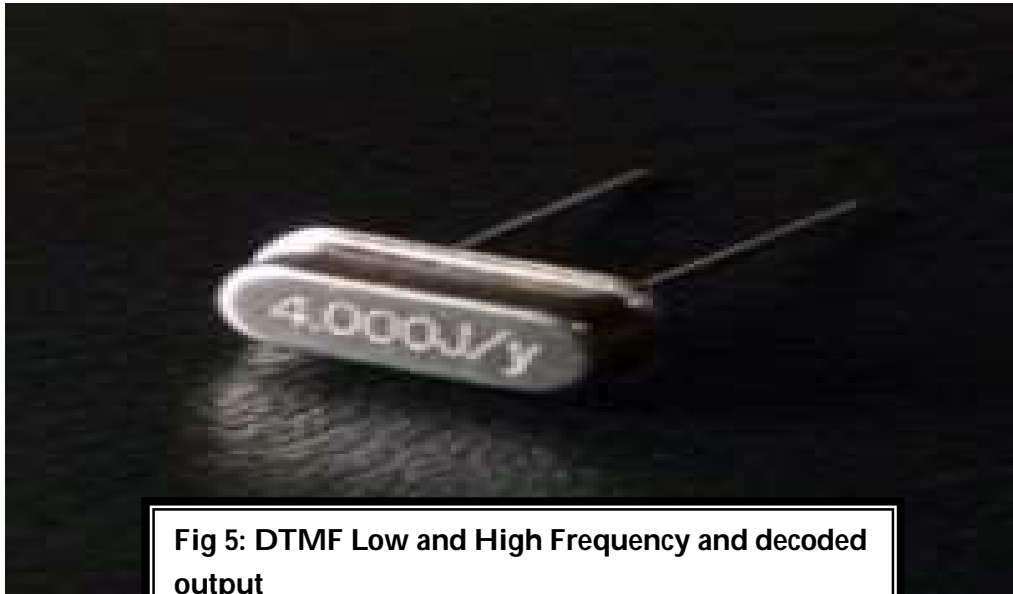


Fig 5: DTMF Low and High Frequency and decoded output

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

Table 1: Low and High Frequency and Decoded output

3 RELAYS

In order to enable a circuit to be isolated from the system only under faulty conditions, protective relays are used. In normal cases, it is open circuit 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

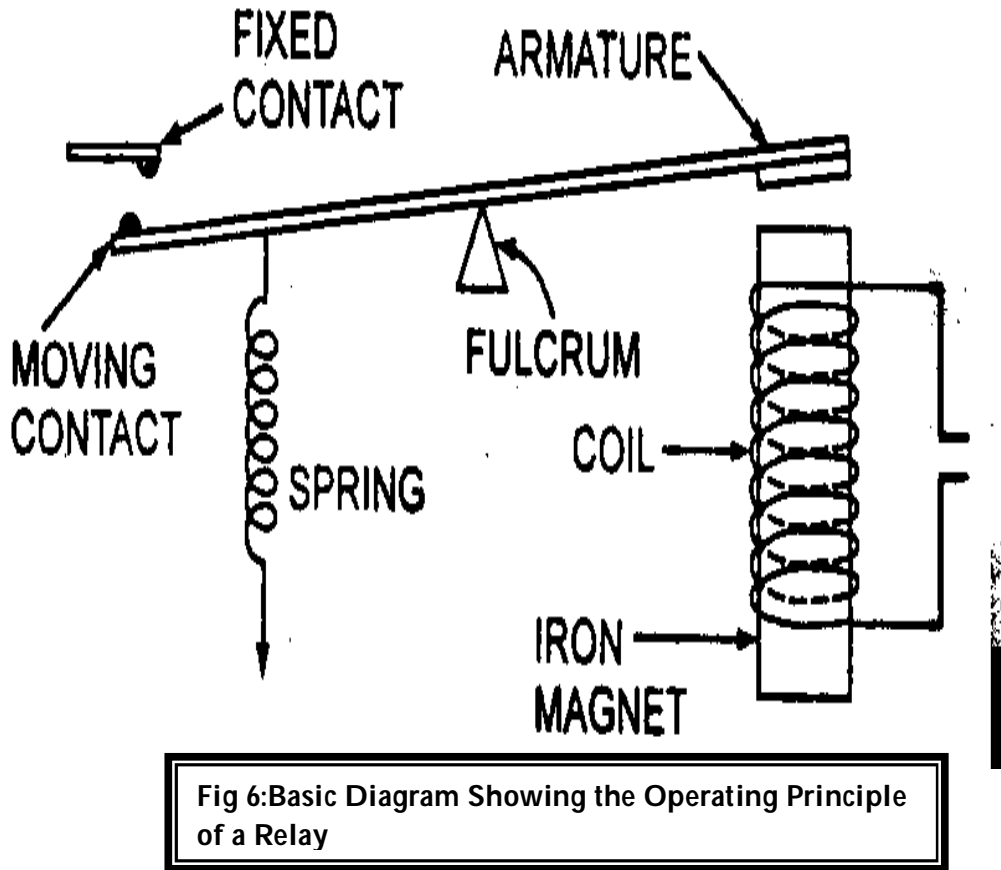
3.2.1 TYPES OF RELAYS:

- Electromagnetic Attraction Type: These relays are actuated by DC or AC quantities.
- Electromagnetic Induction Type: its operation depends upon EMI phenomena.
- Thermal Relays: its operation depends upon the heating effect of electric Current.
- Distance Relays: its operation depends upon the ratio of voltage to current.

3.2.2 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 spring 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.

Standard voltages for D.C. relay are 6,12,24,48 & 110 volts and for A.C. relays are 6,12,24,48,120 & 240 volts.



3.2.4 RELAY CIRCUIT

DIODE: A relay coil is not only an electromagnet but it's also an inductor. When power is applied to the coil the current in the coil builds up and levels off at its rated current (depends on the DC resistance of the coil, $I = V/R$). Some energy is now stored in the coil's magnetic field ($E = 0.5LI^2$). When the current in the coil is turned off this stored energy has to go somewhere. The voltage across the coil quickly increase trying to keep the current in the coil flowing in the same direction ($V = Ldi/dt$). This voltage spike can reach hundreds or thousands of volts and can damage electronic parts.

By adding a flyback diode the current has a path to continue flowing through coil until the stored energy is used up. The diode also clamps the voltage across the coil to about

0.7V protecting the electronics. The stored energy dissipates quickly in the diode ($E = V \cdot I \cdot t$). The current stops flowing and the relay turns off. The diode should be able to handle the coil current for a short time and switch relatively fast. Note: A resistor or zener diode can be placed in series with the diode to use up the stored energy quicker. This increases the amplitude of the voltage spike above 0.7V but the energy is used up quicker (i.e. the voltage spike won't last as long).

ULN2003

The ULx200xA devices are high-voltage, high-current. Darlington transistor arrays. Each consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for Simplified Block Diagram switching inductive loads. The collector-current rating of a single Darlington pair is 500 mA. The Darlington pairs can be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers. For 100-V (otherwise interchangeable) versions of the ULx2003A devices, see the SLRS023 data sheet for the SN75468 and SN75469 devices.

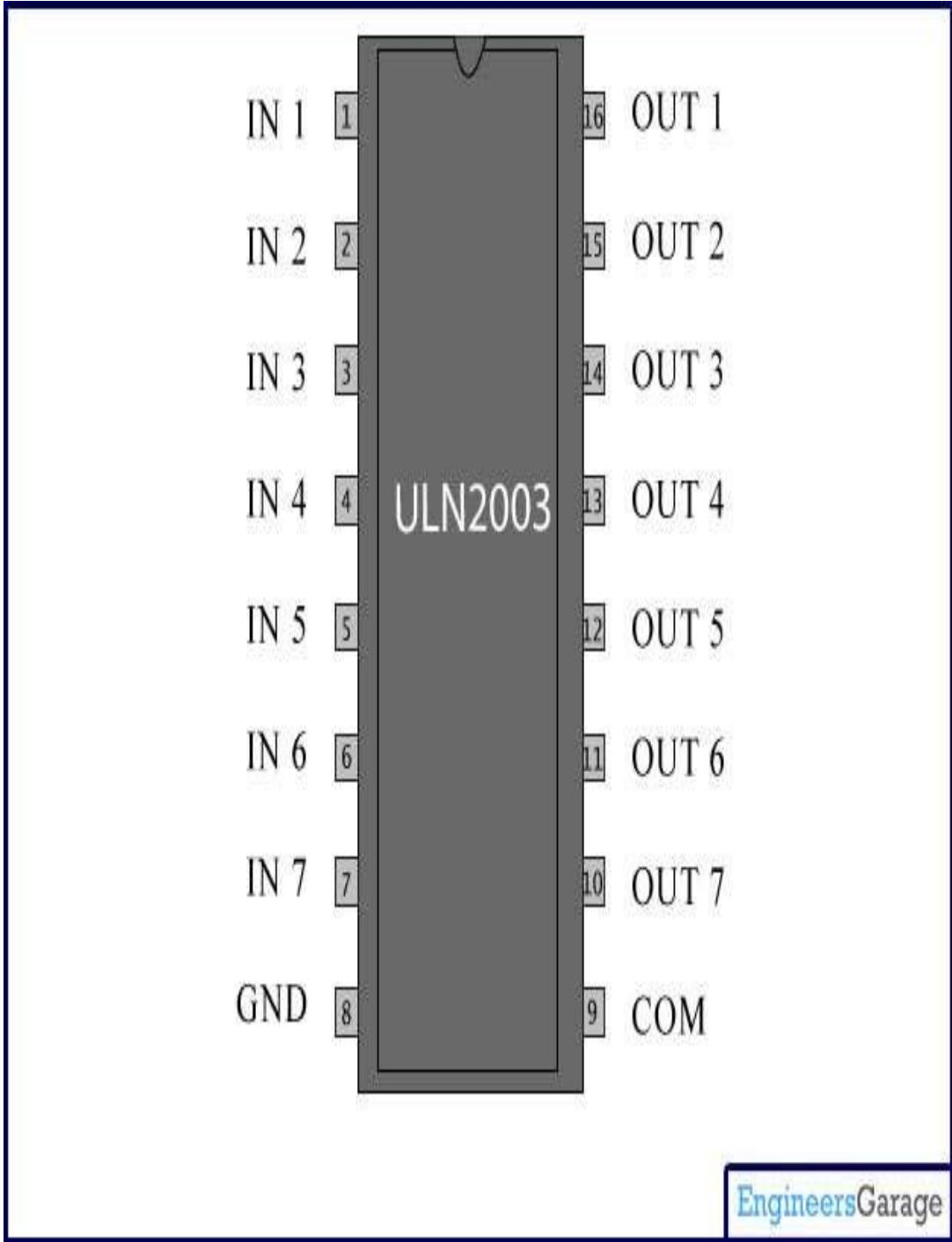


Fig 7:Pin Diagram of ULN2003

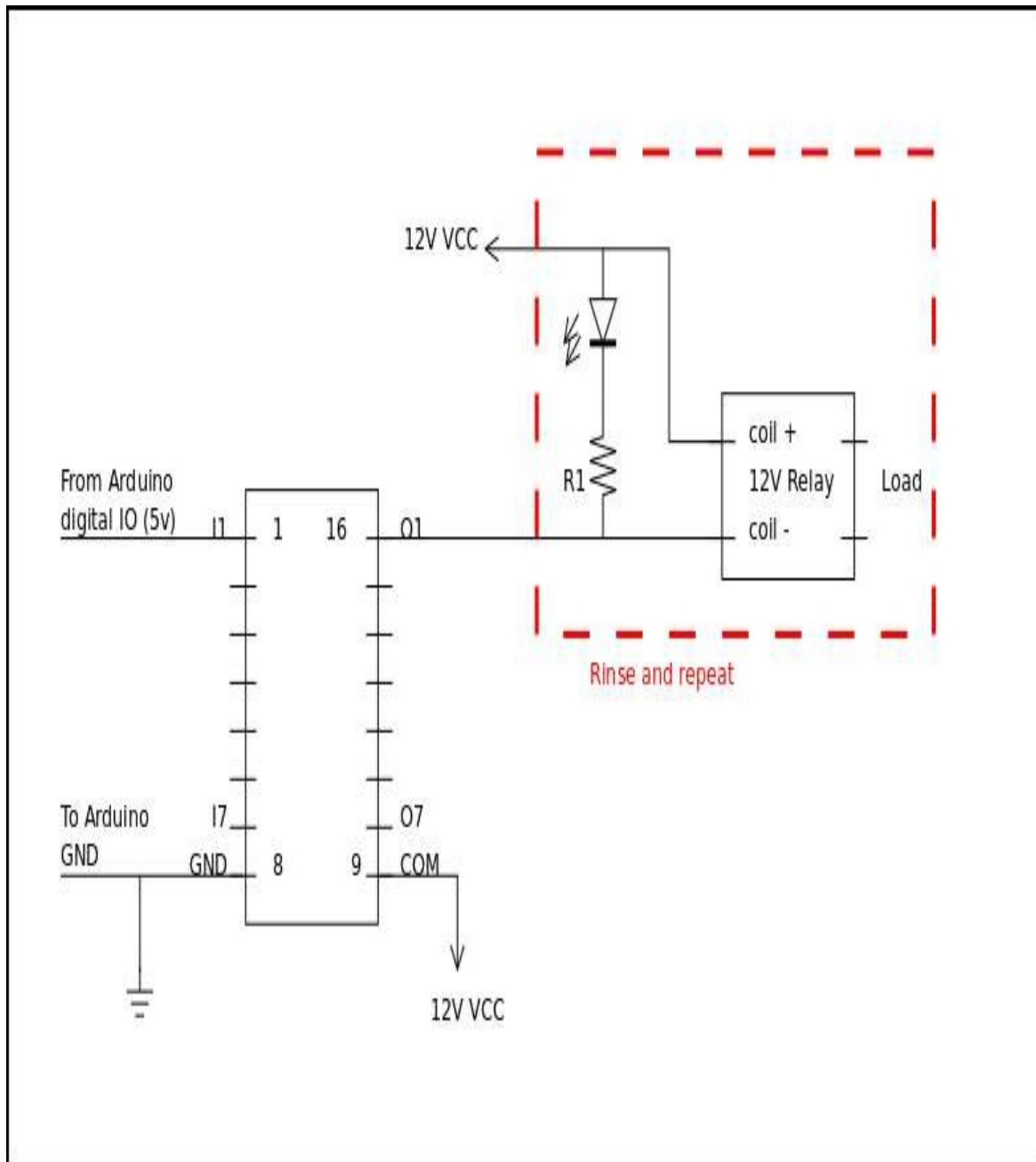
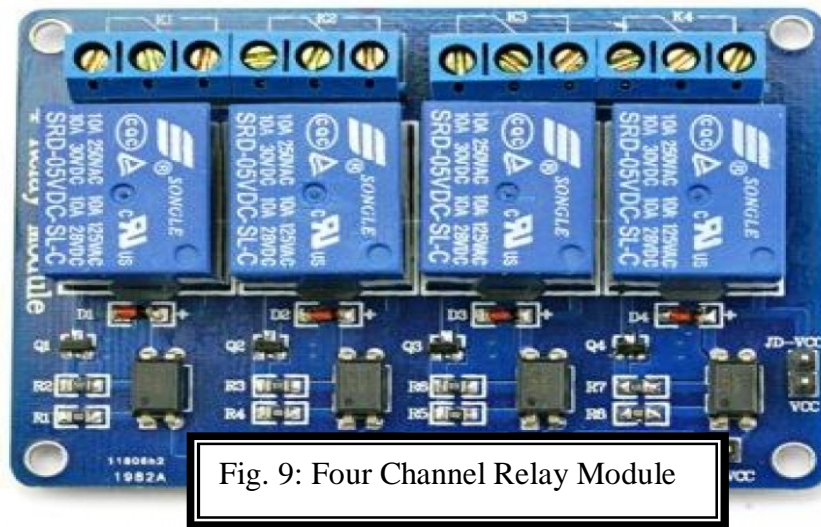


Fig 8: Connection of Relay and Uno

RELAY USED: Four-Channel Relay Module



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.

Project Analysis

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 callee 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.

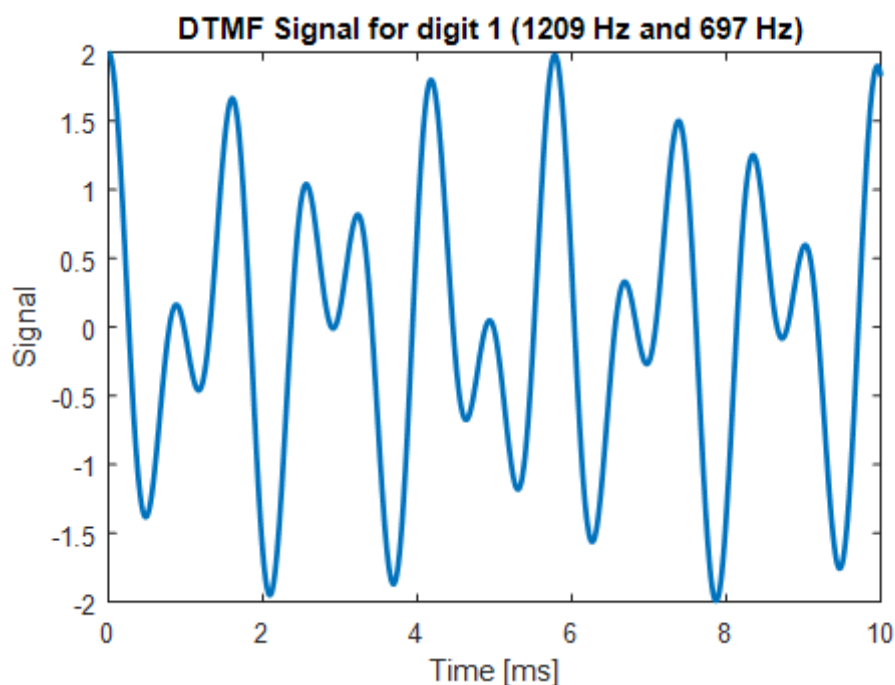


Fig.10: DTMF SIGNAL

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 high-frequency 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.

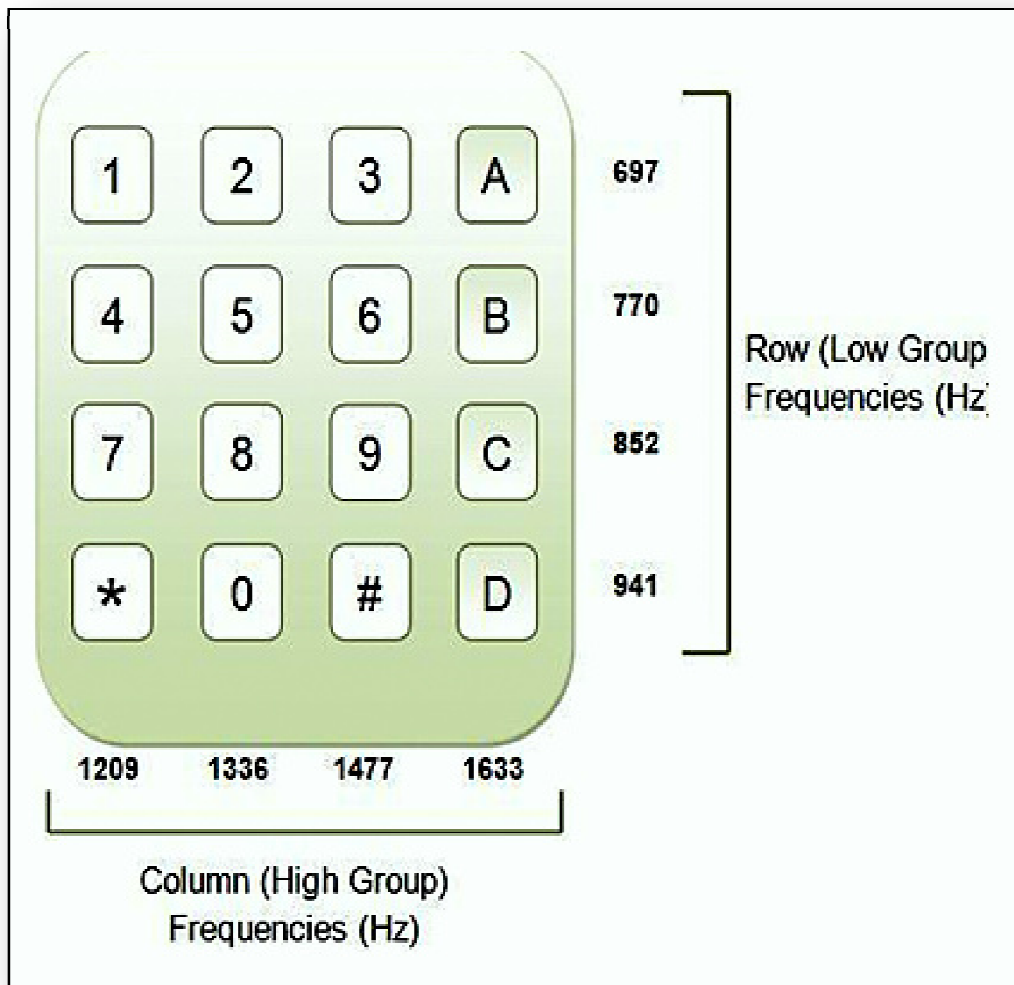


Fig. 11: DTMF Keypad

CONNECTIONS:

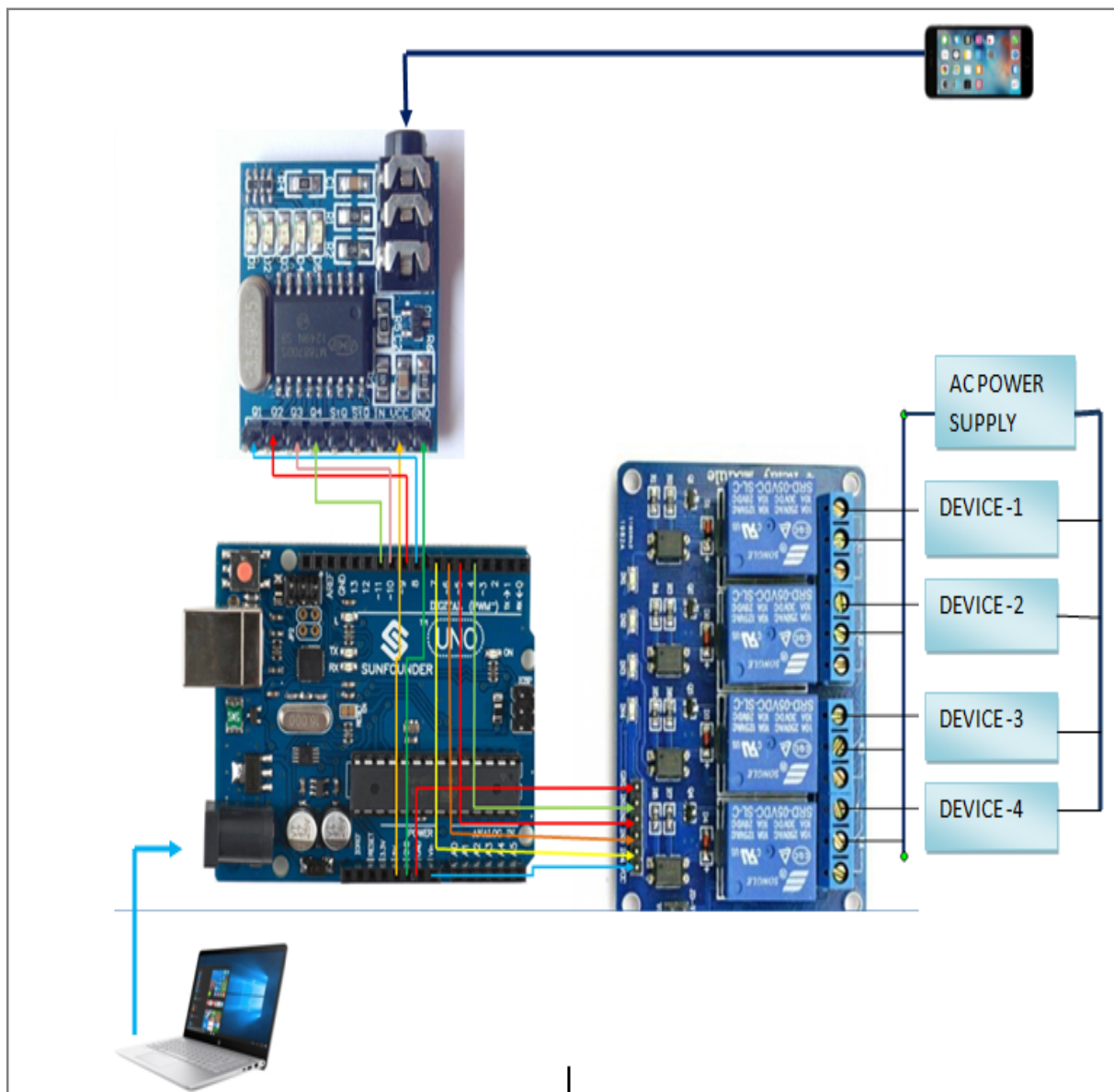


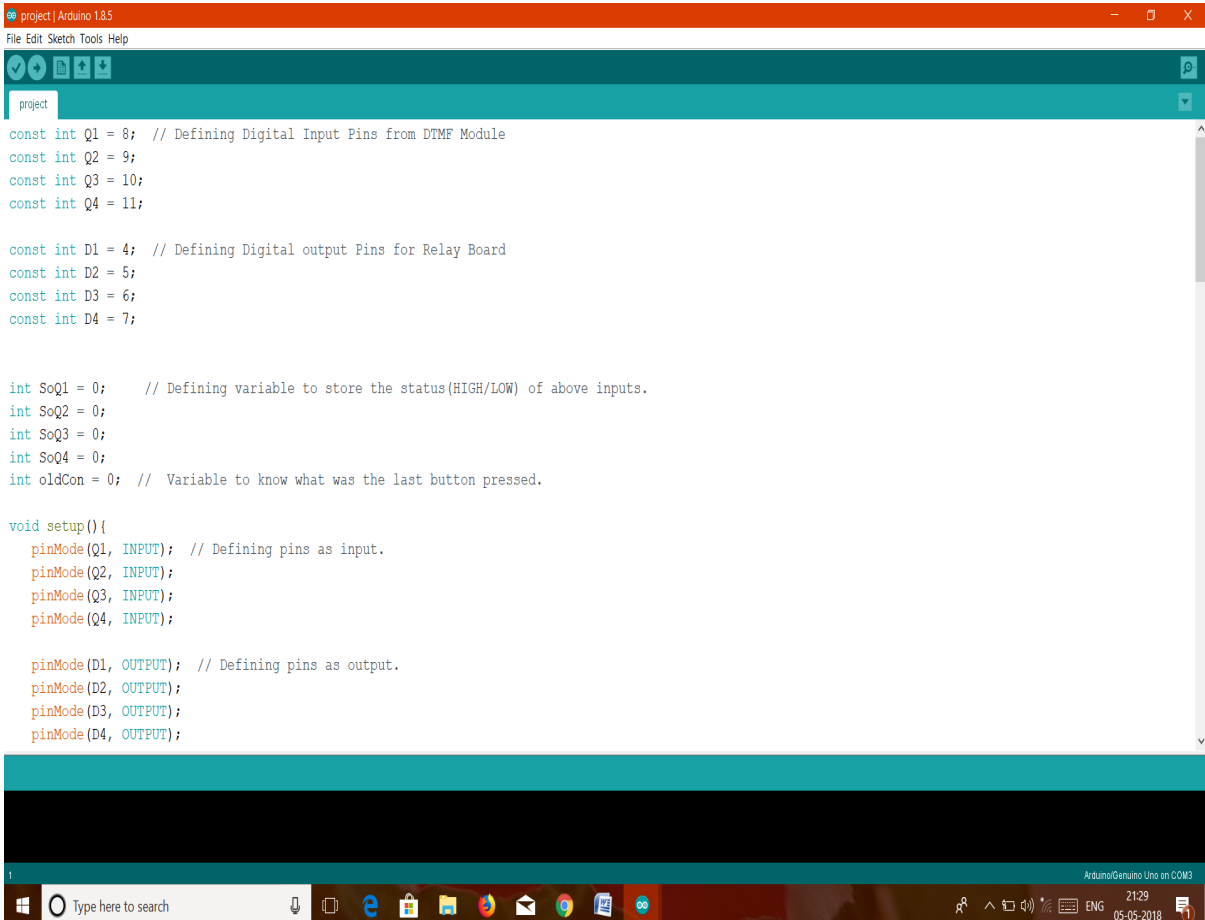
Fig.12: Connection Layout of the Hardware

The above figure (5) depicts the connection of the entire system. When the user dials the home mobile number the phone at home rings and if nobody picks the call, then the system picks up the call automatically. When we press any number on the phone keypad it generates a particular frequency, which is received by the other phone and then the code/number is decoded by the DTMF decoder /receiver. Here the decoder decodes the frequency of the tone generated by the particular code/number. The

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.

CODE:



```
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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 output 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 inputs.
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);
}
}

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```
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}

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 && SoQ1==HIGH ) // Condition for Button 1. It is equal to Binary - 0001
  {
    if (oldCon!=1){
      digitalWrite(D1, HIGH);
    }
    oldCon=1;
  }

  else if(SoQ4==LOW && SoQ3==LOW && SoQ2==HIGH && SoQ1==LOW ) // Condition for Button 2. It is equal to Binary - 0010
  {
    if (oldCon!=2){
      digitalWrite(D1, LOW);
    }
    oldCon=2;
  }

  else if(SoQ4==LOW && SoQ3==LOW && SoQ2==HIGH && SoQ1==HIGH ) // Condition for Button 3. It is equal to Binary - 0011
  {
    if (oldCon!=3){

```

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    digitalWrite(D2, HIGH);
}
oldCon=3;
}

else if(SoQ4==LOW && SoQ3==HIGH && SoQ2==LOW && SoQ1==LOW ) // Condition for Button 4. It is equal to Binary - 0100
{
    if (oldCon!=4){
        digitalWrite(D2, LOW);
    }
    oldCon=4;
}

else if(SoQ4==LOW && SoQ3==HIGH && SoQ2==LOW && SoQ1==HIGH ) // Condition for Button 5. It is equal to Binary - 0101
{
    if (oldCon!=5){
        digitalWrite(D3, HIGH);
    }
    oldCon=5;
}

else if(SoQ4==LOW && SoQ3==HIGH && SoQ2==HIGH && SoQ1==LOW ) // Condition for Button 6. It is equal to Binary - 0110
{
    if (oldCon!=6){
        digitalWrite(D3, LOW);
    }
    oldCon=6;
}

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project

else if(SoQ4==LOW && SoQ3==HIGH && SoQ2==HIGH && SoQ1==HIGH ) // Condition for Button 7. It is equal to Binary - 0111
{
  if (oldCon!=7){
    digitalWrite(D4, HIGH);
  }
  oldCon=7;
}

else if(SoQ4==HIGH && SoQ3==LOW && SoQ2==LOW && SoQ1==LOW ) // Condition for Button 8. It is equal to Binary - 1000
{
  if (oldCon!=8){
    digitalWrite(D4, LOW);
  }
  oldCon=8;
}

else if(SoQ4==HIGH && SoQ3==LOW && SoQ2==LOW && SoQ1==HIGH ) // Condition for Button 9. It is equal to Binary - 1001
{
  if (oldCon!=9){
    digitalWrite(D1, LOW);
    digitalWrite(D2, LOW);
    digitalWrite(D3, LOW);
    digitalWrite(D4, LOW);
  }
  oldCon=9;
}

delay(50); // Debounce Delay.

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Project Outcome

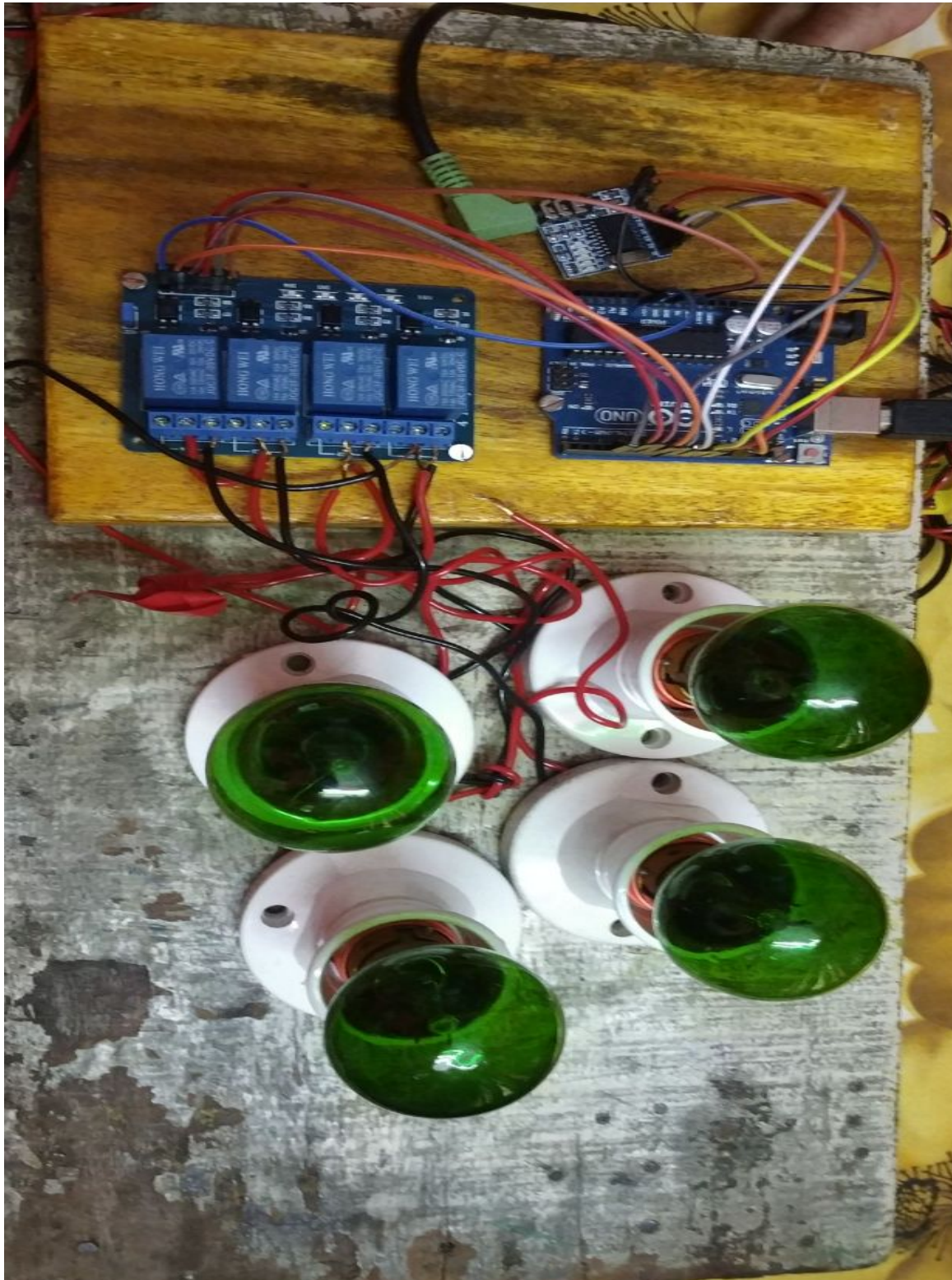


Fig. 13: PHYSICAL CONNECTION

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.2.

Number	Binary Output of DTMF Decoder	Action
1	0001	Device 1 will be ON
2	0010	Device 1 will be OFF
3	0011	Device 2 will be ON
4	0100	Device 1 will be OFF
5	0101	Device 3 will be ON
6	0110	Device 1 will be OFF
7	0111	Device 4 will be ON
8	1000	Device 1 will be OFF
9	1001	All devices will be ON
0	1100	All devices will be OFF

TABLE:2 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 WiFi 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.

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