Dual Tone Multiple Frequency Based Home Automation System

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Abstract: This paper presents the approach the design of home automation system using dual tone multiple frequency based home automation system. Today's the demand for better home security systems has drifted over to a need for home automation. Not only does a home need to be secure but home appliances need a more refined control system. Home appliances should not be limited to only local control. There needs to be a simple and elegant way to avoid this type of situation and allow people the freedom of having complete control of their house from anywhere. Using a mobile and help of microcontroller home appliances will be controlled.

Keywords: Mobile phone, DTMF decoder, microcontroller, appliances.

I.   Introduction

Dual-tone multiple-frequency signalling (DTMF) is an in-band telecommunication signalling system using the voice-frequency band over telephone lines between telephone equipment and other communications devices and switching centres. DTMF system also known as touch-tone system. The touch-tone system using a telephone keypad gradually replaced the use of rotary dial and has become the industry standard for landline and mobile service. Other multi-frequency systems are used for internal signalling within the telephone network .As register signalling is used in DTMF phones 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 and another from high group) 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 minimum stator is made possible by forming pairs with one tone from the higher group and the other from the lower group 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 the codes represents digits 1 through 9 and 0.Tones in DTMF dialling are so close that none of the tones is harmonic of the other tone .Therefore there is no change of distortion caused by harmonics. Each tone is sent as long as the key is remained 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 component each of which may be handled individually. The underlying principle mainly relies upon the ability of DTMF 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 decoder. 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 mobile set. [i].

The application of this project is to switch on and off home appliances by a cell phone. When we are not at home it may happen that we do not remember whether the appliance is switched on or off. So we can develop this project such that we get the status of the appliances as a message on our cell phone and hence take the required action. This can be done using gsm module. It helps in effective control of home appliances   and increases power efficiency. It increases appliances lifetime and also power efficiency. DTMF   tones are mainly use in terrestrial stations for turning on and shutting off remote transmitter .It is mainly use in telephone stations for detection of called and dialled numbers. It also helps us to reduce electrical power wastage.

Dual tone multiple frequency keypad:

The DTMF keypad is laid out in a 4×4 matrix, with each row representing a low frequency, and each column representing a high frequency. Pressing a single key (such as '1') will send a sinusoidal tone of superimposition of two frequencies (697 and 1209 hertz (Hz)). The original keypads had levers inside, so each button activated two contacts. The multiple tones are the reason for calling the system multi frequency. These tones are then decoded by the switching center to determine which key was pressed. Present-day uses of the A, B, C and D signals on telephone networks are few, and are exclusive to network control. For example, the A key is used on some networks to cycle through different carriers at will. The A, B, C and D tones are used in radio phone patch and repeater operations to allow, among other uses, control of the repeater while connected to an active phone line. The *, #, A, B, C and D keys are still widely used worldwide by amateur radio operators and commercial two-way radio systems for equipment control, repeater control, remote-base operations and some telephone communications systems. But nowadays in mobile handsets the A,B,C,D keys are not used usually [ii]. The DTMF tone frequencies are shown in TABLE 1.

TABLE 1 .DTMF TONE FREQUENCIES

	1209Hz	1336Hz	1477Hz	1633Hz
697Hz	1	2	3	A
770Hz	4	5	6	B
852Hz	7	8	9	C
941Hz	*	0	#	D

II.   Hardware Implementation

The system, through telephone network connects the user home appliances at home and gives him/her the ability to switch them ON or OFF. The schematic diagram of the project is shown in Fig. 1.
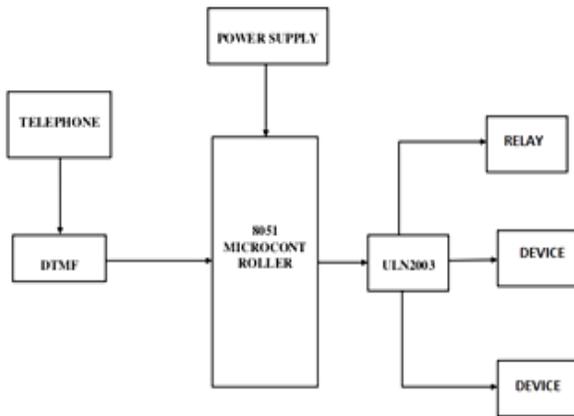

Fig.1. Schematic block diagram

 When the user dials the home telephone number the telephone 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. Here the decoder decodes the frequency of the tone generated by the particular code/number. Then the decoded signal goes to the microcontroller. Here a program code is given to the microcontroller which is meant for which code is assigned for which appliance. Suppose ,if number '1' is pressed then the fan will be on; if '2' is pressed fan will go off. At the output of the microcontroller the devices are connected through ULN2003A.ULN2003A is a driver which drives the appliances based on the microcontroller output. To drive any high voltage appliances the relays are used. The circuit diagram of this project is shown in Fig.2.
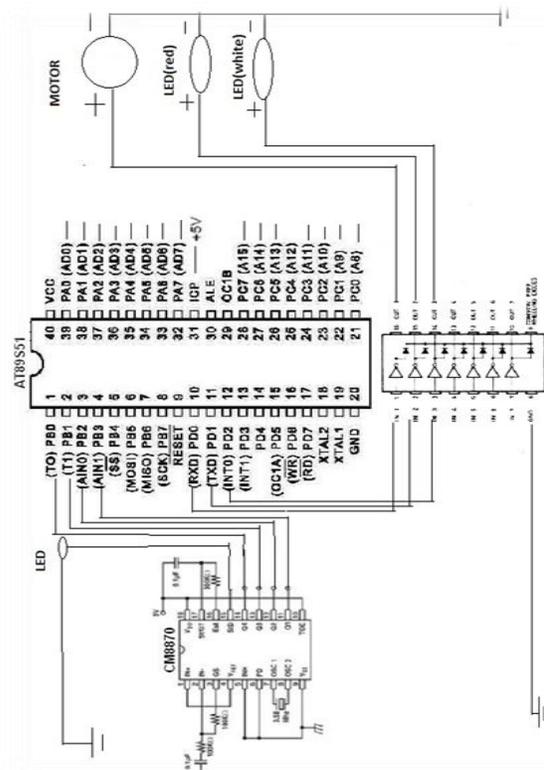

Fig.2. Circuit diagram of the hardware

We can connect the relays with the ULN2003A Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others. Here in our application we need a 5v DC power supply for all electronics involved in the project. This requires step down transformer, rectifier, voltage regulator, and filter circuit for generation of 5v DC power. The voltage regulator is a three pin IC used as a voltage regulator. It converts unregulated DC current into regulated DC current. The telephone line is hooked to another phone attached to the system. This will communicate directly with the microcontroller through the CM8870 decoder which decodes all 16 DTMF tone pairs into a four bit code. Here we have used a nokia1100   phone as the receiver side phone which will be in auto answering mode. CM8870/70C is a Full DTMF receiver, uses less than 35mW power consumption, uses quartz crystal or ceramic resonators, has adjustable acquisition and release times, works in Industrial temperature range and is available in 18-pin dip,18-pindipeiaj,18-pinsoic. We will attach a 5V power supply to the decoder IC. The AT89C51 is a low-power, high-performance CMOS eight bit microcomputer with 8K Flash bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density non-volatile memory technology and is compatible with the industry-standard 80C51

and 80C52 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications [iv].

The ULN2003A is high voltage, high current Darlington arrays each containing seven open collector Darlington pairs with common emitters. Each channel rated at 500mA and can withstand peak currents of 600mA. Suppression diodes are included for inductive load driving. Output voltage 50V.Outputs can be paralleled for higher current.

The software design of the system includes main program. When the DTMF decoder output is given to the port one of the microcontroller then the memory of the microcontroller will store the respective bit pattern obtained from the decoder and it will set the bit of the output port of the microcontroller where three the devices are connected. [v].

III.   Results and Analysis

When the call is initiated and the keys are pressed the DTMF decoder decodes the signal into such form so that it can be further processed by the microcontroller to generate the specific signal to drive the motor driver for driving the output devices .When key '1' is pressed the fan is set. When key 3 is pressed the red light is on ad when key 7 is pressed then white light is on and the appliances are set to off mode when keys six, four, eight are respectively pressed. Function of the different keys of mobile phone is shown in TABLE 2.

TABLE 2. RESULT OBTAINED FROM THE STUDY

DUAL TONE MULTIPLE FREQUENCY		ACTION PERFORMED BY THE DRIVING CIRCUIT
PRESSED KEY	CODE	
1	00000001	"FAN" ON
3	00000011	"RED LIGHT" ON
7	00000111	"WHITE LIGHT" ON
6	00000110	"FAN" OFF
4	0000100	"RED LIGHT" OFF
8	00001000	"WHITE LIGHT" OFF

The photographic view of the hardware is shown in Fig.3.
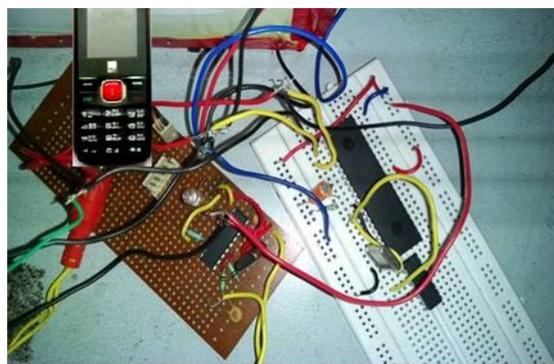

Fig.3. Hardware snapshot of the design.

IV.   Conclusion

Our effort towards building the home automation concept did not utilize the relay concept. This project can be further enhanced to the High voltage A.C Applications by changing the ratings of the Relay. We can control and monitor the high speed induction motors as well as synchronous motors. This can be done in an economical way. We can also add some security features in the circuit. One of the ways is password protection. Through this only selected people can access this control over the home appliances. This type of application is also very secure as we can use different number codes for different appliances. We can control a vast number of appliances if we can develop a program of higher level. In this project in future we can add a multimedia camera to see what is going inside the home by sitting in office or somewhere. Also a LCD display can be used to display which device is going to be on/off. This is mainly done with the aim that now a day home security is of prime importance that cannot be ignored. So with this we can easily achieve the home security by automatically controlling the home appliances if someone forgets to put off any devices and if we have reached someone far off places from our home. Thus in this way we can keep track on both the things that is home when you are busy at in workplace and without any worry we can perform our task. DTMF can be used in various fields .It have vast applications like it can be used in controlling the robotic arm and irrigation system in farm ,so with this vast telephone network we can control our home appliances.

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