A Tele Remote based Home Automation System

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***Abstract*—In recent years, the home environment has seen a rapid introduction of network enabled digital technology. This technology offers new and exciting opportunities to increase the connectivity of devices within the home for the purpose of home automation. In this paper a home automation system using telephone lines is presented. This system consists of two subsystems i.e. remote control system and phone monitoring system. The remote control system uses the dual tone multi-frequency signals to control the operations of various appliances. The hardware and software are designed based on the standard telephone system, whereas the phone monitoring system provides convenient services for the user to better monitoring the usage of their phones. Experimental results show that the two subsystems provide better home services and living quality for modern lives.**

Keywords- Home Automation System(HAS), Dual tone multifrequency(DTMF), Tri state out enable(TOE)

I. INTRODUCTION

Technology aims at making the life comfortable by inventing various home appliances. But in this hustle bustle of life one may forget the switching ON-OFF of these appliances or one would like to have remote control on some preliminary operations of their home appliances before they go back to home. These operations may be the turn on or off the air conditioner, the cooker, the light, the video, or the security system. It will be comfortable and convenient for people to live in such a modern house with the above facility. Besides this, phone is an important bridge of these two parties. Sometimes it is important to keep the information of conversations to protect the family. In this case, it is useful to have extra functions to monitor the usage of phones. These functions include automatic warning and recording.

The above needs bring up the idea of Home Automation in modern lives. Home automation means the control of home appliances by means of a telephone, computer or mobile. This paper presents HAS by using telephone system. This includes two major parts. One is the RC (Remote Control) system. The other is the PM (Phone Monitoring) system. Both applications introduced in this paper were designed based on the standard telephone system. This means that the above systems can be installed for public use widely. Both systems were designed based on the DTMF signals that are produced by the telephone system. The DTMF signals were sent from the user end to the destination end. The RC system detects the number of phone ring and a set of defined codes to determine if a remote control signal has been sent out to control the operation of target appliance. If the control signal is confirmed by the system, the system will send out a control signal to initiate the operation of the appliance. The PM system will send out a warning signal and automatically record the content of the conversation if it detects an in or out call of the phone.

The rest of the paper is organized as follows. Section II focuses on the features of telephone line. In Section III Design of Remote control system is described. Section IV describes about DTMF. Advantages of telephone system and disadvantages of cell phone are described in Section V. Finally the conclusion and future work is presented in Section VI.

II. FEATURES OF TELEPHONE LINES

Every phone on the standard public telephone network is connected to the phone-exchange office with two pair copper line. Any two people communicate each other by the help of switching unit in the phone-exchange office. There are two methods to sent phone numbers to the switchboard: first one is dial pulse system, other is multi frequency system. The phone, of which key pad information is sent by audio tone, is used to remote control devices. This is also called Dual Tone Multi Frequency (DTMF) and every button on the key pad has different frequency as shown in Fig.1. Therefore, when the button is pressed, its relevant frequency is sent to the switchboard. These button identification signals are transmitted via telephone line with voice signal.

III. REMOTE CONTROL SYSTEM DESIGN

The hardware circuit of the remote control system includes a power supply circuit,

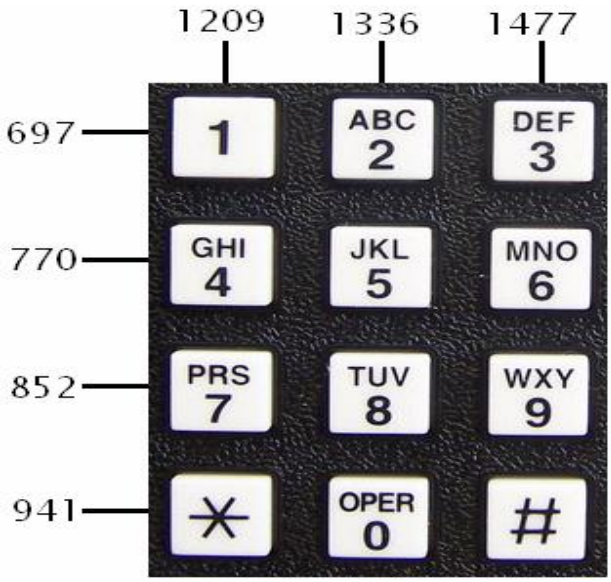

Fig.1. Keypad with 12 keys and frequencies (Hz).[1]

a multifrequency MT8870 chip, Dual latch and a multi frequency decoder**.** The circuit diagram of the remote control system is as shown in Fig. 2.

The circuit can be used to switch up to 8devices using the keys 1 to 8 of the telephone. Digit # is used to switch the telephone system between remote switching mode and normal conversation mode. By using this circuit we can overcome the problem which occurred during the use of infra red or radio remote control. Here the DTMF signal on telephone instrument is used as control signal. The digit '#' in DTMF mode is used to toggle between appliance mode and normal operating mode. This tele remote circuit which enables switching ON/OFF of appliances through line. Thus telephone can be used for switched on or switched off as well as work for communication. The IC MT8870 is DTMF to BCD converter.

Once a call is established (after hearing ring back tone) dial '#' in DTMF mode. IC 1 decodes this as 1100 which is further demultiplexed by IC 2 as output O14 of 74LS154. The active low output of IC 2, after inversion and amplified by tri-state buffer(74LS373),becomes logic 1, this is used to toggle IC 4 and relay energized. After pushing '#' key telephone keys from 1 to 8 will work as an on/off switch.

The line is now connected for appliance mode of operation. After selection of appliance mode of operation, if digit '1'is dialed, it is decoded by IC 1 and its output is '001'.This BCD code is then de-multiplexed by 4 to 16 line de-multiplexer ic whose corresponding output, after inversion by 'a' 74LS373 gate, goes to logic '1' state. This pulse toggles the corresponding flip flop to alternate state. The flip flop o/p is used to drive a relay'1' which can switch ON or OFF the appliance connected through its contacts. By dialing other digits in a similar way, other appliances can also be switched ON/OFF. Once the switching operation is over, push '#' key to be removed appliance mode from telephone line. The telephone line is thus again set free to receive normal calls. This circuit is to be connected in parallel to the telephone instrument.

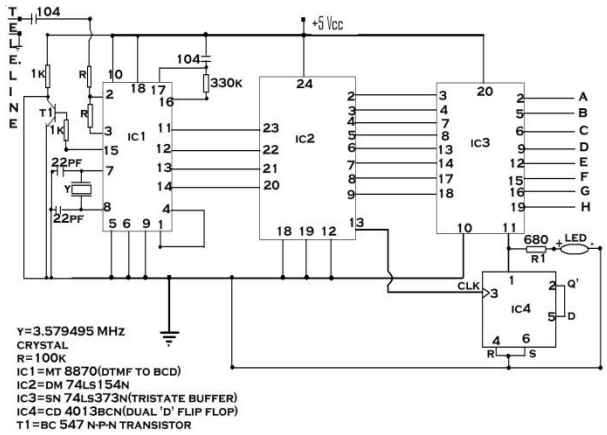

Fig.2. Hardware Circuit of Remote Control System.

IV. DUAL TONE MULTI FREQUENCY(DTMF)

DTMF is a generic communication term for touch tone .The tones produced when dialing on the keypad on the phone could be used to represent the digits, and a separate tone is used for each digit. However, there is always a chance that a random sound will be on the same frequency which will trip up the system. It was suggested that if two tones were used to represent a digit, the likelihood of a false signal occurring is ruled out. This is the basis of using dual tone in DTMF communication. DTMF dialing uses a keypad with 12/16 buttons. Each key pressed on the phone generates two tones of specific frequencies, so a voice or a random signal cannot imitate the tones. One tone is generated from a high frequency group of tones and the other from low frequency group [3]. The frequencies generated on pressing different phone keys are shown in the Table 1.

Remote controller system designed is connected parallel to telephone line and electrically operated home appliances can be controlled by using telephone from any places away from the home. Main component of the project is IC MT 8870 which is DTMF to BCD converter.

DTMF (Dual tone Multiple Frequency) is one of the most common standards of telephone key boards. In other words, transmission of message between telephone user and communication switches is performed with DTMF signal, leading improvement in the quality of encoding and decoding of DTMF.

Table 1: DTMF Frequency Assignment [4]

Button	Low Frequency(Hz)	High Frequency(Hz)
1	697	1209
2	697	1336
3	697	1477
4	770	1209
5	770	1336
6	770	1477
7	852	1209
8	852	1336
9	852	1477
0	941	1209
*	941	1336
#	941	1477

DTMF is a decoder when any key on telephone is pressed a two different frequencies are generated, the DTMF detects these frequencies and decode a four digits latched output whose value depends on the pressed key. For example if bottom "1" is pressed on the keypad the DTMF decoder output is 0001. If bottom "5" is pressed the decoder output is 0101 and so on [2]. The presented system uses the MT 8870 DTMF decoder as shown in Fig.3. to allow the system to decode the DTMF signals sent by the user through telephone phone in to BCD code, these digitals codes fed to microcontroller input. It consists of mainly 4 sections.

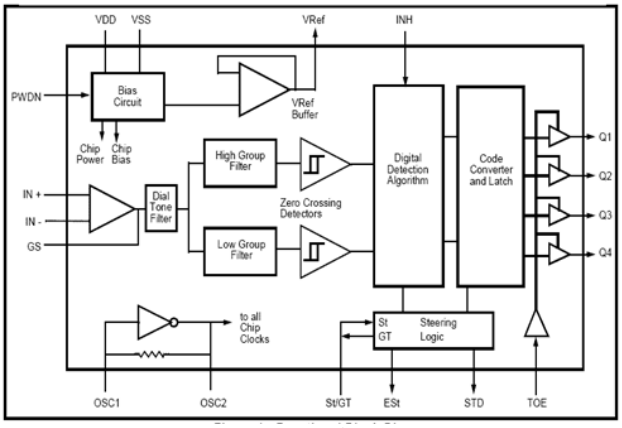

Fig.3. Block Diagram of DTMF Decoder.

A. Filter Section

The Separation of low group and high group tones are achieved by two sixth order capacitor band pass filter. Frequency between 350Hz to 440Hz is not allowed. Following are the different DTMF tones.

A=697Hz	E=1209Hz
B=770Hz	F=1336Hz
C=852Hz	G=1477Hz
D=941Hz	H=1633Hz

B. Decoder section

The filter section is followed by a decoder section employing digital counting techniques to determine the frequencies of the incoming tones and to verify that they correspond to standard DTMF frequencies. A complex averaging algorithm protects against tone simulation by extraneous signals such as voice while providing tolerance to small frequency deviations and variations. This averaging algorithm has been developed to ensure an optimum combination of immunity to talk-off and tolerance to the presence of interfering frequencies (third tones) and noise. When the detector recognizes the presence of two valid tones (this is referred to as the "signal condition" in some industry specifications) the "Early Steering" **(**ESt**)** output will go to an active state. Any subsequent loss of signal condition will cause ESt to assume an inactive state as shown in Fig. 4

C. Crystal Oscillator

The internal clock circuit as shown in Fig. 5 is completed with the addition of an external 3.579545 MHz crystal and is normally connected as shown in Figure 5 (Single-Ended Input Configuration). However, it is possible to configure several MT8870D/MT8870D-1 devices employing only a single oscillator crystal. The oscillator output of the first device in the chain is coupled through a 30 pF capacitor to the oscillator input (OSC1) of the next device. Subsequent devices are connected in a similar fashion.

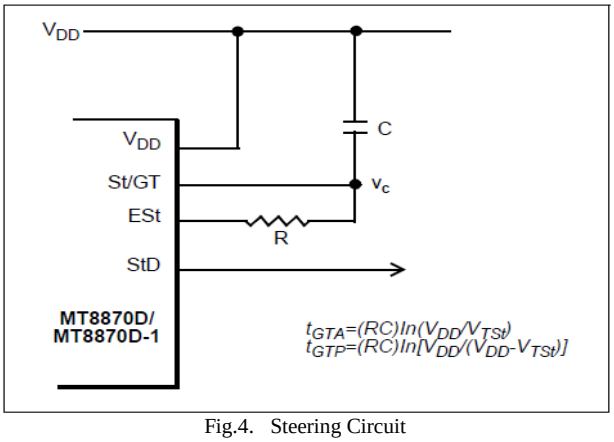

Fig.4. Steering Circuit

The problems associated with unbalanced loading are not a concern with the given arrangement i.e., precision balancing capacitors are not required.
There are two important pins of DTMF:

a. The TOE (Tri-State out enable): is an active low input used to disable/enable the output latch the TOE pin will be connected to ground in disable the output with high impedance, it is useful in case of unwanted output code, and connect to VDD in order to have output latch enabled at all times.
b. The STD signal: This signal goes high during the time any valid key is pressed, if the key is released the STD goes low, this signal is used in the present system to tell a microcontroller that the key is pressing and the DTMF tones are transmitting and the output latch has been updated and at this time a microcontroller read the data.

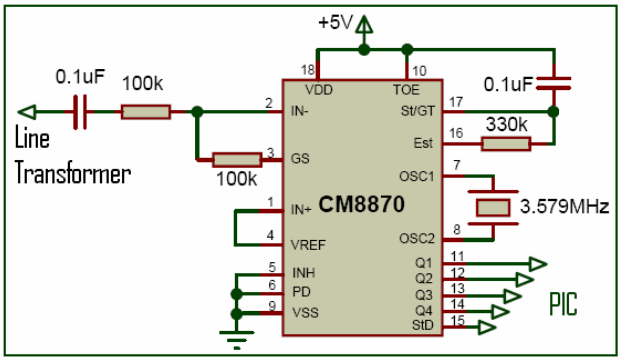

Fig.5. Internal Clock Circuit [9]

D. Relay Driver Unit

Relay Driver circuit shown in Figure 8 can remotely control 3 different electrically operated home appliances. Relay contacts are normally open and therefore devices are not working at the beginning. When proper order has been entered using telephone key pad, proper relays are excited. Therefore devices such as oven, lamp, heater or computer start working. 1, 2 and 3 get start (ON) relevant device and 4, 5, 6, 7 and 8 stop (OFF) devices respectively.

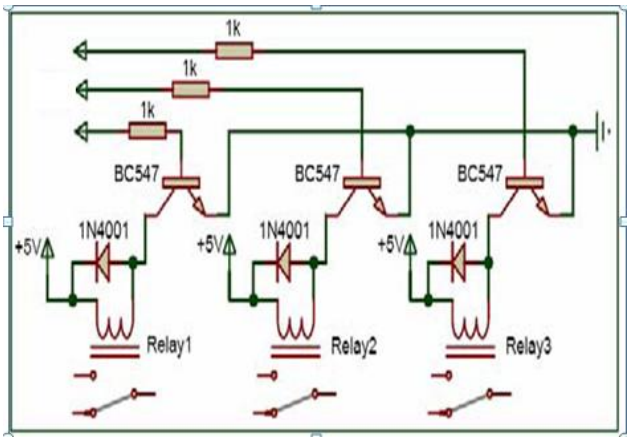

Fig.6. Relay Driver Circuit

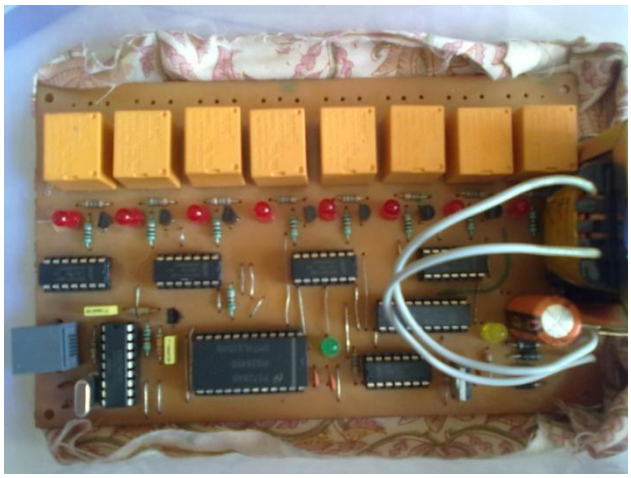

Fig. 7. Project Implementation View

V. ADVANTAGES , DISADVANTAGES AND APPLICATIONS

The HAS system using telephone line has following advantages.

A. Advantages

- Simple structure.
- Maximum 8 devices can operate.
- Complex programming is not required.
- For increasing more number of devices one has to just add another telephone instrument.
- No problem of network like cell phone.
- When telephone is not used for HAS it can be easily used for normal operation.
- It is not affected by high frequency waves.
- Cheap, safe and secure.

Home Automation System using cell phone suffers from following limitations.

B. Disadvantages of cell phone system

- Complex structure.
- Maximum 6 devices can operate.
- Complex programming is required.
- During programming improper delays may occur.
- For increasing more number of devices one has to modify the program and also there is need of adding predefined security code.
- No network –No operation.
- Master mobile must be in auto receiving mode.
- It can be affected by high frequency waves.

C. Applications

As shown in the Fig.7 presented circuit can be used to switch ON/OFF many electronic devices (maximum 8 devices as per one telephone instrument). So one can use the same circuit for home automation as well as for the industrial purpose.

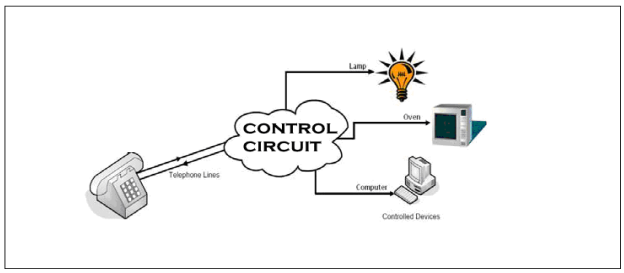

Fig.8. Home Automation System

VI. CONCLUSION

The presented Home Automation System in this paper is realized practically and tested using LEDs instead of home appliances for multi modes of operation and gave an excellent switch ON/OFF of the relays under test. The system presented in this paper has very secure structure. Designed circuit is isolated both optically and electrically; therefore it does not create any effect on telephone lines. One can use the pin-check system so that only authorized people can connect to or use this system. This system gives secure, cheap and safe remote control system for intelligent houses.

In this project maximum 8 devices can be connected to relays due to limitation of telephone keypad. But as we are using 4 to 16 decoder it can be possible to operate 16 devices by pressing two times any switch like “11”, “22” up to “88”.

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