DTMF Based Remote Control System

Conference Paper · January 2007

DOI: 10.1109/ICIT.2006.372611 · Source: IEEE Xplore

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DTMF Based Remote Control System

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Abstract: **An attempt has been made to address automation based on Dual-tone multi-frequency remote control system for industrial and household applications. In this work, we design a teleremote system. The system is implemented on existing telephone lines to give a cutting edge advantage over conventional Infrared and Bluetooth remote systems.**

I. INTRODUCTION

A teleremote is a remote control system which enables switching 'on' and 'off' of appliances through telephone lines. It can be used to switch appliances from any distance by just making a phone call. This system is designed to overcome the limitation of the range offered by infrared or wireless technology, by making use of the already available telephone lines, all over the world [1].

The system described here can be used to switch up to eight appliances. There should be a parallel connection maintained between the telephone lines and the system. The heart of the system lies in the Dual-Tone Multi-Frequency (DTMF) decoder [5]. It is a tone consisting of two frequencies superimposed (see Fig (1)).

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

Figure 1 DTMF Frequencies

The DTMF signals on telephone instrument are used as control signals. It decodes the DTMF tone from the keypad of telephone into its respective BCD code after the system receives the call. This BCD code is passed through a decoder which selects a particular D-flip flop. This activates a switching transistor, which in turn triggers the relay connected to the appliance.

Various innovations have been made in this field. A system could be designed based on the DTMF signals that could be sent through a loop of wire to switch on/off various appliances via a Personal Computer (PC) [2], [3].

The organization of the paper is as follows: In section II, we discuss the previously designed models. An insight is thrown on the pros and cons of them. Section III presents the block diagram for our teleremote system. Detailed circuit description is provided for each block used in this section. In section IV, we present the simulation results on circuit maker 2000. A comparative study of the design and some of its possible applications are presented. Finally, some conclusions are offered in section V.

II. BACKGROUND

In [2], a teleremote model is proposed. The system is designed to receive DTMF signals and consists of three major parts. The first part is the ring detector and DTMF receiver. The task of the DTMF receiver is to detect the presence of a valid tone pair on a telephone line or other transmission medium. The presence of a valid tone pair indicates a single dialed digit. There is a low frequency tone for each row and a high frequency tone for each column. These DTMF tones are transmitted in a manner similar to speech transmission over telephone lines. Thus the system permits us to receive DTMF tones through the receiver in the event of a number being pressed on the keypad.

The second part is the Input/Output interface unit. A standard I/0 interfacing card is used to interface the ring detector and the DTMF receiver outputs to the PC. This card is inserted into a PC expansion slot. The third block is a PC, programmed with Turbo Basic Software to perform the online operations.

However, the system suffers from the fact that the control mechanism is controlled by a PC. This necessarily ensures the presence of the PC at all times. Further, control from remote locations is not guaranteed. These shortcomings are the basic reasons for our motivation in this work. The present system is designed to address control related issues even from the most remote locations.

III. PROPOSED WORK

In the present work, the teleremote system is incorporated. The system works using DTMF tones. The decoder decodes the DTMF tones generated by the keypad of a commercial landline or mobile touchtone set.

Fig (2) presents the block diagram of our teleremote system.

Block Diagram

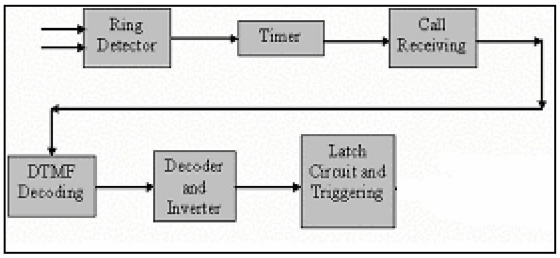


Figure 2 Block diagram of teleremote system.

Alternating Current (AC) present over the phone line is detected by the touchtone set to produce ringing. IC 741 op-amp is used to detect this AC [4]. When the phone is ringing, the output of the op-amp goes low. This is made high by connecting the output to an inverter. The ring detector triggers the switching transistor which starts a timer. For our purpose, we have used IC 555 as timer [4]. An inverter is connected to invert the output of timer. The timer provides a delay of approximately 35 seconds. The output of timer triggers the call receiving circuit for 14 seconds in order to make a DTMF tone transfer. The output of the 555 timer IC is inverted and fed to a switching transistor [4]. This transistor triggers a relay across the phone line which is enough to receive a call and also enables the transfer of DTMF tones. The DTMF decoder converts the code from the telephone keypad into its corresponding equivalent BCD code. It uses two band-pass filters consisting of switched capacitor filters and suppresses any harmonics present in the decoder output. Thus it produces good fidelity signal even from a distorted input. The decoder remains in a sleep mode and gets activated automatically whenever a call is received. The BCD code is transferred to a 3 X 8 line decoder that receives the signal, processes the algorithm to interpret the signal as meaningful data, and provides an interface to other devices. The output is now active low therefore a hex-inverter IC is also attached. The output is latched using a D-flip flop which in turn activates the switching transistor thus triggering a relay.

A. Ring Detector

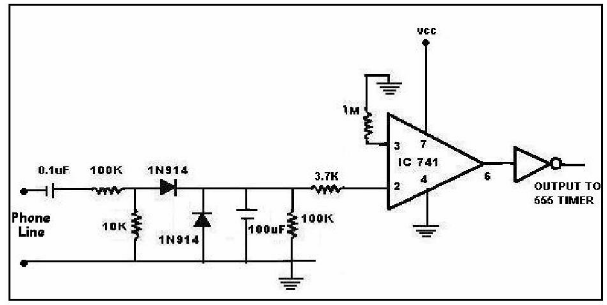


Figure 3 Circuit Diagram of Ring Detector

Fig (3) depicts two input wires from the telephone line. The first line is connected to a 0.1 μF capacitor which operates in the 200V range.

There are two 1N914 diodes connected (with opposite polarities) in parallel between the lines as shown. Gold is used as the recombination center allowing a fast recombination of minority carriers. This allows the diode to operate at the same rate as the signal frequencies, but at the expense of a higher forward voltage drop. The 3.7KΩ resistor acts as input resistance to IC 741. The phone line rings at 100V rms. To detect the ring; we detect the large AC in the phone line. An IC 741 op-amp detects this AC. Once the phone ring is acknowledged (heard at the caller), the output of the op-amp drops low. A connected inverter makes the output high.

B. Timer

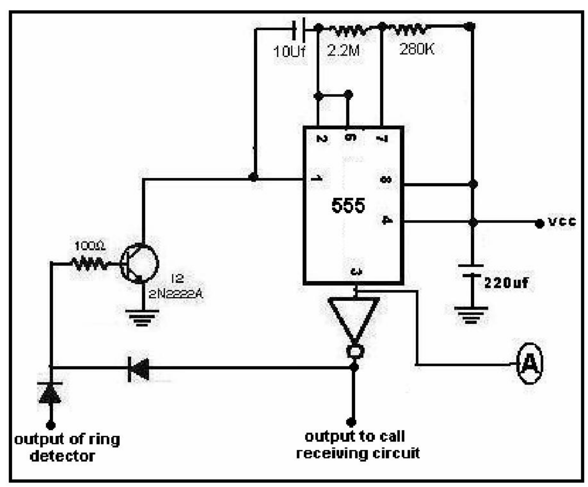


Figure 4 Circuit Diagram of 555 timer

The ring detector triggers the switching transistor (2N2222A) which starts the timer. We use 555 IC as the timer. This IC's circuit oscillates from one state to another over time, creating a resultant square wave. There are two basic forms of this timer. A monostable multivibrator circuit which stays in a given state (say +9V) until a separate signal triggers the timer. Once a signal is received, the output state is shifted to 0V.

The low state is maintained until a pre-determined time delay is completed. The output then switches back to the high state (+9V, in this case), waiting for a new trigger signal to toggle it again.

An astable multivibrator, on the other hand, spontaneously switches from one state to another (say +9V to 0V to +9V...). The pulse durations of the high and the low state are determined by external components. An inverter is connected to invert the output of timer. The timer triggers the call receiving circuit for 14 seconds in order to make a DTMF tone transfer.

C. Call Receiving

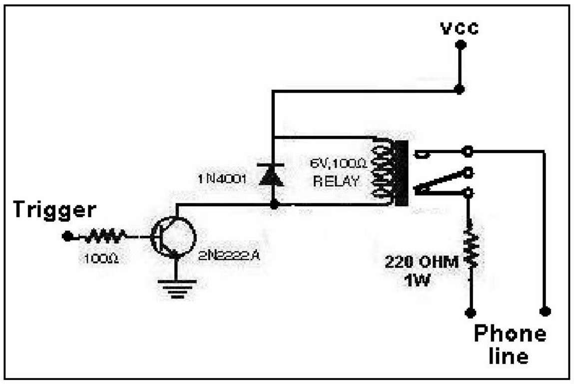


Figure 5 Circuit Diagram of Call Receiving

The output of the 555 timer IC is inverted and fed to a switching transistor (2N2222A). This transistor triggers a relay across the phone line to receive a call enabled transfer of DTMF tones.

D. DTMF Decoder

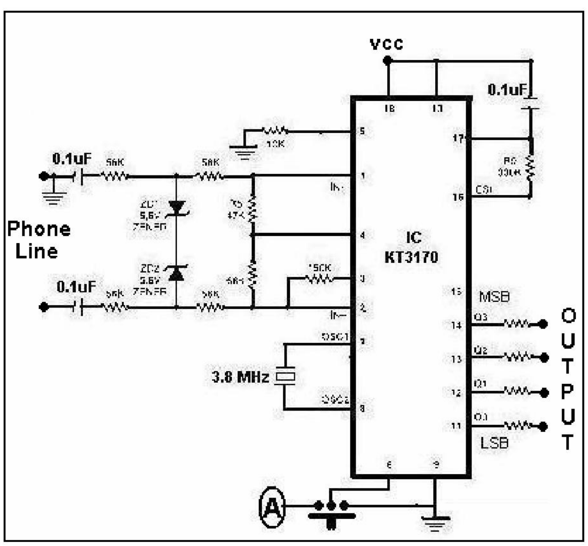


Figure 6 Circuit Diagram of DTMF Decoding

A KT 3170 DTMF decoder IC which converts the corresponding code from keypad of telephone to its equivalent BCD code is employed in this part of the circuit. This 3170 IC remains in sleep mode and gets activated only when a call is received.

E. Decoder and Inverter

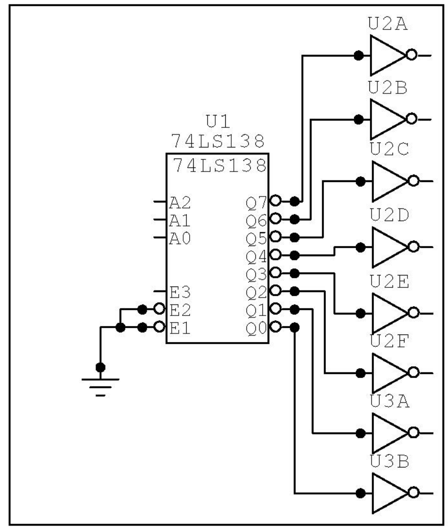


Figure 7 Circuit Diagram for Decoder and Inverter

The BCD code is passed through a 3 X 8 line decoder. The output is active low, so a hex-inverter IC is also attached.

F. Latch Circuit and Triggering

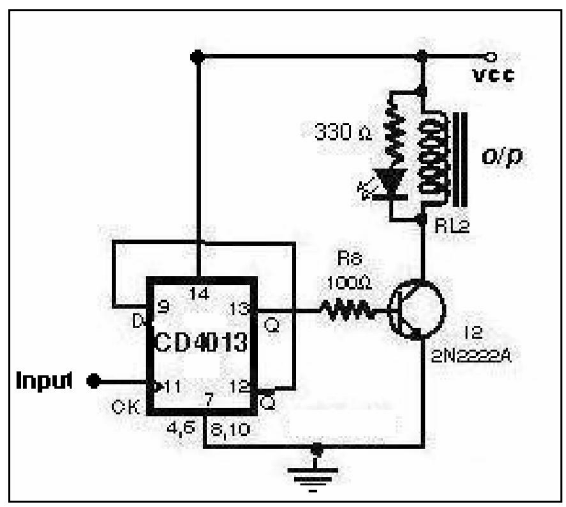
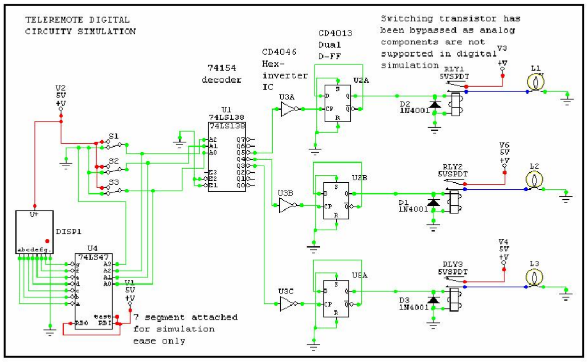


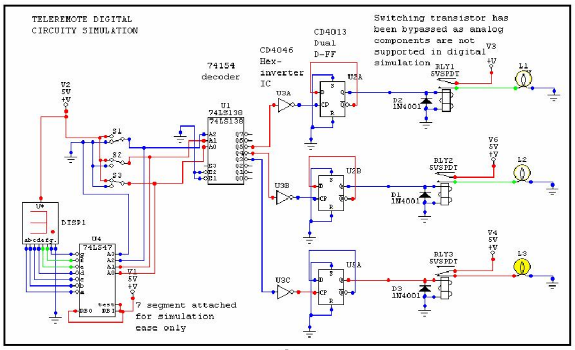
Figure 8 Circuit Diagram of Latch and Triggering

The output is latched using a delay flip flop which in turn activates the switching transistor thus triggering a relay.

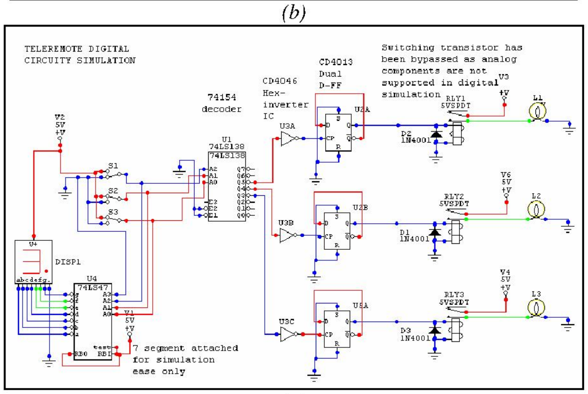
IV. SIMULATION RESULTS AND DESIGN HIGHLIGHTS



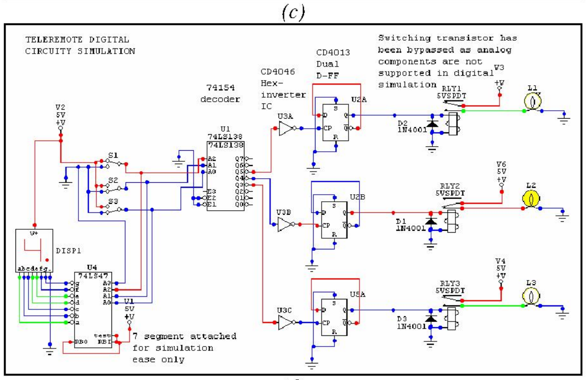
(a)



(b)



(c)



(d)

Figure 9 Simulation results for Circuit Maker

The results are presented above. Fig (9a) shows the circuit made by us in circuit maker in its initial state. Fig (9b) shows the running state of the circuit with a high state on 3rd output for a BCD input 011 (decimal 3). If the output device is to be switched off, the same code 011 (decimal 3) is pressed once again Fig (9c). Fig (9d) shows the state of output for BCD code 100 (decimal 4) corresponding to the 4th pin of the decoder.

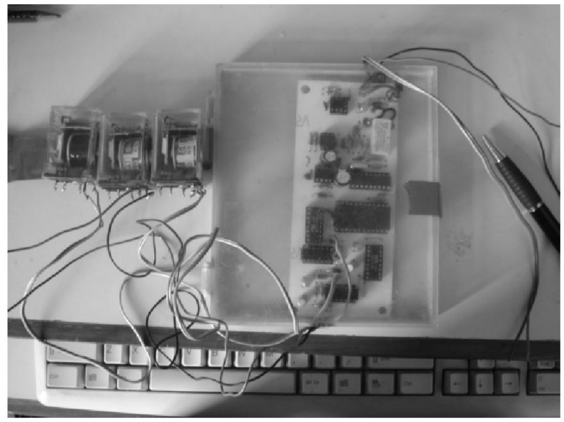


Figure 10 Hardware circuit

The present work takes the advantage of using existing telephone network, thereby, reducing the added cost of installation of a separate dedicated network. This also overcomes the range limitation of Bluetooth and Infrared remote systems. The system could be activated by the user using either landline or mobile handsets. This feature removes any location disadvantage. Currently the system is designed to control only eight devices. However this number could be increased by using a dedicated microcontroller. The system designed and implemented above can be used in industries especially mining to know as well as change the status of costly machinery from a distance, to control entry/exit at gates in homes, factories, banks etc. thus saving enormous manpower. It can be used for spying purposes e.g. Activation of a microphone or a camera in a room. Control of home appliances can be incorporated thus improving the standard of living. Recording on television while away from home; general lighting and security are some of the potential areas of its application.

V. CONCLUSION

A Teleremote system using DTMF tones is implemented. The entire design uses the network of existing telephone providers, thus minimizing the cost substantially. Also the limitation of range being imposed by Bluetooth and Infrared systems are overcome.

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