DTMF CONTROLLED ROBOT WITHOUT USING MICROCONTROLLER

Dissertation Submitted in partial fulfillment of

the requirement for the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

UTKARSH SHARMA(121020)

UTKARSH SRIVASTAVA (121007)

PRADEEP TOMAR (121031)

UNDER THE GUIDANCE OF

Dr. RAJIV KUMAR

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY,WAKNAGHAT

JUNE 2

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DECLARATION

I hereby declare that the work reported in the B-Tech thesis entitled **"DTMF CONTROLLED ROBOT WITHOUT USING MICROCONTROLLER"** submitted at **Jaypee University of Information Technology, Waknaghat, India,** is an authentic record of my work carried out under the supervision of **Dr. RAJIV KUMAR**. I have not submitted this work elsewhere for any other degree or diploma.

Utkarsh Sharma Utkarsh Shrivastava Pradeep Tomar

Department of Electronics and Communication Engineering

Jaypee University of Information Technology, Waknaghat, India

26th May 2016

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT

SOLAN, HIMACHAL PRADESH

Date: 26th May 2016

CERTIFICATE

This is to certify that the work reported in the B-Tech. thesis entitled **"DTMAF CONTROLLED ROBOT WITHOUT USING MICROCONTROLLER"**, submitted by **Utkarsh Sharma, Utkarsh Shrivastava and Pradeep Tomar** at **Jaypee University of Information Technology, Waknaghat**, **India,** is a bonafide record of their original work carried out under my supervision. This work has not been submitted partially or wholly to any other university or institution for award of this or any other degree program.

ABSTRACT

Cell phone operated Robot is a Robot whose movement can be controlled by pressing the number of cell phone. The robot can move forward, backward, right or left which depends on the numbers you are pressing. The property of Robot to operate by the cell phone helps you to operate the robot from some distance The Cell Phone controlled Robot uses DTMF (Dual tone-multi frequency) module. It is capable of receiving a set of command (instructions) in the form of DTMF (Dual tone multiple frequency) tones and performs the necessary actions. The robot is controlled by making call to the mobile connected to the robot. The robot performs various operations like moving forward, backward etc. if any key is pressed in the course of the call, by hearing at the other end of the call (i.e. at the mobile connected to the robot). Each key corresponds to a particular frequency which is decoded by the DTMF decoder & processed by logic circuit by giving each key a particular operation like moving forward, backward, right, left etc. The benefit is that we can operate the robot by using any mobile with the working range as large as the coverage area of the service provider**.**

ACKNOWLEDGEMENT

The realisation of this project depended upon the shared efforts from several experts of knowledge and sources of information .

I am indebted to management of JUIT to allow me to carry out this project . I express my sincere gratitude and indebtedness to Dr. Rajiv Kumar, ASSISTANT PROFESSOR(ECE), arranging necessary facilities for the project and providing me an opportunity to involve myself in the topic of the project and with the working environment and people of JUIT.

I owe my sincere gratitude to my course coordinator Dr Rajiv Kumar, associate professor(ECE) , for his valuable and inspiring guidance towards the subject matter and progress on the topic 'DTMF CONTROLLED ROBOT WITHOUT USING MICROCONTROLLER' and providing valuable information for progress of the project.

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Dual-tone multi-frequency signaling (**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 centers. DTMF was first developed in the Bell System in the United States, and became known under the trademark **Touch-Tone** for use in push-button telephones supplied to telephone customers, starting in 1963. DTMF is standardized by ITU-T Recommendation Q.23. It is also known in the UK as *MF4*.

Multi-frequency signaling is a group of signaling methods that use a mixture of two pure tone (pure sine wave sounds. Various MF signaling protocols were devised by the Bell System and CCITT

The DTMF system uses a set of eight audio frequencies transmitted in pairs to represent 16 signals, represented by the ten digits, the letters A to D, and the symbols # and *. As the signals are audible tones in the voice frequency range, they can be transmitted through electrical repeaters and amplifiers

Controlling a robot wirelessly is possible with several methods such as Remote, Bluetooth, Wi-Fi, etc. But, the controls of these communication methods are limited to certain areas, and complicated to design as well. To overcome these difficulties, we have come up with a Mobile Controlled Robot.

A Mobile Controlled Robot is a mobile device, which provides wide-range of wireless control ability to your robot unless your cell phone gets out of signal.

A general concept of mobile controlled robot is that it can be controlled from any part of the world with just an inclusion of a camera. We will definitely offer you the simplest method for developing this kind of robot in the coming days.

Now, we like to introduce the simplest technique of fabricating a Mobile Controlled Robot via GSM. As we have eliminated the use of a microcontroller, it could certainly help the beginners to feel better.

wireless controlled vehicles had been extensively used in a lot of areas like unmanned rescue missions, military usage for unmanned combat and many others. But the major disadvantage

of these wireless unmanned robots is that they typically make use of RF circuits for maneuver and control. Essentially RF circuits suffer from a lot of drawbacks such as limited frequency range i.e. working range, and limited control. To overcome such problems associated with RF control, few papers have been written, describing methods which make use of the GSM network and the DTMF function of a cell phone to control the robotic vehicle. This paper although uses the same principle technology of the GSM network and the DTMF based mobile phone but it essentially shows the construction of a circuit using only 4 bits of wireless data communication to control the motion of the vehicle without the use of any microcontroller. This improvement results in considerable reduction of circuit complexity and of manpower for software development as the circuit built using this system does not require any form of programming. Moreover, practical results obtained showed an appreciable degree of accuracy of the system and friendliness without the use of any microcontroller.

DTMF Keypad

The DTMF telephone keypad is laid out in a 4×4 matrix of push buttons in which each row represents the *low* frequency component and each column represents the *high* frequency component of the DTMF signal. 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 hertz (Hz). Initial pushbutton designs employed levers, so that each button activated two contacts. The tones are decoded by the switching center to determine the keys pressed by the user.

CHAPTER 2

DTMF ROBOT

In principle, RF (Radio Frequency) can be regarded as the control which deals with the use of radio signals to remotely control any device. A remotely controlled vehicle may be defined as any mobile device which is controlled by means that it does not restrict its motion with an origin external to the device i.e. the possibility of an existence of a radio control device, a cable between the control and the vehicle or an infrared controller. A RCV is always controlled by a human operator and takes no positive action autonomously.

The IR system follows the line of sight approach which involves the process of actually pointing the remote at the device being controlled; this makes communication over obstacles and barrier quite impossible. To overcome such problems, a signaling scheme utilizing voice frequency tones is employed. This is known as Dual Tone Multi-Frequency (DTMF), TouchTone or simply tone dialing. A valid DTMF signal is the sum of two tones, one from a low group (697-941Hz) and the other from a high group (1209-1633Hz) with each group containing four individual tones. DTMF signaling therefore play an important role in distributed communication systems such as multiuser mobile radio.

In this paper, phones making use of the GSM network interfaced directly with the DTMF decoder and the motor driver is used to remotely control an unmanned robotic vehicle thus overcoming the distance barrier problem and communication over obstacles with very minimal or no interference but is solely network dependant. The design of an unmanned vehicle proposed here does not make use of any microcontroller. The transmitter used, is a handheld cell phone.

In this project the robot, is controlled by a mobile phone that makes call to the mobile phone attached to the robot in the course of the call, if any button is pressed control corresponding to the button pressed is heard at the other end of the call. This tone is called dual tone multi frequency tome(DTMF) robot receives this DTMF tone with the help of phone stacked in the robot

The received tone is processed by the atmega16 microcontroller with the help of DTMF decoder MT8870 the decoder decodes the DTMF tone in to its equivalent binary digit and this binary number is send to the microcontroller, the microcontroller is preprogrammed to take a decision for any give input and outputs its decision to motor drivers in order to drive

the motors for forward or backward motion or a turn.
The mobile that makes a call to the mobile phone stacked in the robot acts as a remote. So this simple robotic project does not require the construction of receiver and transmitter units.
DTMF signaling is used for telephone signaling over the line in the voice frequency band to the call switching center. The version of DTMF used for telephone dialing is known as touch tone.
DTMF assigns a specific frequency (consisting of two separate tones) to each key s that it can easily be identified by the electronic circuit. The signal generated by the DTMF encoder is the direct al-gebric submission, in real time of the amplitudes of two sine(cosine) waves of different frequencies, i.e. ,pressing 5will send a tone made by adding 1336hz and 770hz to the other end of the mobile.
In this project, the robot is controlled by a mobile phone that makes a call to the mobile phone attached to the robot. In the course of a call, if any button is pressed, a tone corresponding to the button pressed is heard at the other end of the call. This tone is called „dual-tone multiple-frequency" (DTMF) tone. The robot perceives this DTMF tone with the help of the phone stacked in the robot.

DTMF signaling is used for telephone signaling over the line in the voice- frequency band to the call switching centre. The version of DTMF used for telephone tone dialing is known as „Touch-Tone". DTMF assigns a specific frequency (consisting of two separate tones) to each key so that it can easily be identified by the electronic circuit. The signal generated by the DTMF encoder is a direct algebraic summation, in real time, of the amplitudes of two sine (cosine) waves of different frequencies, i.e., pressing „5" will send a tone made by adding 1336 Hz and 770 Hz to the other end of the line

CHAPTER 3

CONSTRUCTION AND WORKING

A DTMF decoder is a device which takes a signal from the headset line of a cell phone and gives a 4 bit output corresponding key pressed in the cell phone. Whenever a key is pressed in the mobile, a sum of two fixed frequency is sent as input to the decoder IC. This IC converts the number into its corresponding binary value for example if 3 is pressed its binary value 0011 is produced at the output.

Conventionally, robots controlled by wireless communication employ radio frequency(RF), which have the drawbacks of limited working range, limited frequency range and the limited control. Use of a mobile phone for robotic control can overcome these limitations. It provides the advantage of robust control, working range as large as the coverage area of the service provider, no interference with other controllers and up to twelve controllers. Although the appearance and the capabilities of robots vary vastly, all robots share the feature of a mechanical, movable structure under some form of control. The control of the robot involves three distinct phases: perception, processing and action. Generally, the preceptors are sensors mounted on the robot , processing is done by the on-board microcontroller or processor, and the action is performed using motors or with some other actuators.

When constructing any robot, one major mechanical constraint is the number of motors being used. Either a twowheel drive or a four-wheel drive can be used. Though four-wheel drive is more complex than two-wheel drive, it provides more torque and good control. Two-wheel drive, on the other hand, is very easy to construct. The chassis used in this model is a 10×18cm2 sheet made up of par ax. Motors are fixed to the bottom of this sheet and the circuit is affixed firmly on top of the sheet. A cell phone is also mounted on the sheet as shown in the picture. In the four-wheel drive system, the two motors on a side are controlled in parallel. So a single L293D driver IC can drive the rover. For this robot, beads affixed with glue act as support wheels.

3.1 HARDWARE DESIGN FRAMEWORK:

The blocks of the receiver model which is seen in fig are explained in detail in this section:
However, upon implementation we also found that the proposed method could also be implemented without using a microcontroller, which was one of the key elements in the design of the circuit. In case of motion control as described in these papers , we found that a considerable amount of circuit complexity can be reduced when we omit the use of the microcontroller. And the need for writing any software code is also absent.
The main components of the circuit are DTMF decoder IC, motor driver IC and motors. The decoder IC used here is HT9107B IC. The second pin of decoder IC is an inverting pin of the operational amplifier.

Tone is applied to the IC through a series of capacitor and resistor. The output of the Op Amp is feed back through GS pin of the IC. An external crystal is connected to the 7^{th} and 8^{th} pins of the IC.

Motor driver IC used is L293D. It has 16 pins. 2, 7, 10, 15 pins are the inputs of motor driver IC connected from output pins of the decoder IC. The output pins are 3, 6, 11, 14. These pins are connected to the two motors of robotic vehicle. 8^{th} pin is connected to the 5v. Vss is the input voltage with which the motors runs. Motors cannot be driven with 5Vof microcontroller. So, a driver IC is used to amplify this voltage. VSS pin provides this voltage

3. PROPOSED MODEL

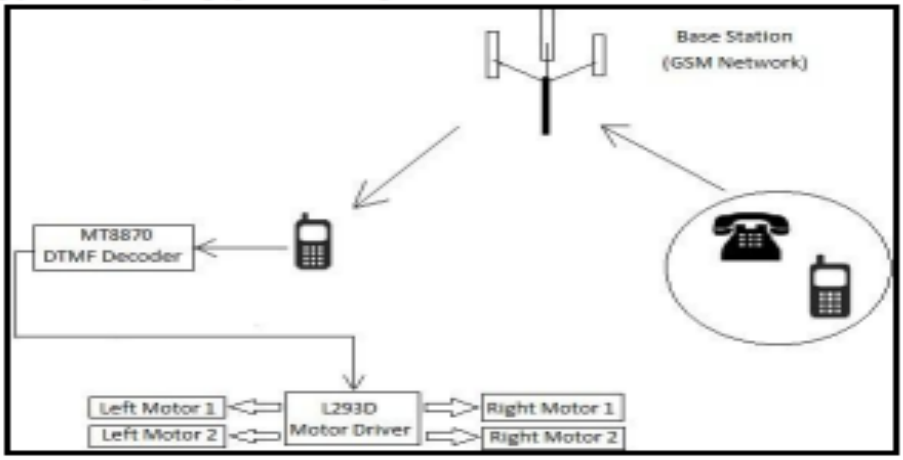


Figure 1 Functional Block Diagram

3.1.1

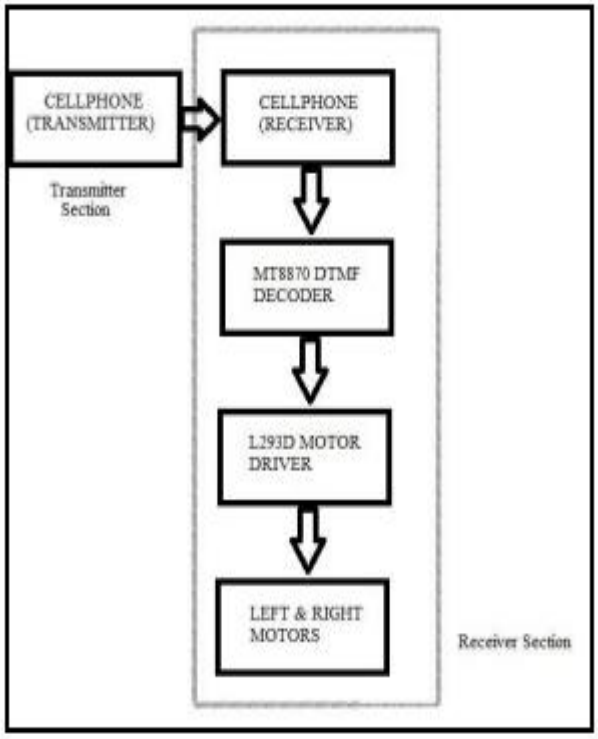


Figure 2 Block Diagram of the proposed model

3.1.2

3.2 DTMF DECODER:

NEED OF DTMF DECODING:

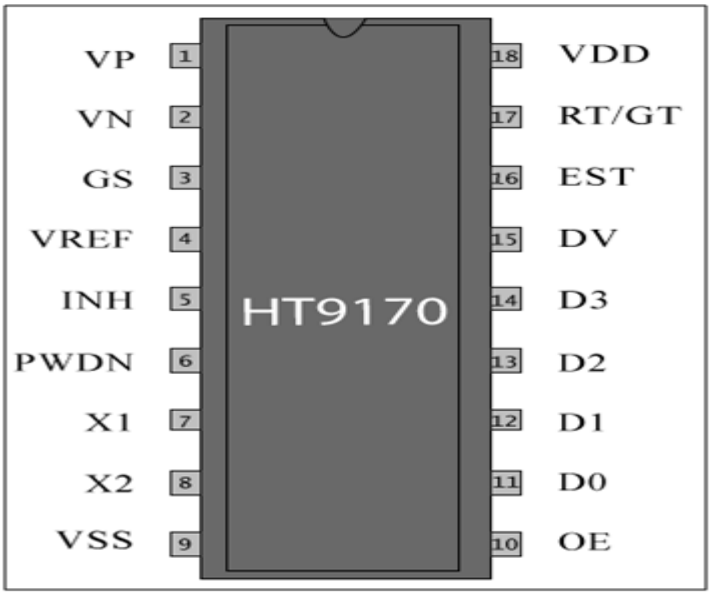
In the premature days, our telephone systems were operated by human operators in a telephone exchange room. The caller will pick up the phone, giving instruction to the operator to connect their line to the destination. It is a kind of manual switching. As more and more people entered in the telephone technology as useful communication gear, manual switching becomes a time consuming tedious task.

As technology established, pulse or dial tone technique were invented for telephone communication switching. It employs electronics and computers to support switching operations. DTMF is the ultimate technique used in any of the Mobile, Telephone communication systems.

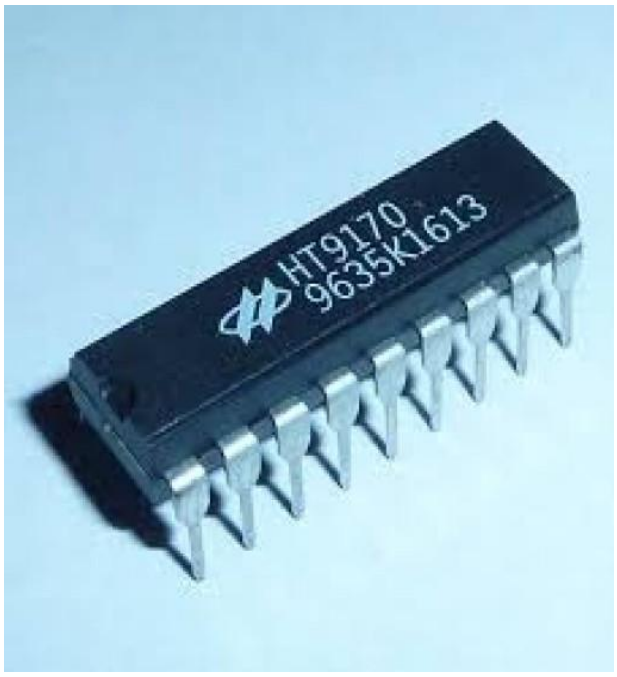
DTMF (Dual tone multiple frequency) is the most popular and nowadays ubiquitously used telecommunication signalling method. A DTMF decoder detects the DTMF tones and generates the binary sequence corresponding to key pressed in a **DTMF** keypad. The circuit of this project presented here is a DTMF decoder. DTMF keypads are used in almost all landline and mobile handsets. The DTMF decoders, therefore, are used at the telephone switching centres to detect the number dialled by the caller. The DTMF version used in pushbutton telephones is called touch tone and is a registered trademark of AT&T.

An HT9170 series DTMF decoder is used here. The MT8870 series use digital counting techniques to detect and decode all the 16 DTMF tone pairs into a 4-bit code output. The need for pre-filtering is eliminated using the built-in dial tone rejection circuit. In single-ended input configuration when the input signal given at pin 2, is effective, the correct 4-bit decoded signal of the DTMF tone is generated and transferred to Q1 (pin 11) through Q4 (pin 14) outputs of the DTMF decoder which are given as input to the corresponding input pins of the motor driver.

Integration of both the band split filter and digital decoder functions makes the DTMF decoder a complete receiver. Switch capacitor techniques for high and low group filters are used; digital counting techniques are used to detect and decode all 16 DTMF tone pairs into a 4 bit code. The external component count is minimized as an on chip provision of a differential input amplifier clock oscillator and latched three state bus interfaces are provided. The functional description of the HT9170 is given in the following section


VP 1
VN 2
GS 3
VREF 4
INH 5
PWDN 6
X1 7
X2 8
VSS 9
HT9170
18 VDD
17 RT/GT
16 EST
15 DV
14 D3
13 D2
12 D1
11 D0
10 OE

3.2.1


HT9170
9635K1613

3.2.2

3.3 PIN DESCRIPTION

Pin No	Function	Name
1	Operational amplifier non-inverting input	VP
2	Operational amplifier inverting input	VN
3	Operational amplifier output terminal	GS
4	Reference voltage output terminal	V_{REF}
5	Active high. It inhibits the detection of tones corresponding to A, B, C and D. It is internally pulled down.	INH
6	Active high. It leads the chip to power down mode and inhibits the oscillator. It is internally pulled down	PWDN
7	Connection for standard 3.579545 MHz crystal	X1
8		X2
9	Ground (0V)	V_{SS}
10	Active high; Enables output D0-D3	OE
11	Output terminals	D0
12		D1
13		D2
14		D3
15	Data valid. It goes high on reception of valid DTMF signal; otherwise remains low	DV
16	Early steering output	EST
17	Tone acquisition time and release time can be set by using external resistor and capacitor	RT/GT

18	Supply voltage; 5V (2.5V-5.5V)	V_{DD}

3.4 FILTER SECTION

Separation of the low group and high group tones are achieved by applying the DTMF signal to the input of the two sixth order switched capacitor band pass filter, the band width of whose correspond to the low and high group frequencies. Prior to limiting each filter output is followed by a single order switched capacitor filter section which conditions the signal; limiting is performed by the use of high gain comparators which are provided with hysteresis to prevent detection of unwanted low level signals. Full rail logic swing is provided at the output of the comparators at the frequency of the incoming DTMF signals.
Satellites are manmade objects put into orbit. They often affect our lives without our realizing it; they make us safer, provide modern conveniences, and broadcast entertainment. Here are some of the jobs satellites do

3.5 DECODER SECTION

On the telephone exchange side, it has a decoder circuit to decode the tone to digital code. For example, the tone of 941hz + 1336hz will be decoded as binary '1010' as the output. This digital output will be read in by a computer, which will then act as a operator to connect the caller's telephone line to the designated phone line. The telephone exchange center will generate a high voltage signal to the receiving telephone, so as to ring the telephone bell, to notified the receiving user that there is an incoming call.

As technology matures, pulse/dial tone method was inverted for telephony communication. It uses electronics and computer to assist in the phone line connection. Basically on the caller side, it is a dial tone generator. When a key is being pressed on the matrix keypad, it generate a unique tone consisting of two audible tone frequency. For example, if the key '1' is being press on the phone, the tone you hear is actually consist of a 697hz & 1209hz sine signal. Pressing key '9' will generate the tone form by 852hz & 1477hz. The frequency use in the dial tone system is of audible range suitable for transmission over the telephone cable.

This project article focus on a simple DTMF (dual tone multi-frequency) decoder circuit. This circuit can be interface to a computer, allowing caller to computer interaction. Many communication application can be build for example, a computerize call receiving/diverting phone network system. Remote control to Home/Office electrical appliances using a telephone network.

DTMF is a popular project especially in DSP (digital signal processing) subject. DSP software algorithm can be implement to generate as well as to decode DTMF tone. It is very interesting, and I will try to cover that aspect in near future. For now we do the hardware way.

In the decoder section, there is a decoder employing digital counting techniques to determine the frequencies of the incoming tones and to verify whether they correspond to standard DTMF frequencies or not. Use of a complex averaging algorithm protects against tone simulation by extraneous signals such as voice in addition to providing tolerance for small frequency deviations and variations.

The development of this averaging variation algorithm is to ensure an optimum combination of immunity to talk off and tolerance to the presence of interfering frequencies (third tone) and noise. As the presence of two valid tones is recognized (this is referred to as the signal condition) the early steering (Est) output will go in to an active state. Subsequent loss of signal condition, if any, will force EST to assume an inactive state.

3.6 STEERING CIRCUIT

The receiver checks for a valid signal duration before registration of a decoded tone pair. An external Resistance Capacitance (RC) of time constant Est. performs the check. Logic high on Est causes the collector voltage (Vc) to rise as the capacitor discharges. The function of the decode algorithm is to estimate the time required to detect the presence of two valid tones top, the tone frequency and the previous state of the decode logic. EST indicates and initiates an RC timing circuit.

If both tones are present for the minimum guide time (tCTP) which is determined by the external RC network, decoding of the DTMF signal takes place and the resulting data is latched onto the output register. Indication that new data is available is given when the delay steering (StD) output is raised high. The time required to receive a valid DTMF signal (Trec) is equal to the sum of time to detect the presence of valid DTMF signals (tDP) ,guard time and the tone present.

3.7 MOTOR DRIVER:

Motor driver IC used is L293D. It has 16 pins. 2, 7, 10, 15 pins are the inputs of motor driver IC connected from output pins of the decoder IC. The output pins are 3, 6, 11, 14. These pins are connected to the two motors of robotic vehicle. 8th pin is connected to the 5v. Vss is the input voltage with which the motors runs. Motors cannot be driven with 5Vof microcontroller. So, a driver IC is used to amplify this voltage. VSS pin provides this voltage.

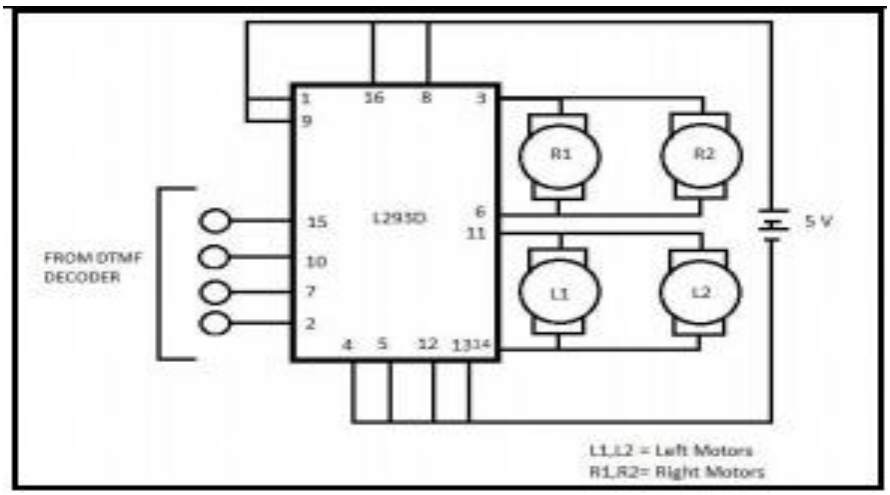
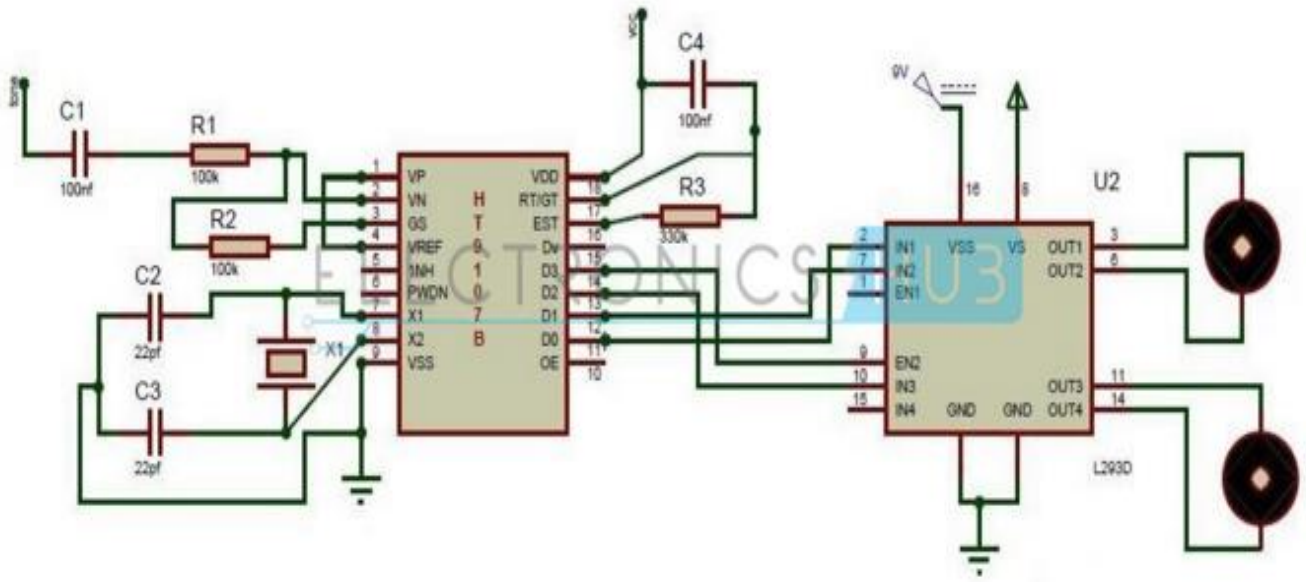


Figure 4 Motor driver configuration

3.7.1



DTMF based Mobile Controlled Robot Circuit Diagram

3.7.2

3.8 CIRCUIT COMPONENTS

1. HT9170 IC

2. MOTOR DRIVER IC

3. MOTORS

4. RESISTORS R1,R2,R3

5. CAPACITORS C1 TO C4

6. CRYSTAL OSCILLATOR

3.9 FUNCTION OF CRYSTAL OSCILLATOR

An electronic circuit or electronic device that is used to generate periodically oscillating electronic signal is called as an electronic oscillator. The electronic signal produced by an oscillator is typically a sine wave or square wave. An electronic oscillator converts the direct current signal into an alternating current signal. The radio and television transmitters are broadcasted using the signals generated by oscillators. The electronic beep sounds and video game sounds are generated by the oscillator signals. These oscillators generate signals using the principle of oscillation.

3.10 WORKING

The unmanned vehicle could either have a two wheel drive or a four wheel drive. We choose to go with a four wheel drive as it provides a better control and more torque than the two wheel system. The circuit as shown in fig.5 has been designed on a breadboard. The breadboard on which the circuit was constructed is mounted on a steel chassis. In addition the cell phone (receiver one) which is attached to the vehicle is also mounted on the chassis (not shown in the figure). Motors which are used for motion of the robotic car are fixed to the bottom of the steel chassis. In the four wheel drive system which we had used in the configuration of our circuit, the motors on both the sides are managed independently of one another. However a single L239D motor driver IC is enough to control the four motors. Now to operate the vehicle, we need to make a call to the cell phone attached to the circuit on the receiver side. Moreover, we should note, that the call is only possible if the operator on the transmitter side knows the cell phone number of the other phone. Any GSM enabled phone can be used as the transmitter; which sends the DTMF tones through the existing GSM network.

The tones are received by the receiver phone accordingly. One thing to keep in mind is that the cell phone at the receiver side should be kept in auto answer mode, so that the call can be taken after a single ring. The DTMF tones which are received are fed to the circuit through the headset of the cell phone.

The DTMF tones are fed as input to the DTMF decoder which produces the 4 bit equivalent of the received tone and passes it on to the motor driver as input. The motor driver on receiving the corresponding input drives the motor as specified.

3.9 OPERATION

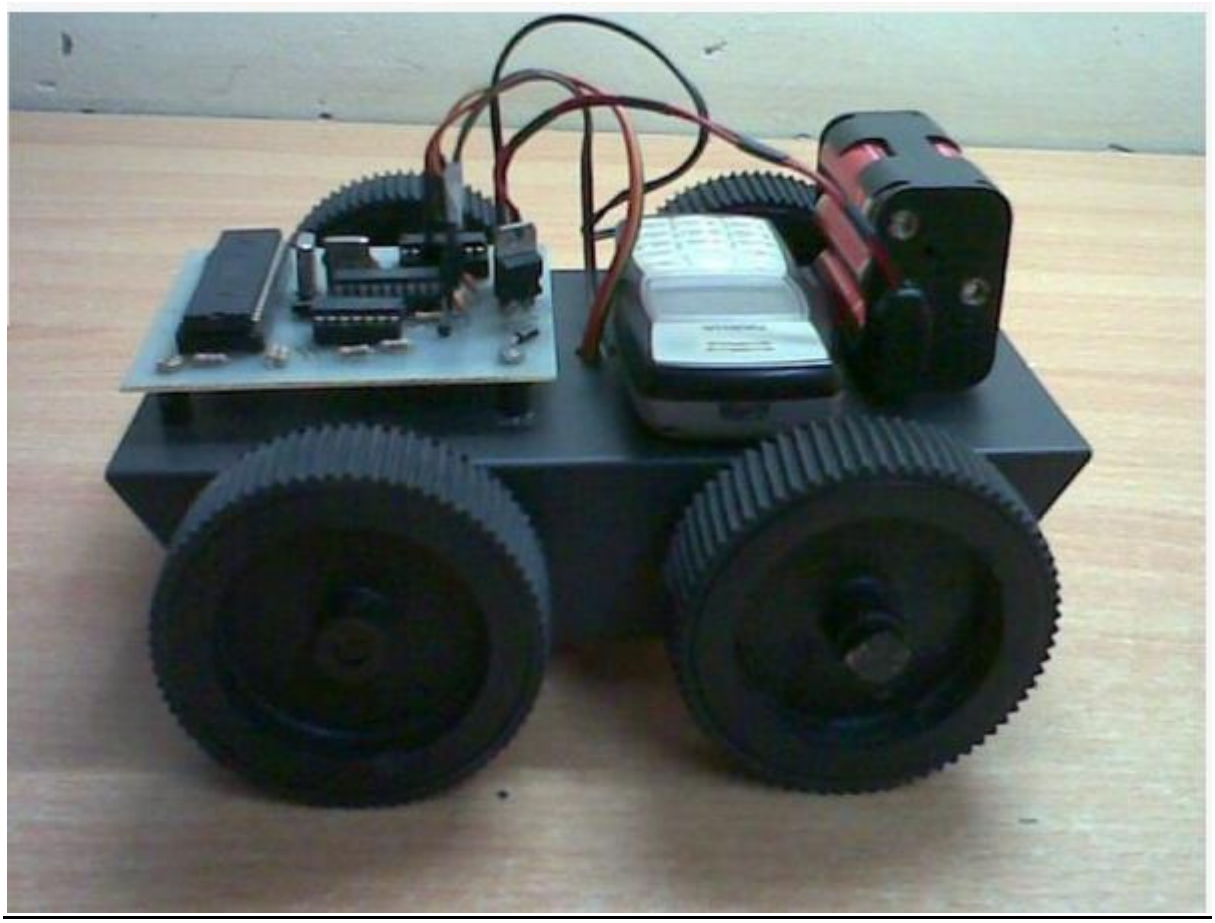
We see that when key ‘6’ is pressed on the mobile phone, the robotic car executes forward motion. When we press key ‘9’ on our mobile phone, the car moves in the reverse direction. When we press key ‘4’, the car takes a left turn. When we press key ‘2’ on our mobile phone, the vehicle turns in the right direction. Similarly when ‘0’ is pressed on the cell phone, the vehicle halts. Five keys on the keypad are used for motion control of the unmanned car

Number Pressed	Output of DTMF decoder	Input to the Motor driver	Right Motor Action	Left Motor Action	Robot's Net Movement
6	0 1 1 0	0 1 1 0	Forward	Forward	Forward
9	1 0 0 1	1 0 0 1	Reverse	Reverse	Reverse
4	0 1 0 0	0 1 0 0	Forward	Stop	Left
2	0 0 1 0	0 0 1 0	Stop	Forward	Right
0	0 0 0 0	0 0 0 0	Stop	Stop	Stop

3.9.1

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

3.9.2



3.9.3

3.9.4

3.10 COMPARISON

In the previous two sections, we have seen that our proposed model achieves a considerable amount of accuracy as is evident from Table 5 in case of motion control. More specifically looking at the circuit diagram it is clearly visible that our circuit requires much less components to obtain the same objective as is proposed in papers [2-4]. From convention reduced circuitry results in less complexity. A cost analysis shows that our proposed design method is also quite cost effective. This reduces manufacturing costs also. There is no need of any programming so deployment of manpower to program the circuit is also not required.

3.11 APPLICATION

These unmanned vehicles can have various scientific uses in hazardous and unknown environments. USVs have also been used for space exploration purposes examples of which are Voyager-I and the Martian explorers Spirit and Opportunity. Similarly, military usage of these robotic vehicles dates back to the first half of the 20th century .

Remote controlled vehicles are used by many police department bomb-squads to defuse or detonate explosives. Current USV's can hover around possible targets until they are positively identified before releasing their payload of weaponry. USVs also play an increased role in search and rescue. These vehicles could be used in case of natural calamities & emergencies. This can also be a great asset to save the lives of both people and soldiers.

In recent times, there has been a serious endangerment to the wildlife. Many animals are significantly on the verge of extinction. These spy robotic cars can be used to patrol the different sections of the forested areas for any suspicious activity and since it is a live streaming device as well as mobile, it can keep the forest guards constantly updated and alert about the status of different areas which are vulnerable to attack. As a result, it can help to prevent further destruction of the forest resources by enabling correct prohibitory action at the appropriate time.

3.12 EXPERIMENTAL RESULTS

The experimental values of the frequency of sinusoidal waves for DTMF and the voltage level at the out-put pins of HT9170 and L293D motor driver were measured. These values are juxtaposed with the theoretical values in the Table 1 and 2 respectively. Table 3 shows the HEX reading obtained from output pins of HT9170 and L293D. Table 4 shows how the robot's resultant movement is achieved as a combination of the right and left motor movements. We also compared the output value of the motor driver given in Table 5 when input was given from

1.MICROCONTROLLER

2.DTMF DECODER DIRECTLY

TABLE 1
Frequency Readings

KEY	LOWER FREQUENCY (Hz)		HIGHER FREQUENCY(Hz)	
	TH.	EXP.	TH.	EXP.
2	697	672	1336	1320
4	770	731	1209	1201
6	770	731	1477	1475
8	852	855	1336	1322
5	770	735	1336	1325

TABLE 2
Voltage Readings

LOGIC LEVEL	OUPUT VOLTAGE OF MT8870		OUTPUT VOLTAGE OF L293D	
	TH.	EXP.	TH.	EXP.
LOW	0.03	0.09	0	0.11
HIGH	4.97	4.80	5	4.82

TABLE 4
Combination of Left and Right Motor Movement

INPUT	RIGHT MOTOR ACTION	LEFT MOTOR ACTION	RESULTANT MOTION
0110	Forward	Forward	Forward
1001	Reverse	Reverse	Reverse
0100	Forward	Stop	Left
0010	Stop	Forward	Right
0000	Stop	Stop	Stop

CHAPTER 4

SUMMARY

As the microcontroller which is essentially “a micro-computer on a chip” is not used we are truly unaware and not certain at this point of time whether extra functions can be added to the robotic vehicle in addition to direction control. Considerable amount of intensive research in this area is required to come to any such definite conclusion. Even if it is possible then as described in paper [4] the project can be extended to include IR sensors, a camera or even a system for password protection of the USV. Now, IR sensors can be automatically used to detect and avoid obstacles if the vehicle goes beyond the line of sight. Coming to password protection, a brilliant scheme has already been described in paper [5] where the purpose had been achieved without the use of any microcontroller. Moreover, still research is needed to see whether the inclusion of a camera with the vehicle could be achieved without the use of a microcontroller and without much circuit complexity

The basic aim to develop an USV which overcomes the drawbacks of the conventionally used RF circuits has already been achieved in papers .But the method proposed in this paper can be said to improve upon the current design or provide an alternative to the existing one. The design described here does not make use of any microcontroller and it can be seen that even without the usage of the microcontroller we achieve similar and comparable accuracy in direction control. Whether new functions which are described in the section 11 can be added is beyond the scope of this paper. As discussed in section 9, the advantage of this system can be summarized as reduced circuit complexity, reduced cost of manufacturing and ease of deployment. In addition to these advantages, the robotic car constructed based on the design in this paper would have the same benefits associated

4. REFERENCES

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