Design And Implementation Of Metal Detector Using DTMF Technology

Ratnesh Kumar
EEE Department
Xavier Institute of Polytechnic and Technology
Ranchi, India
ratneshkr2@gmail.com

Amulya Niraj Khalkho
EEE Department
Xavier Institute of Polytechnic and Technology
Ranchi, India
amulyaniraj@gmail.com

***Abstract*— The outline and usage of a mobile phone worked metal detector is introduced in this paper. Presently days, metal recognizing framework are turning out to be imperative part in securing live and properties of regular citizen and military. This metal detector is connected on mobile phone worked vehicle. For this paper, the metal identifier worked in a way that the metal sensor (Colpitts oscillator) detects any electrically or metallic object conveyed near it. The metal indicator circuit creates a sound which can hear to the end client through the cell Phone. The vehicle comprises of arduino board, a L293D interface circuit, and an motor driving framework. The controlling electronics are associated with the arduino board. The arduino board sends signs to the interfacing board L293D that controls the motor driving framework. 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 vehicle perceives this DTMF tone with the help of the phone stacked in the vehicle.**

***Key Words*— DTMF;Arduino Board; L293D, DC Motors; Metal Detector.**

I. INTRODUCTION

The mobile that makes a call to the cell telephone stacked in the vehicle goes about as a remote. Along these lines, this straightforward mechanical task does not require the development of receiving and transmitter units. The vehicle might have the capacity to identify 90% of Metal and stamp the areas of the mines inside a resilience of 5cm.For the security of the administrator, the composed vehicle must have the capacity to work remotely. The vehicle might not explode the mines while checking the range and denoting the areas of the mines. The Control of vehicle includes three particular stages: observation, preparing and activity. For the most part, the preceptors are sensors mounted on the vehicle, handling is finished by the on-board microcontroller or processor, and the errand is performed utilizing engines. In this anticipate the vehicle, is controlled by a cellular telephone that makes call to the cellular telephone joined to the vehicle throughout the call, assuming any. The important components of this vehicle are DTMF decoder, Microcontroller and motor driver. An MT8870 series DTMF decoder is used here. All types of the mt8870 series use digital counting techniques to detect and decode all the sixteen DTMF tone pairs in to a four bit code.

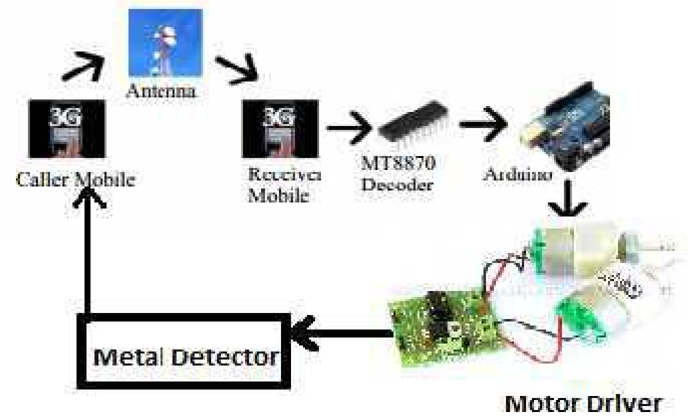


Figure 1: Pictorial Representation

II. DTMF AND WORKING OF THE SYSTEM

DTMF Signalling is utilized for phone motioning over the line in the voice-frequency band to the call exchanging centre. The version of DTMF utilized for phone tone dialing is known as Touch-Tone. DTMF allocates a particular frequency (comprising of two separate tones) to every key so that the electronic circuit can without much of a stretch distinguish it. The signal created by the DTMF encoder is a direct logarithmic summation, continuously, of the amplitudes of two sine (cosine) wave of various frequencies, i.e., squeezing the "1" key: For instance, to produce the DTMF tone for "1", blend an immaculate 697 Hz signal with an unadulterated 1209 Hz signal, similar to so: 697 Hz Sine Wave +1209 Hz Sine Wave = DTMF Tone "1"DTMF horizontal axis in tests. The frequency of the tone is around 1900 Hz - near the 1906 Hz anticipated by Table 1 (697+1209).

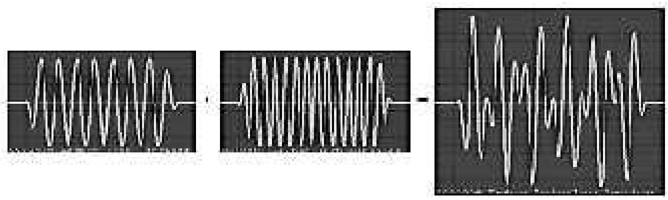


Figure 2 : 697 Hz Sine Wave +1209 Hz Sine Wave = DTMF Tone "1"DTMF generated signal

978-1-5090-4620-1/16/$31.00 ©2016 IEEE

The tones and assignments in a DTMF system are shown in Table 1.

Key	Low DTMF Frequency (Hz)	Low DTMF Frequency(Hz)	Binary Coded Output			
			Q 1	Q 2	Q 3	Q 4
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	882	1209	0	1	1	1
8	882	1336	1	0	0	0
9	882	1477	1	0	0	1
0	941	1209	1	0	1	0
*	941	1336	1	0	1	1
#	941	1477	1	1	0	0

Table 1: MT8870 Output Truth Table

III. DTMF Decoder IC-CM8870

It is 18 pin IC. The working voltage is 2.5V-5.5V. One wire of the earphone is associated with the wire of the IC and another to ground. The phone (recipient) to a 3.5mm jack is associated at the flip side. The mobile phone must be kept at auto answer mode. Presently approach that telephone from another telephone (transmitter). Press the keys on the remote telephone and the vehicle pushes ahead (press 2), in reverse (press 8), left (squeeze 4) and right (press 6).The four yield pins (D0,D1,D2,D3) of the IC is associated with any part of the microcontroller.

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

Table 1:MT8870 Output Truth Table

IV. Arduino UNO Board

This is the brain of this vehicle in which the project is stacked to do the required working and is interfaced with decoder IC and the motor driver to make the framework function as required. Arduino is an open-source electronics prototyping stage in view of adaptable, simple to-use equipment and programming. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. Arduino projects can be stand-alone or they can communicate with software running on a computer (e.g. Flash, Processing, and MaxMSP) and three in another group. The LEDs labelled TX and RX light up when data is being transmitted or received between the Arduino and attached devices via the serial port and USB. The little black square part to the left of the LEDs is a tiny microcontroller that controls the USB interface that allows , Arduino to send data to and receive it from computer.

V. Motor Drive IC (L293D)

The L293D IC Motor Driver ICs are principally utilized as a part of self-governing mechanical technology as it were. Likewise most microcontrollers work at low voltages and require a little measure of current to work while the motor require a moderately higher voltages and current. Along these lines current can't be supplied to the engines motor from the microcontroller. This is the essential requirement for the motor driver IC. The L293D IC gets signals from the microcontroller and transmits the relative signal to the motor. It has two voltage pins, one of which is utilized to draw current for the working of the L293D and the other is utilized to apply voltage to the motor. The L293D switches it yield signal as indicated by the information got from the microcontroller. For Example: If the microcontroller sends a 1(digital high) to the Input Pin of L293D, then the L293D transmits a 1(digital high) to the motor from its Output Pin. An imperative thing to note is that the L293D just transmits the signal it gets. It doesn't change the sign in any case. The L293D is a 16 pin IC, with eight pins, on every side, devoted to the controlling of an motor. There are 2 INPUT pins, 2 OUTPUT pins and 1 ENABLE pin for every motor. L293D comprise of two H-bridge. The got tone is handled by the atmega8 microcontroller with the assistance of DTMF decoder (MT8870). The decoder unravels the DTMF tone into its equal paired digit and this parallel number is send to the microcontroller. The microcontroller is pre-modified to take a choice for any given info and yields its choice to motor drivers keeping in mind the end goal to drive the motor for forward or in reverse movement or a turn.

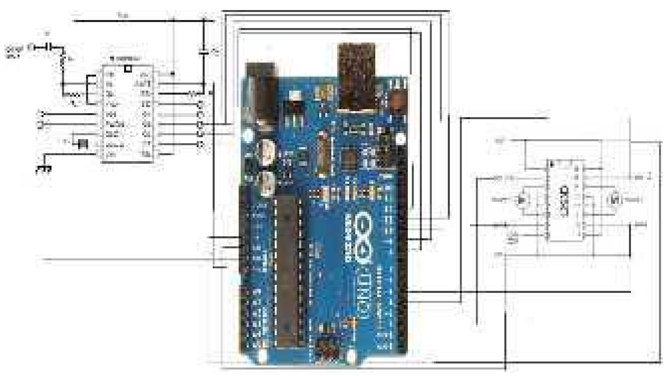


Figure 3: Connection Diagram of Microcontroller

VI. The Design Of The Hardware

The equipment comprises of the accompanying units in particular: the Power supply unit, detecting unit, the activating unit and the disturbing unit. Sensory/ Oscillator plan. The inductance to be utilized is computed utilizing

$$L = \frac{0.8R^2N}{R+1.11S} \qquad (1)$$

Where L is inductance in μH, S is the depth of turn, R represents the radius of coil, while N is the number of turns. For the purpose of this project, the sensor (coil) is desired to

be reasonably small. So, radius R and length S is chosen to be 0.04 and 0.004 respectively.
Therefore using the above equation to derive the value of L when S=0.004m; R=0.02m; N=26 is

$$L = \frac{2.8 \times .025^2 \times 26}{0.025 + 1.11 \times 0.004}$$

L=1.545μH

The frequency of the oscillating discharge current depend on two factors Capacitance of the capacitor to be used and Self inductance of the coil to be used To realize the oscillation of 9.34MHz, the oscillatory tank in Figure 4 was considered. The choice of 10nF and 2.2nF was considered in such away that their equivalent capacitance when combine with the inductor using equation 1 gives the frequency of oscillation to be 9.34MHz as calculated below.

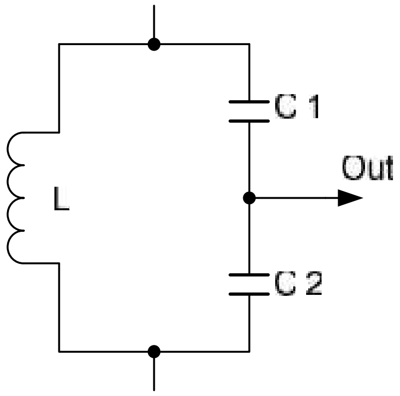


Figure 4: Oscillatory Tank

$$ceq = \frac{C1 \times C2}{(C1 + C2) C1}$$

C1= 1 ; C2= 220pF

ceq = 1.8nF

Since the oscillator to be used is a **Colpitt** oscillator,

$$F = 1/2\pi\sqrt{LC} \qquad (2)$$

$$F = \frac{1}{2\pi\sqrt{1.545\times10^{-6}\times1.8\times10^{-9}}}$$

F=3.31MHz

To stabilize the oscillation generated by the oscillatory tank, a BC547 transistor was considered. The slope of a transistor amplifier as we all know is given by:

$-1/Re = change\ in\ Ic\ axis/(change\ in\ Vce\ axis)$

$-1/Re = Ic/Vce$

$$Re = Vce\ /\ Ic \qquad (3)$$

Ic (collector continuous current) is at 100mA for a BC 547
Choosing Re = 10k =$R3$

For β = 125 for BC547 transistor,

$$I_E = Ic/\ I_E \qquad (4)$$

I_E =0.15/125

I_E = 1.20mA

For the voltage across the base of the transistor Q_1:
Resistors that will act as voltage divider will be connected to the base of Q_1 i.e two resistor such that the voltage drop at R_2 is half Vcc

$$V R_2 = R_2/R1+ R_2 \qquad (5)$$

For Vcc = 12v, $VR2$ = 6v

$R_2/R1+ R_2$= 0.5, let $R1 = R2$

$R1/2R1$ = 0.5, lets choose $R1$=10k, then $R2$ =10k
Capacitor $C3$ was chosen to serve as ac by pass to $R3$ while $C4$ is meant to filter or block dc signals, $C3$ =4.7nF, $C4$=10nF.

Calculation of $R_E= V_E/I_E$

V_{cc}= *10% of 5v*

Since $I_C >> I_B$

$R_E=V_E/I_E$=0.12V/1.2mA=1K

Calculation of R4= V_{cc} / I_c

V_{cc}= 10% of 12v

R_c=1.2/1.2mA=10KΩ

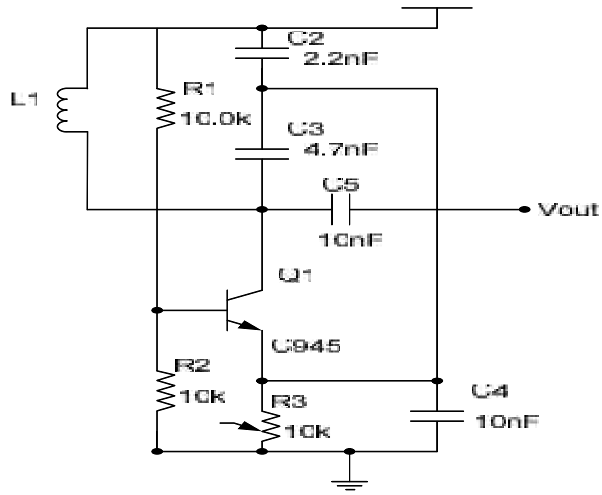


Figure 5:Sensory unit (colpitt oscillator)

Triggering unit A shaping circuit that is capable of converting sinusoidal wave to rectangular wave is desired, and to adequately give a low or high output, CD4093 was the choice. CD4093 is a quad 2 input Nand gate Schmitt trigger, but only two Nand gate were required; first for converting the sinusoidal waveform to square and the second for converting the square waveform to either a low or high output**.**

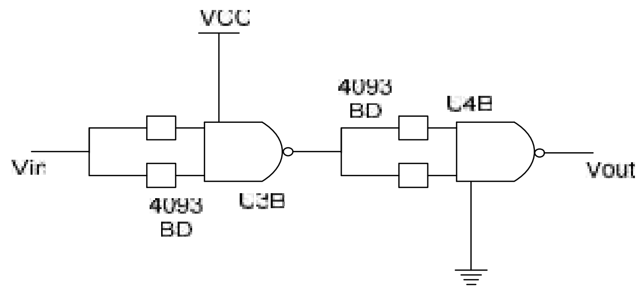


Figure 6:Triggering Unit

VII. Alarming unit

Since the output of the triggering unit is either high or low, a transistor switch arrangement is required to properly Power the buzzer. The high of the CD4093 is equivalent to the Vcc. The buzzer is off at high which means that transistor $Q2$ is saturated and transistor $Q3$ is cut off. At low, $Q2$ is cut off and $Q3$ is at saturation with $Vout = (sat) = 0.2v$.A buzzer that will produce an alarm is needed when the voltage drop across it is $Vcc - Vc(sat)$.The operation of a transistor in saturation is determined by the value of IE .

From Figure 4:

$Vin - IERE - VBe = 0$ (6)

To determine the minimum value of RE to be used from equation 6,

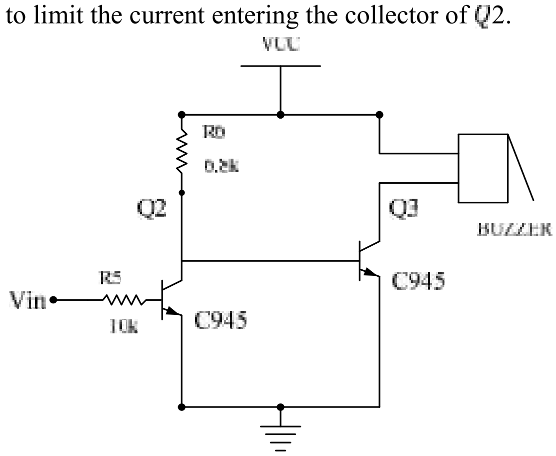
$RE = R5 = (Vin -)/IBmax$

$IE = 1.15$, for $Vcc = 12v$, $VBe = 0.7v$ and $Vin = Vcc$, then$RE = 9826.1\Omega$

A resistor of 10k is a good choice for RE since 10k> 9826.1

Therefore, $R5 = 10k$

$R6$ is used to limit the current entering the collector of $Q2$.



$R6 = 6.8k$

Figure 7: Alarming Unit

References

[1] U.S. Department of State, Hidden Killers: The Global Landmine Crisis, Report to Congress, U.S. Dept. of State, Washington, D.C., Publication 10225, December 1994 (See also http://www.state.gov/).

[2] Anti-personnel Mines: An Overview 1996, International Committee of the Red Cross, Geneva, 1996 (See also http://www.icrc.org/).

[3] K. Eblagh, \Practical Problems in Demining and their Solutions", Proceedings of the Eurel International Conference on The Detection of Abandoned Landmines, Edinburgh, UK, 7-9 October 1996, IEE Conference Publication 431, pp.1-5.

[4]Lulian,R.,(2013) High frequency VCO design and schematics.http//www.qsl.net/va3iul/ (retrieved 15/01/13).

[5] Gupta, J.B. (2011): An Integrated Course in Electronic Engineering. Published by S.K Kataria& Sons Ansari Road Daryayni Road New Delhi 2nd edition Pp578-599.

[6] Jasper Bank.(2006) A harmonic oscillator Design Methodology based on Describing Functions Thesis for PHD. Department of signal and systems circuit design group. Chalmers University of tech. Goteborg Sweden ISBN 91-72 to 748- 2.Http//www.oscillator design.com (retrieved 20/8/2012).

[7] I.Coskun and H.Ardam. November 1998. A remote Controller for Home and office. Application by Telephone, IEEE trans. Consumer Electronics . Vol. 44, no 4 pp. 1291-1297.

[8] Hausila Singh and Sudhansu Shrama, Some Novel microprocessor based configuration for controlling Remotely Located Stepper Motors as Actuators of control valves, IEEE transaction on industrial electronics, AUGUST 1991,38(4), pp 283-287.

[9] Charl Joseph, Device switching using password page No.273.

[10] www. triindia .co.in.

11] Makram, M. M and Mohammed M .M., (2008): On the design of low Phase Noise CMOS LC-Tank Oscillators 2008 International Conference on Micro-electronics. Http//www.colpittoscillator.com (retrieved 12/7/2012)

[12] Metha, V.K and Metha R., (2008): Principle of Electronic S.Chand& company Ltd Ram Nagar, New Delhi 11th Edition Pp 141-191.

[13] Robert, L. Boylestard and Louis Nashelsky (2009): Electronic Device and Circuit Theory Published by Pearson education Inc., Prentice Hall 10th Edition Pp763-767.

[14] Sedha, R.S (2006): Applied Electronics. S. Chand & company Ltd Ram Nagar, New Delhi 13th Edition Pp780-781.

[15] Theraja, B.L and Theraja, A.K (2006): Electrical Technology S.Chand & company Ltd Ram Nagar, New Delhi 24th Edition Pp2416-2421.

[16] Wayne, S., (2013), Tuned LC oscillator tutorial and oscillator basis. Http//www.variable LC oscillator.com (retrieved 15/01/13).

[16] I.J.Nagrath,Electric Machines, 3rd edition, Tata McGraw-Hill,New Delhi.2004.

[17] Muhammad H.Rashid, Power Electronics:Circuit, Device and Application, 3rd Edition.

[18] M.Gopal,Digital Control and State Variable methods, Tata McGraw-Hill Education, 2003.

[19] R.P. jain, Digital Electronics, TMH, New Delhi 2010.

[20] B.K Bose advancement of Power Electronic IEEE paper 1992.

[21] E.Wong.February 1995. A phone- Based remote Controller for Home And office Automation, IEEE Trans. Consumer Eletron., vol.40no4, pp.28-33.