Acoustic Based Electronic Rodents Repellent System

[1,]ASIF ALI, [2,] Mehran Memon

[1,] *Student M.E(Communication System and Networking), Mehran UET Jamshoro;*
[2,] *Assistant Professor, Telecommunication Engg., Mehran UET Jamshoro;*

---ABSTRACT---
All Around the world, Rodents are major threat to the society causing damage to storage houses, restaurants, Offices, hospitals and create hazardous situation for human beings. Such most common rodents in the world are pigeon bird, rats, mosquitos, locusts etc. The proposed research paper is to distract these rodents away using soundwaves, many traditional methods such as chemical substances involved process Fumigation, scarecrow, Electric shock needles are used which do not seem very effective. Using RC-oscillator, circuits are designed to gain the desired frequency in order to irritate the rodents and force them to evacuate the area, varying values of R and C in circuits the frequency ranging from 10 KHz, 25 KHZ, 35 KHz and 50 KHz has been obtained to target different audible range to repel the pests.

KEYWORDS: Rodents Repellent System, Ultrasonic, Storage houses, RC- Oscillators, ECO- Friendly.

Date of Submission: Date, 19. December 2019   Date of Publication: 10. January 2020

I. INTRODUCTION

The Science has done tremendous work in the field of engineering, it is evident that lot of research work has been carried out in the field of software and hardware application to the many fields of engineering [1-3]. The acoustic based electronic rodents' repellent system is among them. There are many traditional repellent systems in the market that generates irrelevant range of frequencies and that mostly repel pests for the very short period and are not effective [4]. This repellent system is designed to repel almost every pest according to their irritating response of the desired frequency. Pests are the major destructive agents harboring the fruits and vegetables with negative impact over their quality. The designed repellent is focused on bird's repellent that cause hazardous impact on food quality that is mostly stored in warehouses, is has been so far noticed that the Birds specially pigeon bird always stay near to the food storage warehouses, buildings etc. for their easiness to hunt food [5]. The medical research alerts that birds dropping cause serious illness, respiratory problems to human beings such as histoplasmosis [6]. It has been found experimentally that the nervous system of birds disturbs in the range of Infrasonic frequency and that is about 8KHz to 10KHz, as it will be implemented outdoor so the Infrasonic will not impact any issue on human being's health [7]. At this range of frequency, the repellent system will repel birds from such places in order to maintain the quality of food that are mainly used by human beings. The repellent will also be most efficient in Substations as the birds pose a considerable threat to the safe operation of substations as the bird's nest is often found on the frame of the substations [8].

On the other phase the designed system will repel the rats as they cause health threats to human beings such as leptospirosis carried animals mostly rats and cattle. It can be caught by humans through contact with rat or cattle urine, most commonly occurring through contaminated fresh water [9]. Practically it has been noticed that about 25KHz to 30KHz is the frequency range that is capable to attack the nervous system of rats that force them to leave that area. [10]. It can be implemented to secure the wires such as communication cable, power lines and household wires from Rats [11]. That ultrasonic range of frequency will not affect the human beings so, it can be installed inside home, warehouses, restaurants and offices. Third phase of the repellent system generate frequency between 30KHz to 40KHz that irritate mosquitos to fly away and leave the area. [12] The dengue fever is the disease that caused by mosquitos that creates the situation of life and death for human beings. It can be implemented and installed inside offices, hospitals, homes etc. The last phase of rodent's repellent system consists of frequency range between 40KHz to 50KHz that is enough to eradicate the locusts from houses, buildings, farmhouses etc. [13]. Locust cause serious threats to crop in the field, repellent system can provide some relief to farmers from locusts damaging their fields. This research paper comprises of many sections starting from background Study, that section has a short review of previous scholars in the same perspective of the Research paper Title. Furthermore, it consists of Oscillator, operational Amplifiers those are explained in the Operation of RC-Oscillators section. The calculations and circuit designing through using electronic simulation software

multism has been furnished in the section and Circuit Designs and simulations, at the last the paper finalized with section of Conclusion and References.

II.   LITERATURE REVIEW

Ibrahim et al. [14] the author used an ultrasonic device which comprises of the power unit - Battery or AC power of 12-volt DC, and then the pulse generator unit by which frequency of emission of ultrasonic sound was continuously varied. The frequency which is ≤ 150 Hz is generated through 555 Timer IC and then send to the CD4017 decade counter for the frequency division and then NPN and PNP transistor are used for the signal amplification. IC CA3130 (Audio Amplifier) is used to amplify this frequency and for transmission to the free space speaker is used. Authors [15] conclude "The world's most dangerous animal is the mosquito," according to a BBC World Service health program as they carry of many harmful diseases like Malaria, Dengue Fever, Chikungunya, Lyme disease etc. Chemical repellent is used generally to repel mosquito which has a remarkable safety profile, but they are toxic against the skin & nervous system and causes rashes, swelling, and eye irritation. It causes brain swelling in children, anaphylactic shock, and low blood pressure. Hence an alternative to the chemical mosquito repellents is to be found and preferred over chemical mosquito repellents. Author's case study the different repellent way that is available in market and their disadvantages that they are more expensive, and accuracy is less.

Author [16] focused on designing an ultrasonic pest repellent system. They used an audio power amplifier that takes 1 V p-p square wave input generated from the microcontroller unit and gives an amplified signal to the speaker. The microcontroller unit can operate in various modes depending on user input Similarly 4x4 keypad was used to give various input depending upon environment condition and availability of pest and different modes can be selected by the user. A standard 16 pin LCD display was used to view the choice entered by the user mode selected in which the circuit was working. LM 380 audio power amplifier was used to generate frequency range around 80 kHz. To transmit these sound waves a speaker of appropriate frequency range is used.

III.   OPERATION OF RC-OSCILLATORS USING OP-AMP

In an RC Oscillator, the input is shifted 180° through the amplifier stage and 180° again through a second inverting stage giving us 180° + 180° = 360° of phase shift which is effectively the same as 0° thereby giving us the required positive feedback. In other words, the phase shift of the feedback loop should be 0.In a Resistance-Capacitance Oscillator or simply an RC Oscillator, we make use of the fact that a phase shift occurs between the input to a RC network and the output from the same network by using RC elements in the feedback branch.
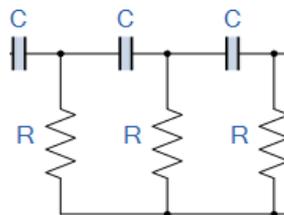

Fig. 1 RC- phase shift network

if all the resistors, R and the capacitors, C in the phase shift network are equal in value, then the frequency of oscillations produced by the RC oscillator expresses in equation (1).

$$f_r = \frac{1}{2\pi\sqrt{2N}Rc} \qquad (1)$$

Where fr is the Output Frequency in Hertz, R is the Resistance in Ohms, C is the Capacitance in Farads and N is the number of RC stages. (N = 3)

Since the resistor-capacitor combination in the RC Oscillator circuit also acts as an attenuator producing a total attenuation of -1/29th ($Vo/Vi = \beta$) across the three stages, the voltage gain of the amplifier must be sufficiently high enough to overcome these RC losses. Therefore, in our three stage RC network above, the amplifier gain must be equal too, or greater than, 29.

IV. CIRCUIT VALUES CALCULATIONS

The repellent system designed with the idea of RC-oscillator using OP-Amp that comprises of Resistors, capacitors and Op amp having vast operations of op amp we have decided LM741 for generating approx. 10khz as a bird repellent system and AD712 for other phases of frequency required to repel the different Rodents.

Table (1). Repellent Frequency Range of All Possible Rodents

S#.	List of Pests/ Rodents/ Insects.	Repellent Frequency Range	
1.	Birds/Pigeon/Crow/Columbidae/ Asian Koel.	8 KHz to 10 KHz	[7]
2.	Mice/Rats/Squirrel and Other Insects	25 KHz to 30 KHz	[10]
3.	Roaches/Blackflies/Mosquitos/ Ants/Louse/ Etc.	30 KHz to 40 KHz	[12]
4.	Fleas/Cricket/Spiders/Bats/ Locusts Etc.	40 KHz to 65 KHz	[13]

Circuit 1: (Bird Repellent System): Repellent frequency for PIGEON is about 10khz so, by entitling that frequency in the formula expressed in equation Number (1) We can calculate the value of R and other respected values for circuit that to be simulated using Electronics Simulation Software Multisim.

$$R = \frac{1}{2\pi\sqrt{2N}fC} \qquad (2)$$

Where R   is the Resistance in Ohms, f is the Output 10,000 Hertz, C   is the C 1*10e-9 Farads and N is the number of RC stages. (N = 3). Therefore, the required value of R will be as:

$$R = 6.8 \ K'\Omega$$

The operational amplifiers gain must be equal to 29 in order to sustain oscillations. The resistive value of the oscillation resistors is 10kΩ, therefore the value of the op-amps feedback resistor Rf is calculated as:

$$Av = \frac{Rf}{R} = 29 \qquad (3)$$

$$R_f = Av \times R$$

$$R_f = 29 \times 6.8$$

Therefore, Rf for the Pigeon Repellent Circuit Will be:

$$R_f = 197K\Omega$$

Similarly, the values of all order rodent Repellent circuits are:

Table (2). Values of Resistors and Rf for all other rodents to build up the circuit

S#.	Repellent Frequency Ranges	$R = \frac{1}{2\pi\sqrt{2N}fc}$	$Av = \frac{Rf}{R} = 29$
2nd circuit RAT Repellent System	25 KHz to 30 KHz	R= 27kΩ	Rf = 750.2kΩ
3rd circuit MOSQUITOS Repellent System	30 KHz to 40 KHz	R= 18.5kΩ	Rf = 536kΩ
4th circuit LOCUSTUS Repellent System	40 KHz to 65 KHz	R= 13kΩ	Rf = 377kΩ

V. CIRCUITS DESIGNING

The circuits for all rodent's Repellent system has been designed using Electronic simulation Software named as Multisim. Here the designs include an IC 741 that has been operated through 5volt dual power supply that generates frequency around 10 KHz, that force the birds to leave the area.
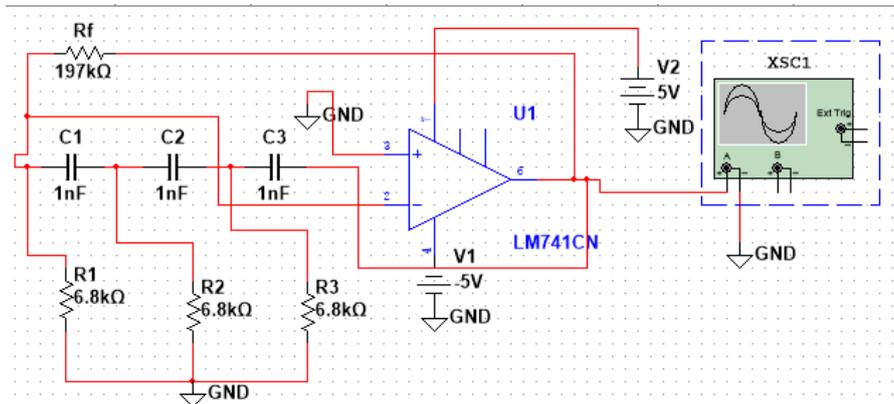
Fig 2(a). The circuit Design of Pigeons/ Birds Repellent System Using Multisim

2nd circuit is constructed using the IC 712, operated at the same power of 5volt dual power supply, that generates 25 KHz frequency to eradicate rodents spreading diseases around the environment. Generated frequency range is ultrasonic that allows to repel the rats causing damages to electric wires in the offices, restaurants etc.
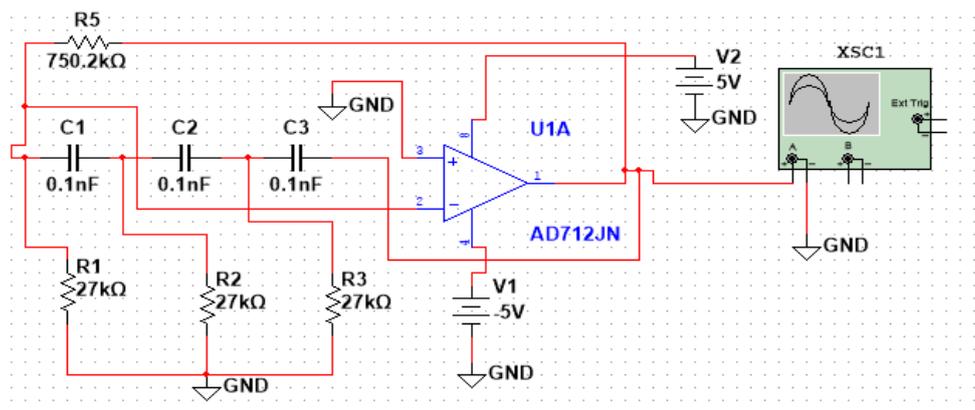
Fig 2(b). The circuit Design of MICE/ RATS/ SQUIRREL AND OTHER INSECTS Repellent System

3rd circuit is designed to curbe the mosquitos to spread deseases such as dengue fever, malaria etc. the designed circuit consists of op-amp ic 712 having a power sipply of 5volt.
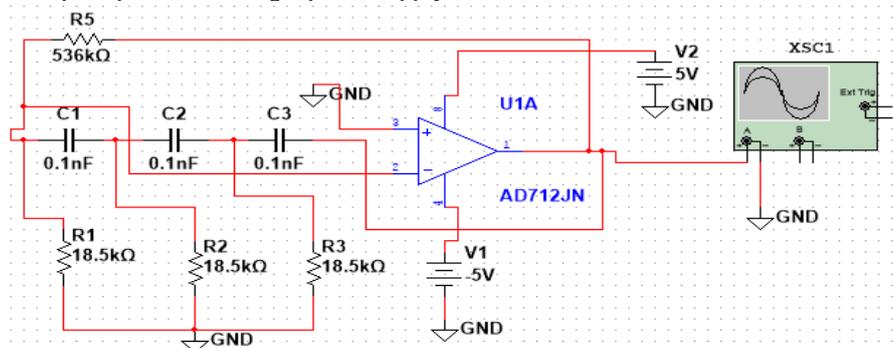
Fig 2(c). The Circuit Design of ROACHES/ BLACKFLIES/ MOUSQUITOS/ ANTS/ LOCUSTS ETC

Repellent System

4th design reduces the losses to farmers caused by locustus through damaging crops in the agriculture field. The circuit used to repell the locusts by generating a 50 KHz of freqeuncy. Circuit constructed using IC 712 with supply of 5volt dual power supply.
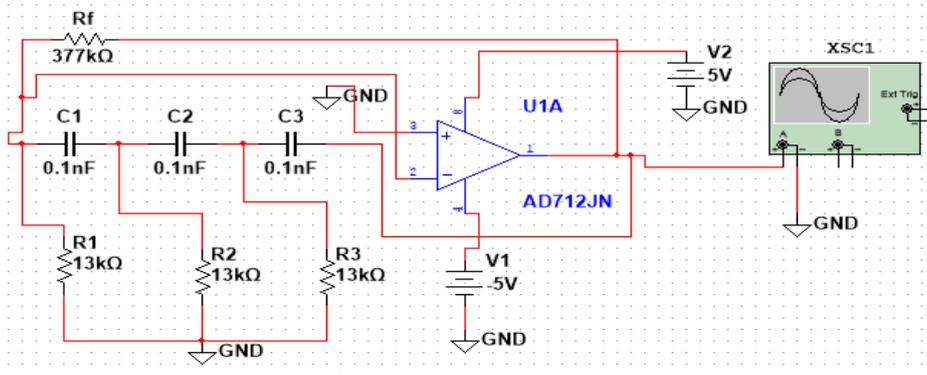

Fig 2 (d). The circuit design of FLEAS/ CRICKET/ SPIDERS/ BATS/ LOCUSTS ETC Repellent System

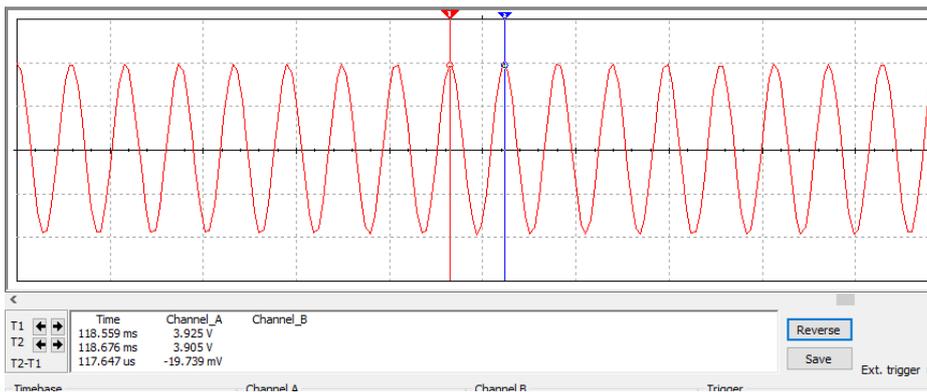**VI. SIMULATION AND RESULTS**

Circuit 1: PIGEON/BIRD Repellent system

Fig 3 (a). Simulation results of PIGEON repellent system

The generated frequency has successfully repelled the birds, at the output the speaker of 4ohm attached that forced the PIGEON to leave the Area in order to secure the environment disease free.
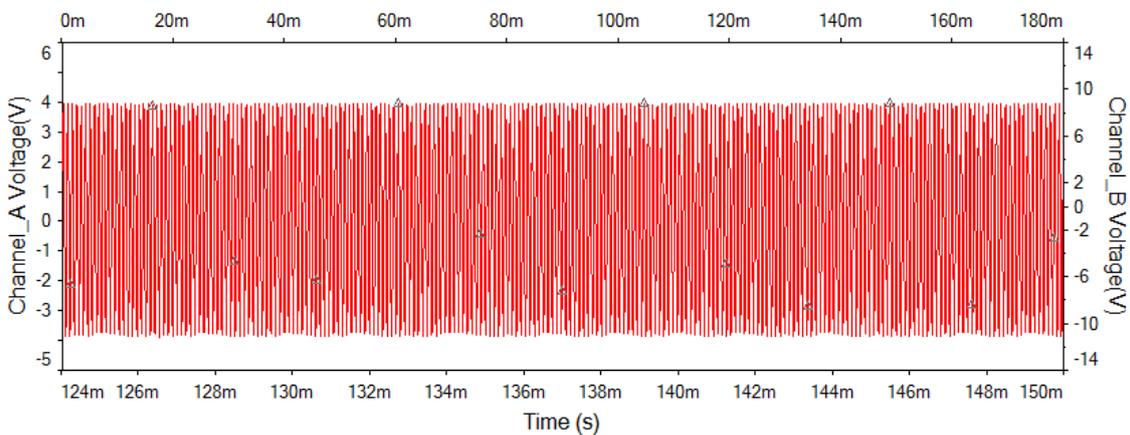
Fig 3 (b). Output Waveform for 10khz (Pigeon Repellent System)

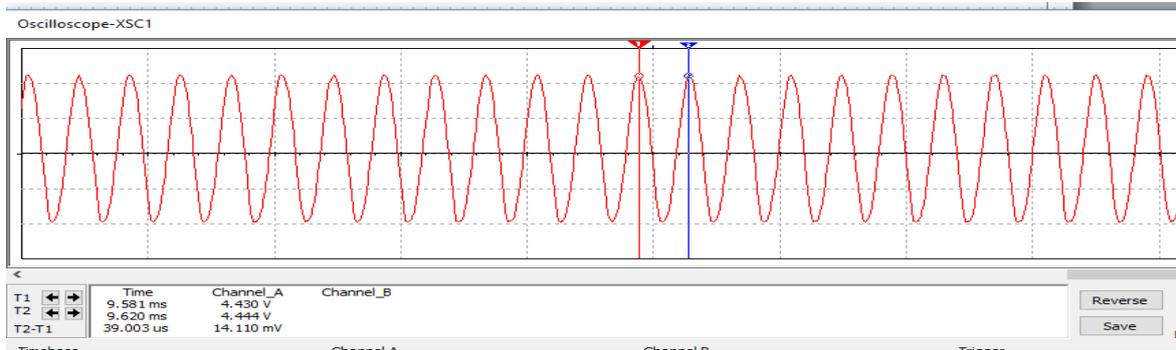**2nd circuit RATS Repellent system:**

Fig 4 (a). Simulation Result of MICE/RATS/SQUIRREL AND OTHER INSECTS Repellent System

The generated frequency about 25khz has successfully repelled the MICE/RATS/SQUIRREL Etc. at the output the speaker of 4ohm attached that forced the Rodents to leave the Area in order to secure the environment disease free.
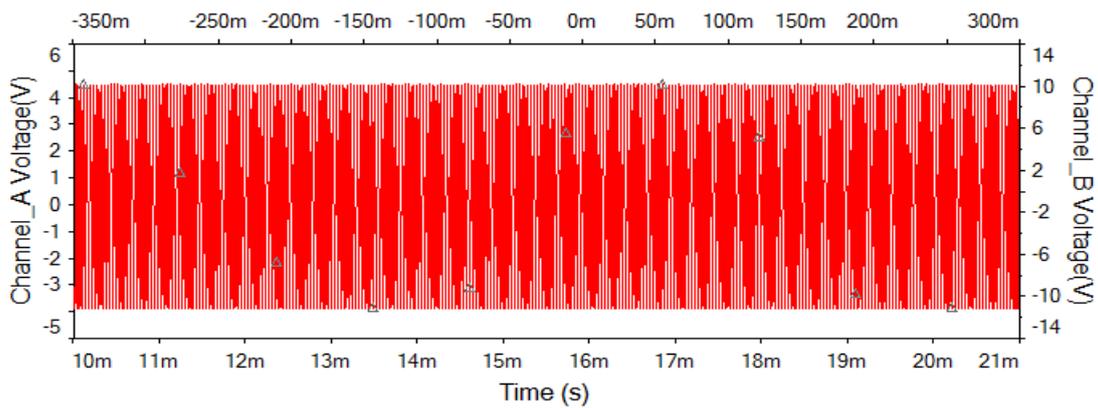

Fig 4 (b). Output Waveform for 25khz (RATS) Repellent System

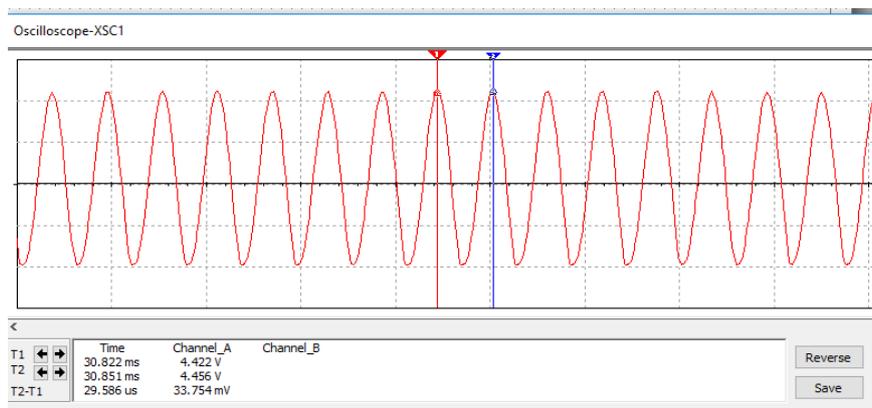**3rd circuit (MOSQUITOS Repellent System):**

Fig 5 (a) Simulation Result of ROACHES/BLACKFLIES/MOUSQUITOS/ANTS/LOUSE/ ETC Repellent System

The generated frequency about 35khz has successfully repelled the ROACHES /BLACKFLIES/ MOUSQUITOS/ ANTS /LOUSE / ETC. at the output the speaker of 4ohm attached that forced the Rodents to leave the Area in order to secure the environment disease free.
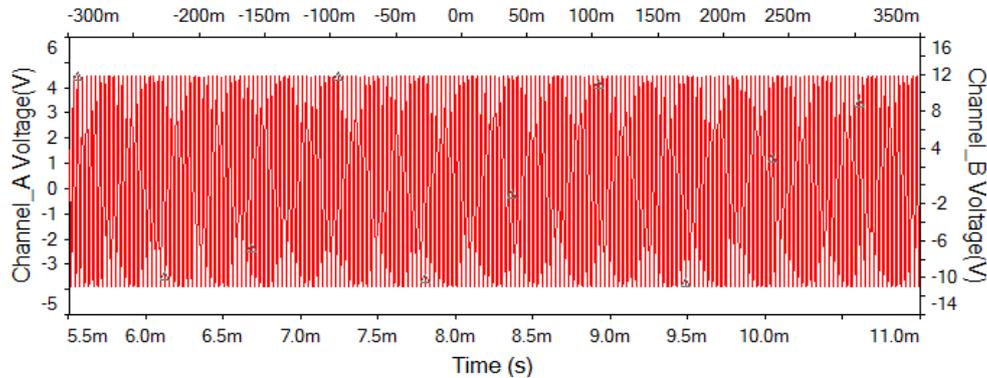

Fig 5 (b). Output Waveform for 35Khz (MOSQUITOS Repellent System)
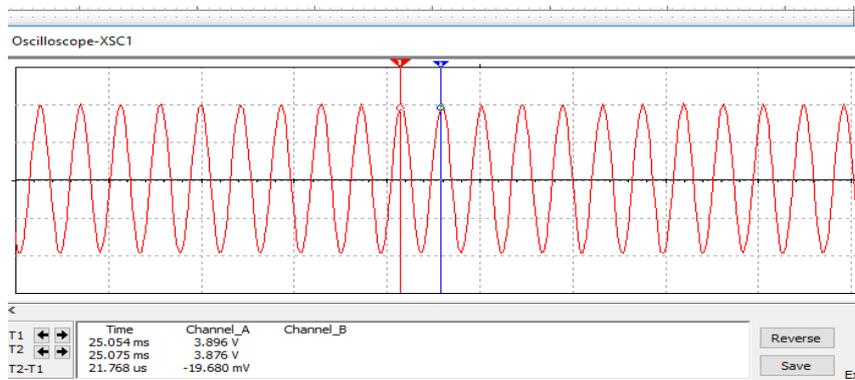
4th circuit (LOCUSTS Repellent System):

Fig 6 (a). Simulation Result of FLEAS/CRICKET/SPIDERS/BATS/LOCUSTS Etc. Repellent System

The generated frequency about 50khz has successfully repelled the FLEAS/ CRICKET /SPIDERS /BATS/ LOCUSTS Etc. at the output the speaker of 4ohm attached that forced the Rodents to leave the Area in order to secure the environment disease free.
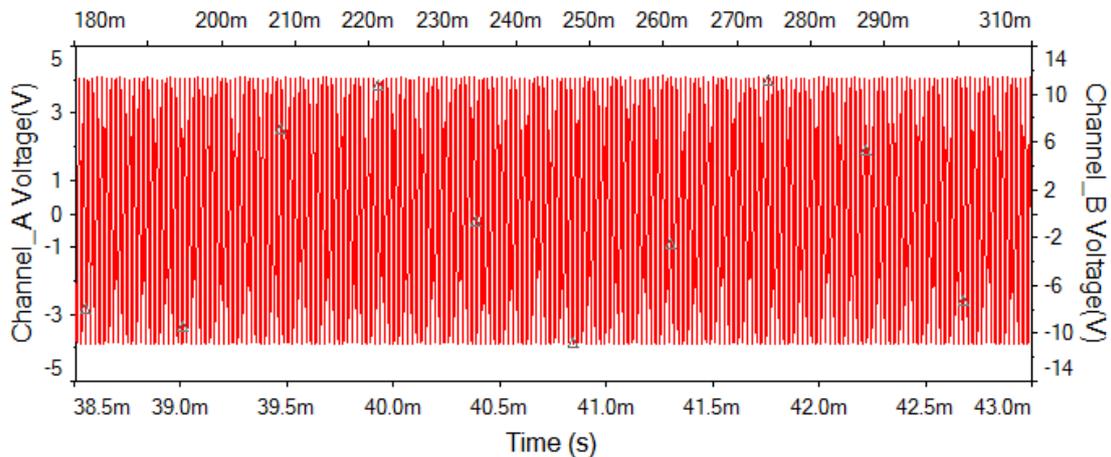

Fig 6 (b). Output Waveform for 50Khz (LOCUSTUS Repellent System)

VII. CONCLUSION AND FUTURE WORK

In this paper, the concept of rodent's repellent system is discussed, designing of circuits and implementation of system in different areas according to the occurrence of pest's types. As the farmers feed the world, it is necessary to increase the crop production to very high level by repelling the Locusts and while ensuring methods which are toxic free as to maintain the quality of food at warehouses the device is to be implemented in order to insure the poison free material. The rats and mosquitos must be eradicated within premises of offices, restaurants, hospitals etc. so that the environment should be pests free. These devices must be promoted publicly as it is mostly for the safety purpose of human beings and toxic free as compare to the fumigation, but its publicity is bounded within the journals and internet that does not command large viewership and usage by public. The device is cost effective as the equipment's used in designing of circuits are easily available in market as the device is Eco-friendly nonpoisonous so, it can be used at offices, storage houses, hospitals etc. The focus of further research and development is varying the capacity of speakers from one to many in order to cover up the large area through implementing few modifications in the circuits.

REFRENCES

[1] Syahrel Emran Bin Siraj, Tan Yong Sing, Raman Raguraman, Pratap Nair Marimuthu, K. Nithiyananthan, (2016) "Application of Cluster Analysis and Association Analysis Model Based Power System Fault Identification", European Journal of Scientific Research, Europe, Vol No 138, No 1.50-55.

[2] S. SamsonRaja, R. Sundar, A.Amutha, K. Nithiyananthan, (2016) 'Virtual State Estimation calculator model for Three Phase Power System Network', Journal of Energy and Power Engineering, vol. 10, no. 8, pp. 497–503, USA

[3] Umasankar, Nithiyananthan.K (2016)'Environment Friendly Voltage Up-gradation Model For Urban Electrical Distribution Power Systems', International Journal of Electrical and Computer Engineering, Asia, Vol No 6, No 6.

[4] Schumake, Stephen A., G. Keith LaVoie, and Kenneth Crane. "Efficacy Test Protocols for Evaluation of Ultrasonic Rodent Repellent Devices." In Proc 11th vertebrate Pest Conference, California, USA, Paper No 37,1984

[5] Heffner H, Masterton B. 1980. Hearing in glires: domestic rabbit, cotton rat, feral house mouse, and kangaroo rat. J Acoust Soc Am 68:1584–1599

[6] Basit MT, Pervez K, Avais M and Rabbani I (2006). Prevalence and chemotherapy of nematodes infestation in wild and domestic pigeons and its effects on various blood components. Journal of Animal and Plant Science 16: 24-27.

[7] Asaduzzaman M, Mahiuddin M, Howlider MAR, Hossain MM and Yeasmin T (2012). Pigeon farming in Gouripur Upazilla of Mymensingh District. Bangladesh Journal of Animal Science 38: 142-150

[8] Z. wang, H. Hou, s. chen, T. Zheng, S. Ding, "Study on Intelligent Repelling Birds Technology at Substations ', Telecom power Technology, 2015.32(04,), pp.187-188+233

[9] Li, W., Wei, W., Zhu, S., Zhu, J., Shi, Y., Lin, T., Hao, E., Hayek, A., Deng, H. and Ding, S. (2009). Generation of rat and human induced pluripotent stem cells by combining genetic reprogramming and chemical inhibitors. Cell Stem Cell 4, 16–19

[10] Portfors CV (2007) Types and functions of ultrasonic vocalizations in laboratory rats and mice. J Am Assoc Lab Anim Sci 46: 28–34.

[11] Stephen A. Shumake, Ray T. Sterner,Stainley E. Gaddis. Repellents to reduce cable gnawing by north pocket gophers. The Journal of Wildlife
Management, Vol.63 No.4, (Oct.,1999), pp.1344-1349.

[12] Cheruiyot, Emmanuel K. "Design and test of an electronic mosquito repellent." Project report, School of Science and Engineering and Technology,Kabarak University, Kenya,2010.

[13] Abou-Ali, H., and Belhaj, M. (2008). Cost benefit analysis of desert locusts' control: a multicountry perspective, in Economic Research Forum Working Papers. (Giza)

[14] 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 SwedenISBN 91-72 to 748-2.Http//www.oscillator design.com (retrieved 20/8/2012).

[15] Ibrahim A.G., Oleum, O.D., Awojoyogbe, O.B., Okeke, "Electronic Pest Control Devices: A Review of their Necessity, Controversies and a submission of Design Considerations" S.S.N. Department of Physics, Federal University of Technology, Minna, Nigeria. The International Journal of Engineering and Science (IJES), VOL.2 pp. 2319 – 1805, 2013

[16] Enayati A, Hemingway J, Garner, "Electronic mosquito repellents for preventing mosquito bites and malaria infection (Review)", The Cochrane Collaboration. Published by John Wiley & Sons, Ltd, 2010.