III SEMISTER B.TECH (E & C ENIGINEERING)

EC-280 MINI PROJECT

ENDSEM EVALUATION

REPORT

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ABSTRACT :

This mini project focuses on the design and implementation of an electronic device harnessing ultrasonic sound waves for insect repellency. With the escalating challenges posed by insect-borne diseases and agricultural pests, there is a growing need for sustainable and non-toxic pest control methods. Ultrasonic technology, with its potential to influence insect behavior, serves as the innovative foundation for our electronic insect repellent device.

The project involves the engineering of a compact and user-friendly device emitting ultrasonic waves at specific frequencies known to affect the sensory perception and communication mechanisms of common insect species. The device's effectiveness is evaluated through controlled laboratory experiments, considering variables such as frequency modulation, intensity levels, and exposure durations. Subsequent field trials assess the practical applicability of the electronic repellent device in real-world environments.

This mini project contributes to the advancement of electronic pest control technologies, offering a cost-effective and sustainable solution for individuals and small-scale agriculture. The insights gained from this research pave the way for further refinement of the device, emphasizing its potential impact on public health and agricultural practices. The project aligns with the broader goal of promoting environmentally conscious alternatives for insect management in electronic devices.

INTODUCTION OF MINI PROJECT:

This mini-project introduces an innovative insect repellent electronic device designed for environmentally conscious pest control. Unlike traditional chemical-based approaches, our device utilizes ultrasonic sound waves to disrupt the behaviors of common insect species. The project involves the creation of a compact, user-friendly device emitting specific frequencies known to interfere with vital insect functions such as mating, feeding, and navigation.

Through controlled laboratory studies and field trials, we assess the device's efficacy in diverse environments. Initial findings suggest promising results in deterring insects without the environmental and health concerns associated with conventional pesticides. Safety is a priority, with a thorough evaluation of non-target effects on beneficial insects to ensure ecological compatibility.

This research aligns with the global shift towards sustainable pest management, providing a safe and accessible alternative for both domestic and agricultural applications. The ultrasonic insect repellent device represents a significant stride towards eco-friendly pest control, offering an efficient, non-toxic, and user-friendly solution to address contemporary challenges in pest management.

OBJECTIVES:

1. Design and Fabrication: Develop a user-friendly electronic device emitting ultrasonic waves for insect repellency.

2. Frequency Optimization: Identify optimal ultrasonic frequencies to disrupt mating, feeding, and navigation of common insects.

3. Laboratory Evaluation: Conduct controlled experiments to assess the device's performance in influencing insect behavior.

4. Field Trials: Evaluate the device's practicality and efficacy in diverse, real-world environments.

5. Efficacy Assessment: Quantify the repellent effectiveness by measuring changes in insect activity and behaviors.

6. Safety Evaluation: Investigate non-target effects to ensure ecological compatibility and minimize unintended impacts.

7. User-Friendly Design: Ensure the device is easy to install, maintain, and suitable for small-scale agricultural applications.

8. Cost-Effectiveness: Evaluate manufacturing and operational costs to determine economic feasibility.

9. Documentation and Dissemination: Thoroughly document the project and disseminate findings to contribute to sustainable pest management knowledge.

LITERATURE REVIEW: (Dileep Kumar Tiwari)

This research paper focuses on the development of an electronic insect repellent device, specifically addressing the design of a power amplifier for an ultrasonic transducer. The key innovation lies in utilizing high excitation voltage to enhance the device's signal-to-noise ratio. The study recommends incorporating a transformer for voltage step-up and impedance matching, facilitating the creation of a B class push-pull amplifier output. The strategic use of a high transformer step-up ratio enables the device to operate on low-voltage power supplies, allowing for the cost-effective integration of low-voltage MOSFETs.

Moreover, the research from the University of Nebraska Lincoln addresses the detrimental impact of insects on agriculture and the challenges posed by conventional pesticide use. The paper suggests an electronic solution using ultrasound as a pesticide-free alternative, minimizing environmental pollution. Experimental findings with rats demonstrate that continuous ultrasound exposure disrupts their activities, highlighting the potential effectiveness of such electronic devices in insect control. The authors emphasize the importance of understanding insect feeding mechanisms for devising effective electronic repellent strategies. In essence, this research explores innovative electronic approaches to mitigate insect-related challenges in agriculture while prioritizing environmental sustainability.

This research aims to develop a variable frequency ultrasonic pest repeller with automatic stepwise adjustments between 25 kHz to 65 kHz. The device utilizes high-frequency pulsed acoustic and electromagnetic waves to target pests' nervous systems, causing discomfort and behavioral changes. Unlike conventional repellers, it directly impacts the pest's brain, leading to their repulsion from the treated area. This unique design feature sets it apart as it functions with multifrequency modulated sounds.

METHODOLOGY:

1. Requirement Analysis: Identify specific requirements for the device, considering targeted insects, environmental conditions, and user preferences.

2.System Design: Design electronic circuitry incorporating an ultrasonic transducer, variable frequency generator, and power amplifier for energy-efficient functionality.

3. Prototype Development: Build a prototype based on design specifications, testing individual components and ensuring overall functionality.

4. Frequency Optimization: Experiment with various ultrasonic frequencies in controlled environments to determine the most effective range for repelling insects.

5. Field Testing: Conduct real-world field trials to assess the device's practical efficacy against common pests and gather user feedback.

6. Safety Assessment: Evaluate the device's safety, considering its impact on non-target organisms, humans, and the environment.

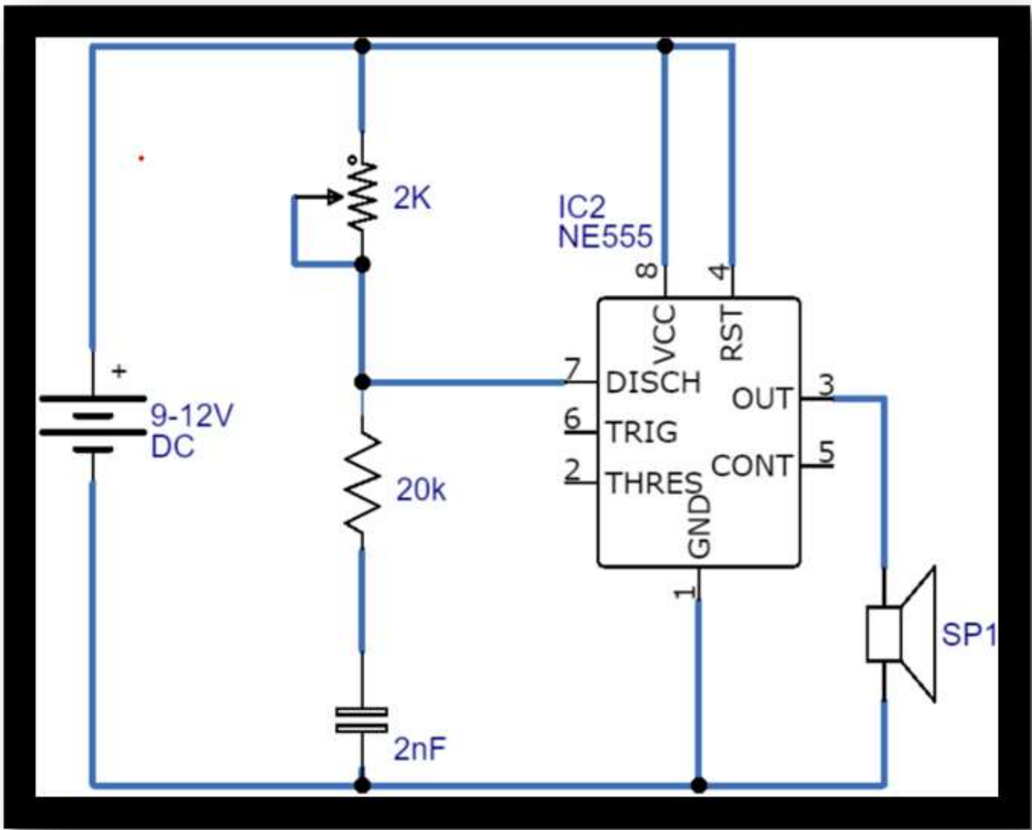
7. User-Friendly Design: Incorporate features for easy installation, maintenance, and adjustable settings based on user feedback.

8. Documentation and Reporting: Document the entire process, including design choices, experimental results, and modifications, preparing a comprehensive report for dissemination.

HARDWARE COMPONENTS REQUIRED:

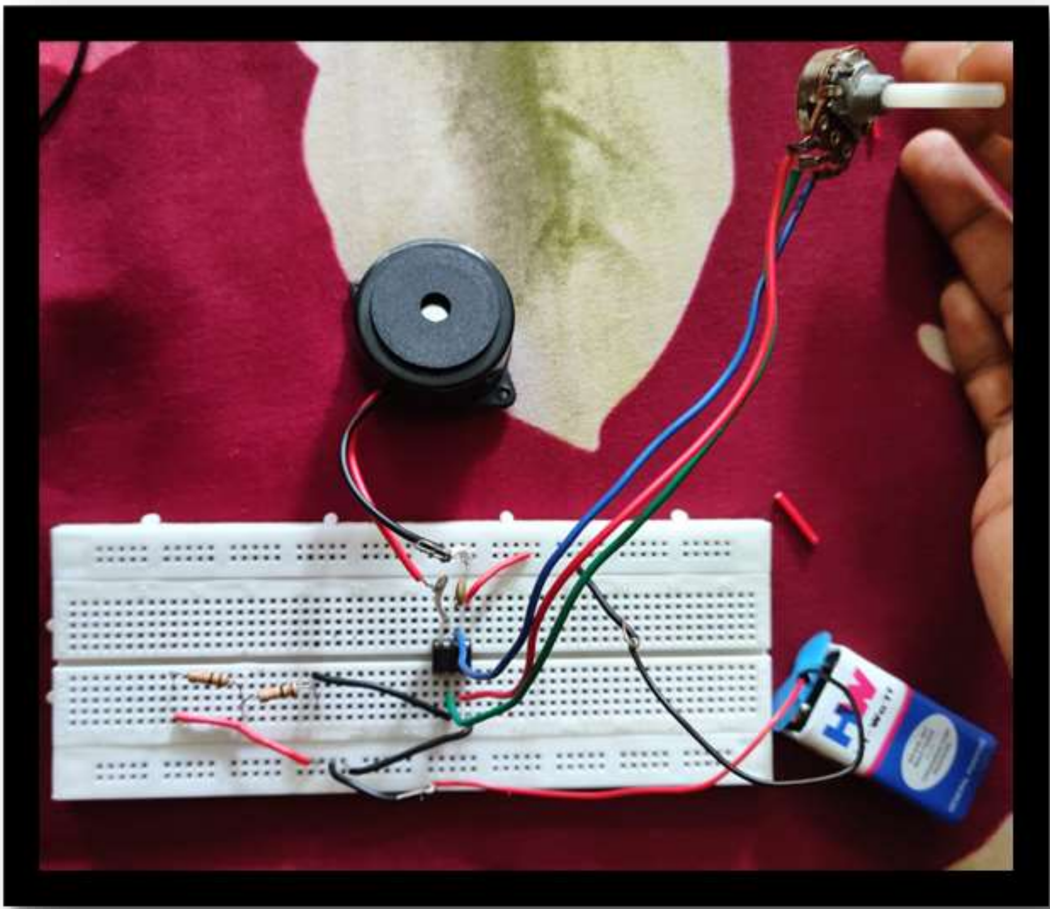
S.no	components	value	Quantity
1.	IC	NE555 Timer	1
2.	variable resistor	120K	1
3.	Speaker Sp1(piezo)	-------	1
4.	capacitor	2nF	1
5.	Battery	9-12V	1
6.	resistor	20K	1

CIRCUIT DIAGRAM:



This circuit employs a straightforward method to create an adjustable sound generator using the widely renowned 555 IC, known for its versatility in the realm of electronics. Operating as an astable multivibrator, the 555 IC facilitates oscillation frequencies ranging from 670 to 680Hz. The circuit utilizes the astable mode, causing the IC to continually alternate between its two unstable states. Given the simplicity and flexibility of the 555 IC, this circuit design provides an effective and widely applicable solution for generating adjustable sound frequencies, making it suitable for various electronic applications.

WORKING IN HARDWARE:



The simplicity of the circuit design, coupled with its minimal components, makes it easily constructible. Operating on a 9-12V DC supply, the circuit functions in the astable mode, providing versatility in frequency generation. A 100K variable resistor allows for convenient adjustment of the desired frequency, varying as the resistance changes. The circuit accommodates different applications based on adjustable frequency requirements. A piezo or tweeter, designated as SP1, serves as the speaker for this circuit. It's noteworthy that the output sound waves fall beyond the audible range, rendering them inaudible to the human ear. This feature adds to the circuit's utility in applications where silent frequency generation is desirable.

OBSERVATIONS AND CALCULATIONS:

The frequency generated through Pulse Width Modulation (PWM) can be calculated by,

$$F = \frac{20Mhz}{4 \times X \times Y}$$

X=Pulse
Y=Range Finder
20Mhz=Crystal Oscillator

From the above circuit we can get the calculations as per,

When a 555 timer is operating in **Astable mode** we obtain a pulse on the output pin whose ON time (Time high) and OFF time (Time low) can be controlled. This controlling can be done by selecting the appropriate values for the Resistor R1,R2 and capacitor C1. The circuit diagram to operate the 555 IC in Astable mode is shown be

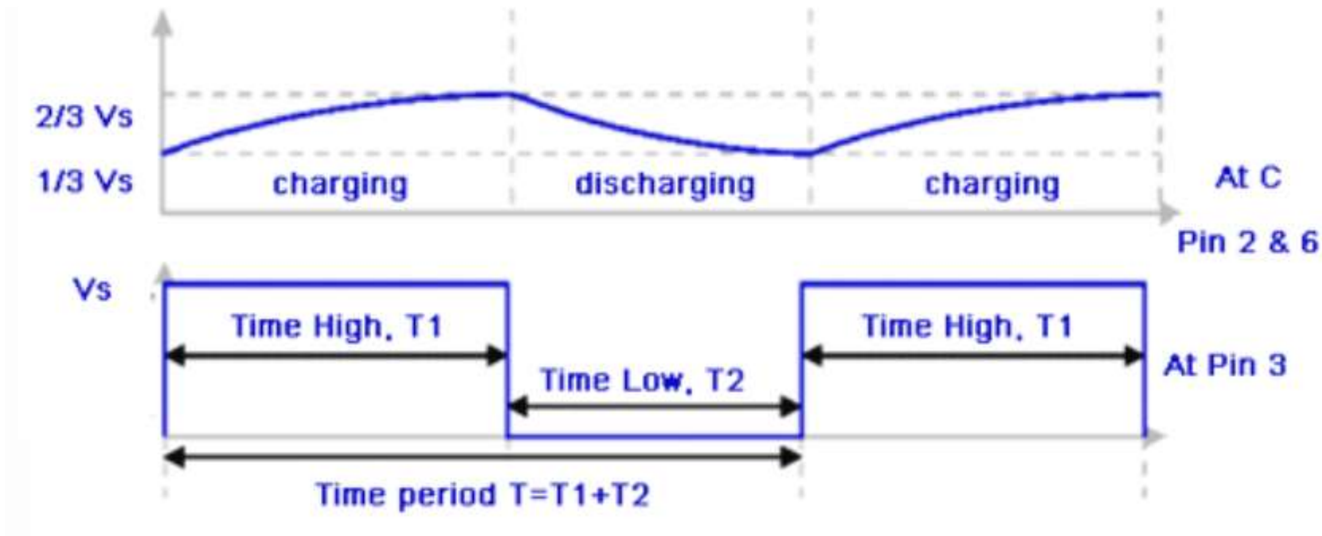
Inputs

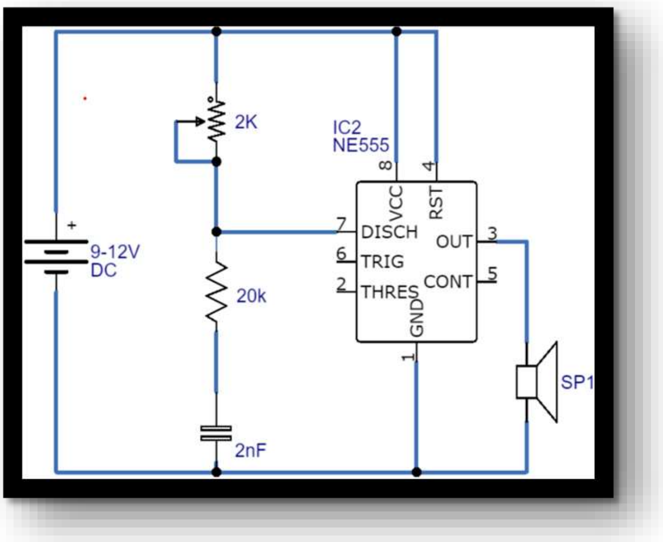
Capacitor (C)	2	nanoFarad (nf)
Resistance 1 (R_1)	20	Kilo Ohm
Resistance 2 (R_2)	120	Kilo Ohm

Outputs

Frequency :	2.775	KiloHertz
Period (T):	360.360	MicroSeconds
Duty Cycle:	53.846	%
Time High (T_1):	194.040	MicroSeconds
Time Low (T_2):	166.320	MicroSeconds

The above circuit can be used to produce a square wave in which the high time (T1) and low time (T2) can be calculated. This method can be used to generate clock pulses for Microcontrollers/Digital IC's or blink an LED or any other applications where specific time intervals are needed. The output wave obtained from pin 3 is shown with markings below





The time axis T is measured in seconds and the Voltage axis is measured in Volts. As said earlier how long the pulse stays high, how long the pulse stays low and the frequency of the pulse can be calculated using the value of components R1,R2 and C1 shown on the circuit diagram above.

The above **555 timer Astable Multivibrator** can be used to calculate these values, but to understand its working we need to know the following formulas..

MODEL CALCULATION:

In our circuit diagram the value of Resistors R1 and R2 is 20K and 100K respectively, the value of capacitor C1 is 2nF.

So, **R1 = 20K; R2 = 100K and 2nF**

The Time high (T1) is the amount of time during which the pulse stays high (5V) in the output wave. This can be calculated as

Time high (T1) = 0.693 × (R1+R2) × C1

= 0.693 × (20000 +100000) × 0.000000002

= 0.194040 seconds

T1 = 194.040 milliseconds

The Time low (T2) is the amount of time during which the pulse stays low(0v) in the output wave. It can be calculated as

Time low (T2) = 0.693 × R2 × C1

= 0.693 × 100000 × 0.000000002

= 0.166320 seconds

T2 = 166.320 milliseconds

The time Period (T) is the sum of Time low and Time high. Changing wither Time high or time low will affect the Total time period T

Time Period (T) = 0.693 × (R1+2×R2) × C1 or (T1+T2)

= 0.693 × (20000 +2×100000) × 0.000000002

T = 1.52460 seconds

As we all know frequency is just the inverse of time. There are certain applications like a servo motor control where the pulse has to be in a certain frequency for the driver circuit to respond. The frequency can be calculated as

Frequency (F) = 1.44 / (R1+2×R2) × C1 or (1/T)

= 1.44 / (20000 +2×100000) × 0.000000002

F = 2.775 Hertz

Duty Cycle is always given in terms of percentage, if high time is equal to low time then the pulse has 50% duty cycle and if the off time is zero then it has 100% duty cycle. We can calculate the duty cycle as.

Duty Cycle = (T1/T) × 100

= (194.040 /1.52460) × 100

DC = 53.846%

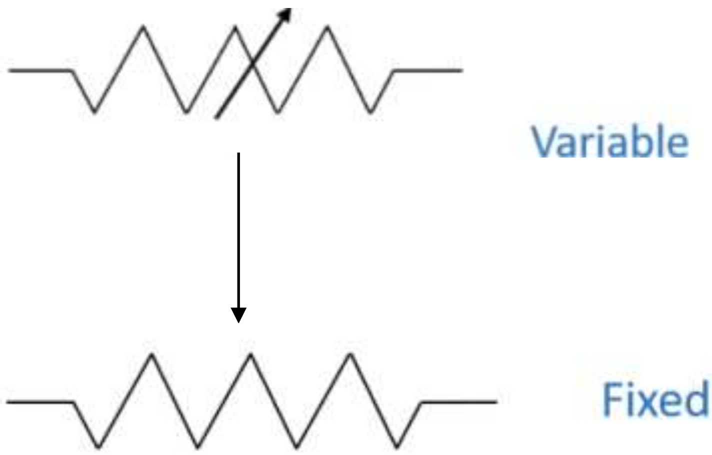
RESULTS & DISCUSSION ON CHANGE IN COMPONENT:

From the Above circuit we can observe there is 120K variable resistor(potentiometer) is placed. Instead of that we can a placed a fixed resistance of 2K,

Then the frequency we obtain will be,

$$\text{Frequency } (F) = 1.44 / (R1+2\times R2) \times C1$$
$$= 1.44 / (20000 + 2\times 100000) \times 0.000000002$$

F = 2.775 Hertz



As it was earlier calculated that that snakes should not come inside 5 meters arc of the device in order to consider it working. During, the first hour period the frequency was not changed, and no snake entered the 5 meters arc of the device. After one hour the frequency of the device was changed to see if the change of the frequency makes the snakes enter the arc comfortably. Thus, the frequency of a grasshopper was set. After few minutes two snakes comfortably entered the arc. As soon as the snakes entered the region the frequency was again set to the frequency of the snakes and it was noticed that the snake again went away from the device arc. Thus, the conclusion was made that the device is completely working properly and the frequencies entered are correct and effective.

FUTURE SCOPE:

- The current device is powered by a battery of 12V. Thus the charging of the battery is required from time to time. To avoid this, the device can also be powered by using solar cells.

- As the device contains electronic components it needs to be protected from water. The material to be used for protection must not cause much interference to the sound waves.

- Use of a piezoelectric transducer can be done to power the device. A piezoelectric transducer is a device that uses the piezoelectric effect to measure changes in acceleration, pressure, strain, temperature, or force by converting this energy into an electrical charge. The above-mentioned methods are cost-effective.

CONCLUSION :

The implementation of the Bluetooth module gives the device capability to repel insects from a wide range. Using this device is an effective way to stop the usage of chemical pesticides with hazardous to the environment.

The device is capable of repelling a variety of pests by using multiple frequencies. The device can be used to keep the snakes out of a particular area as well as to stop the snakes from escaping from a particular area. This is the first device that is made using ultrasonic waves to keep pests, snakes, and other deadly animals like scorpions away. The main device controls all the other devices connected to it using the Bluetooth module, any changes made on the main device automatically make changes on the slave devices as well. Also due to the GSM module the user need not have to go to each device to make changes. All the instructions will be given to the device via SMS. Thus, this device is an effective way to stop the use of chemical pesticides as well as for the protection from animals like snakes and scorpions and also to avoid the snakes getting escaped from the zoos.

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