

# Evanesco-An Ultrasonic Repeller using UAV

Raghunandan G H<sup>1</sup>, Ninaada M S<sup>2</sup>, Keerthana R<sup>3</sup>

<sup>1,2,3</sup>Department of Electronics and Telecommunication Engineering,  
<sup>1,2,3</sup>BMS Institute of Technology and Management, Bengaluru, India.

**Abstract** - Ultrasonic Repeller has an up growing demand in today's world. The main function of this Repeller is to dispel the unwanted creatures in the environment. This ultrasonic Repeller is mounted on UAV. The main component used is 555 timers. Using a simple circuit and required basic components, we can tune the 555 timers to produce the desired frequency. Since this Repeller produces multiple frequencies, it is difficult for the species to adjust to this disturbing ultrasonic sound. The directionality of the ultrasonic sound is maintained. This prototype consists of transmitter and a piezoelectric transducer. It has emerged has a boon for farmers to use in agricultural fields. It can be used an alternative to scarecrows. Since animals and bird's species are detrimental, causing nuisance repellents come to need. In this paper, we propose method to address these factors. This UAV based Repeller will be emerging more efficient than existing one.

**Keywords:** Piezo electric transducers, autonomous UAV, acoustic ultrasound, power amplifiers.

## I. INTRODUCTION

A man with nature is precious. As a matter of advancement research is all along continues. We intend to take a piece of task to uphold for the purpose of both wellbeing. India stands second largest in the world after the United States for having 159.7 million hectares of arable land. Farmers depend on agriculture for their profit in farm areas like banana, jackfruit, coconut, sugarcane etc. Unfortunately, they are destroyed mainly by monkeys and other species which causes huge losses to the them. It is estimated that around 30 to 40% of crops are destroyed annually due to attacks by wild animals in India. According to the research animals namely elephant, boars, deers are the most common perpetrators of the destruction. In some districts of Odisha and Kerala, 60 percent of the crops are destroyed by elephants, claims for which are not payable by insurance companies. In Karnataka, farmers have lost many crops which account to 5 crores in 2010 because of monkeys. The state government forest department states that about 800 farmers have given up cultivation due to menace created mainly due to monkeys and other animals, bird's species in Karkalla district near Mangalore in 2012. Birds and animal repellents are of two types namely electromagnet and ultrasonic. In our project we are discussing only about ultrasonic's. Meaning of ultrasonic: Ultrasound is an acoustic sound having frequency more than 20 kHz or having frequency more

than the audible range of humans and requires a material medium for its propagation. This ultrasound can be exposed in environment in two different types namely-

- A. Airborne ultrasound.
- B. Liquid borne ultrasound.

**A. Airborne ultrasound:** The most adversely affected organ in airborne ultrasound is the ear. The consequences caused by this type of ultrasound includes fatigue, nausea, imbalance of blood sugar level, tinnitus, causes irritation, headache. Further there are wide applications in industrial field namely cleaning, emulsifying, welding and flaw detection etc.

**B. Liquid borne ultrasound:** This have vast application in research and medical field like diagnosis, dentistry, therapy and surgery. The biological background of the animal species is as follows. Humans cannot hear ultrasound because their eardrums cannot vibrate as fast as animals like dogs, pigs, bats, and other lower animals like rabbits, deer. Insects detect sound by sensilla which is located on antennae or genitalia. Some insects like grasshoppers, moths, butterflies detect sounds by tympanal organs. Kansas State University which researched ultrasound confirmed that ultrasound sound benefits by repelling the animal, bird, insects and causes reduction in reproduction and mating. In 2002, Genesis laboratory came up with documentary studies and lent an informative hand about how rodents react to ultrasound. Scientist Dr. Philip Whitford lab experiments proved that birds express severe distress in the presence of ultrasound frequencies. His studies showed reduced bird population in fields. Many birds like turkey, gills, pigeons find the ultrasound irritating and they get repelled. The reactance of birds, animals, insects depend on frequency, intensity of the ultrasound frequency. This prototype model is built in such way that, it is functioning with multi frequency modulated sound. The device produces frequency which changes very few seconds, with a frequency range of 20kHz to 50kHz. Due to this the animals and bird species are not adjusted to the acoustic sound environment. The acoustic sound radiations are highly concentrated to place. Neither this prototype kills the animal and bird species which are causing menace in agricultural fields nor causes disturbance or side effects to human beings as the audible range for human beings is 20hz to 20khz. These nerve-

crushing sounds directly penetrate into animals and birds brain and nervous systems causing discomfort, and make them feel uneasy and act abnormal, such as to become frantic jumping, stampeding and leads to voluntary repulsion against ultrasonic wave areas and making it impossible to stay in such high radiated areas. This paper explains about the prototype model in detail and even throws light on the importance of ultrasonic repellers. In section 2, a brief overview is explained about the existing system models, working principle and the drawbacks faced by the systems. As mentioned above the the proposed system and range of components is explained in section 3. In section 4, the framework is evaluated based on stimulation and implementation of components and their working principle. The future scope and demands are discussed in section 5, along with further upgradation and improvisation of the project.

## **II. EXISTING SYSTEMS**

With reference to the model [1], the ultrasonic device comprises of the power unit - Battery or AC power of 12-volt DC, and then the pulse generator unit which varied the emitted frequency continuously. The frequency which is  $\leq 150$  Hz is generated through 555 Timer IC and then sent 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) was used to amplify this frequency and for transmission to the free space speaker was used.

The accuracy and working of the device had few limitations due to climatic conditions. The distance travelled by ultrasound was found to be different on sunny, rainy, dull days. Climatic conditions played a vital role in rating the performance of the Repeller. The other physical conditions like temperature, humidity also affected the radiation of the ultrasound. The sound travelled fast in moist air when compared to dry air and in mornings due to lower temperature. The project work [2] explains that the ultrasound was detected by the area of 21mm to 37mm. The author used an astable multivibrator, 555 timer which generates frequency and it can be varied by steps of 5 using IC, counter, a D type flip flop. Amplification was done using npn and pnp transistors. Variable resistors of 100K value was used to control the frequency output. The device was tested on mouse. The device sound waves were active for 5 metres from the device and later got deactivated. And caused hearing impediment due to incorrect amplification. In this project [3] an electronic oscillator was used to produce frequency. The function of an electronic oscillator is to repetitively generate electrical signal of a specific frequency. This Electronic pest control device comprised of the oscillator, a small transistor amplifier and additional circuits like tripping circuits, sonic circuit, preamplifier, 555 timer, frequency selection circuit for varying frequency and other additional components making recent designs more

effective. Electronic pest control devices emitted ultrasound which goes beyond the threshold sound hearing capacity of targeted pests. During the testing it was observed that it was difficult to disperse feeding birds (difficult to break the chain). When ultrasound was broadcast over wide open spaces the sound lost their intensity rapidly with distance.

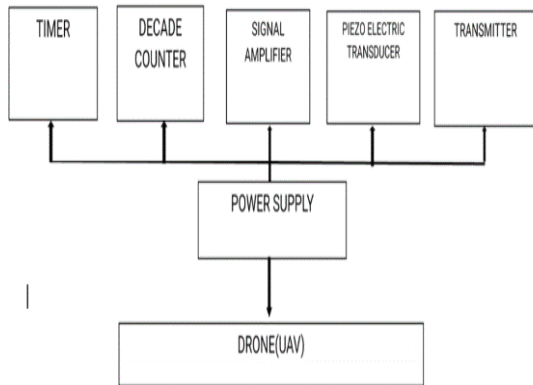
Author [4] used fluorescent lamp at night. These lamps were placed near trees, bushes and the lamp drew many insects towards it in the dark. Then the ultrasonic Repeller was activated and it repelled most of the insects. Some of the insect moved away at certain constant frequency but other species of insect didn't move as repelling frequency was found different for different species of arthropods. He found the accuracy of the device as 75%. Location of crops was required, which was an extra work and thereby the author concluded the ultrasonic range for detection is better than the location of crops if the device is kept it the boundary. This Author also talks about a circuit of an electronic pest repellent [5]. The device was effective over 16 meters from the Repeller. The device consisted of an equipment which produced fog, smokes along with the circuit which produced frequency of 35- 50 kHz. The circuit consisted of a decade counter (CD4017) which had ten outputs. From this output variable frequency was produced and each pin was high one after the other. 555 timers were used, and its output was fed as the clock signal input to decade counter, in order to produce desirable frequency. These smoke and fumes affected adversely human beings, animals, birds, insects. And making it a non eco friendly device and thereby got rejected due to its harmful property. It became too expensive to be inculcated in the day to day living of the farmers.

This prototype model [6] used a transducer for amplification. This transducer can produce 2.5W power and a frequency up to 80 kHz. A speaker of resistance 8ohm is used which is tested experimentally till it produces the required frequency, that is 100kHz. Atmega 16 is a low power AVR, 8-bit microcontroller which will produce varied patterns of frequencies as required in the experiment. LM 7805 is a 3 terminal voltage regulator which is connected in series. This has a wide range of applications as it is made with several diced output voltages. A 4x4 standard keypad is used which acts as an input to the Atmega 16. However, the frequency generated, and polling cannot be used at the same time as both are continuous processes. Sonic pest device [7] is a prototype which can be used in two ways. Firstly, it can be either inserted to an outlet. Secondly it can be plugged to a power-driven battery. This sonic device can vary the monotonous acoustic communication of the targeted pests. Alternatively, this can be achieved by creating confusion or fear in them. The sound that is produced by this device working under ultra or infrasonic range is not audible to humans

and hence will not drive away humans also, this achieving the basic motto of the prototype. Several studies and experiments have been performed by experts and researchers in entomology of Kansas state university on these commercially available devices. Out of them, 3 devices were tested and marketed for controlling pests. Unfortunately, none of the 3 devices were successful in repelling ants in the fields as well as in laboratory trial.

**III. PROPOSED SYSTEM**

The working of the ultrasonic repellent is given by the below block diagram. There are three stages frequency generation, amplification, transducer output.



**Fig 1-Overview of the circuit diagram**

**Frequency generator:** The frequency generation consists of two 555timer IC and decade counter. Refer figure 1. The timer produces time delays and oscillations. IC used in the framework is 8 pin model. 555timer can operate with voltage ranging between +5V to +18V. A voltage of 9V is given to the system model. The e timer is operating on astable mode. An astable multivibrator does not have any stable state, it keeps changing from low to high and high to low. Astable multivibrator does not require an external trigger circuit to change the state of output. The 555timer produces an output frequency of 50khz using resistors of value 4.5kohms and 18kohms respectively and capacitor of 680pF. This output from pin 3 of the 555 timer is fed to the decade counter. And frequency can be continuously varied in the range of 40khz to 50khz. The output from the 555timer is clocked as an input to decade counter. When the clock starts its count the logic 1 output of the counter advances from Q0- Q1 and so on till Q9. Ten resistors ranging from r4 to r1 is placed at the output of Q0 to Q9. The output from resistors is fed to the second IC 555 timer, as shown in the figure(implementation). The second timer also operates as an astable vibrator.

**Amplifier:** The output from the 555 timer IC is given to the two transistors through the resistor of value 1kohm in order to maintain the potential difference. The primary uses of transistor is to amplify signals. Refer figure1 and figure2. The transistors used are NPN and PNP. The transistors are of opposite type and thereby conduct for opposite cycles of the input from

the timer. The PNP and NPN transistors conduct for negative and positive half cycle respectively. Thereby both the transistors produce full wave output across the load. Thus, the weak input signal is amplified at output. The sound wave is amplified by this process.

**Transducer output:** Transducer is a device that converts one form of energy to other. The transducer made of quartz plate is influenced by piezoelectric effect due to the subjected electric field. Refer figure 1. The piezo effect causes the transducer to undergo alternate expansion and contractions at the electric field frequency. When the field frequency is made to coincide with the natural frequency of the crystal, it resonates producing sound waves. The intensity of the sound wave can be determined by the formula  $I = \frac{P}{4\pi r^2}$ , where P is the power of the sound wave and r is the distance travelled by the sound wave. The circuit arrangement consists of four piezo speakers placed at an angle of 90° to produce 360° coverage and the sound wave is dispersed evenly. The use of transducers ensures that the acoustic wave possesses directionality and not spread out during radiation and attenuation is avoided. The entire setup is placed on the drone. Since the drone is in complete motion and the circuit produces multiple frequencies the animals and birds do not become habitual to the acoustic environment. The animals, birds, insects get repelled automatically.

**Table 1: Upper limit frequencies of bird and animals**

Animal and Bird Species	Upper Limit Frequency in KHz
1. Dog	45-67
2. Cat	45-52
3. Sheep	30-100
4. Rabbit	42-67
5. Mouse	91-1000
6. Pig	50-54
7. Raccoon	40-100
8. Elephant	25-56
9. Turkey	6.6-25
10. Sparrow	11.5-32
11. Pigeon	4-26
12. Monkey	8-45

#### IV. IMPLEMENTATION

As discussed in the proposed system, various electronic components are implemented to produce the desired frequency. The components used are resistors, capacitors, decade counter, piezoelectric transducer and 555 timers.

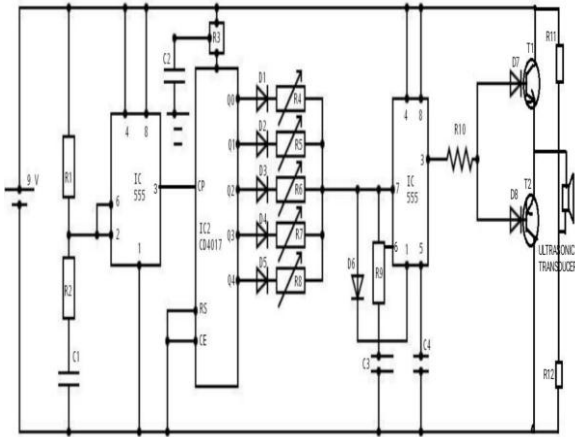


Fig 2- Circuit diagram



Fig 3-Evanesco Implemented model

A 555 timer is an integrated circuit which can be used as flip flop as it provides time delay. This astable multivibrator IC produces frequency when supplied with Vcc input of required voltage. The next major component used is decade counter. It is a circuit whose input signal is a clock signal and has a 4-bit binary output. The basic purpose of using decade counter is it will divide the given frequency. The repellent framework amplifier plays a very significant role. Its significance is explained as below. The power-driven amplifiers amplify the sound wave to larger extent and works for half cycle each. In other words, it increases the power of the signal. The frequency varies from 20 kHz to 100 kHz in an ultrasonic amplifier. A transistor can also be used as an amplifier by raising the strength of a weak signal. This can be achieved when transistors are in common emitter mode. Similarly, piezoelectric transducer is used to convert some charges, or parameters like

pressure, stress etc into electrical energy. The square wave produced by the timer IC is converted into an equivalent amplified electrical signal with the usage of piezoelectric transducers. Due to the production of such oscillations in a short span of time it may also produce ultrasound of frequencies up to 20MHz which can be used for various medical purposes. Figure 2 is an autonomous drone which includes a camera module and a GPS module. The autonomous drone is configured to move to a location and/or a direction based on a command received by the tracking module. They operated autonomously onboard computers. The technology that is involved in constructing an autonomous drone includes obstacle avoidance, UAV dynamics and control. Camera module is configured for providing images and a real time video stream to the base station and the GPS module is configured to send the location of the drone to the base station. The video recording and images obtained from UAV can be used for analyzing and monitoring the activity of animal species. The entire circuit is placed on the drone. The is in complete motion ensuring the animals, birds, insects are repelled due to the high frequency acoustic radiations.

#### V. CONCLUSION

The ultrasonic repellent framework has various applications as mentioned earlier. The novel solution to the exponentially growing problem of animal and bird species destroying the farm fields can be solved by this prototype model. The multiple oscillations producing multiple frequency with varied intensity which is implemented on an autonomous UAV which stands better than the existing systems. The application is further improved by using power amplifiers and thereby achieving the requirements. The computerized controlled drone alerts the user. There is a growing demand and scope for this gadget due to the up growing menace caused by animals and birds. The efficiency of this device can improve by constructing a UAV which can adapt to extreme weather conditions.

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