DESIGN A SMART INSECT REPELLER USING ULTRASONIC SENSOR

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ABSTRACT

Design a smart insect repeller circuit using ultrasonic sensor is a project that using an ultrasonic sensor as it's based on generate frequency which can repel insects in small places. It is design to be a low cost ultrasonic insect repeller. Human beings can't hear these high-frequency sounds. Unfortunately, all insects do not react at the same ultrasonic frequency. While some insects get repelled at 35 kHz, some others get repelled at 38 to 40 kHz. Thus to increase the effectiveness, frequency of ultrasonic oscillator has to be continuously varied between certain limits. By using this circuit design, frequency of emission of ultrasonic sound is continuously varied step-by-step automatically. For each clock pulse output from op-amp IC1 CA3130 (which is wired here as a low-frequency square wave oscillator), the logic 1 output of IC2 CD4017 (which is a well-known decade counter) shifts from Q0 to Q4. Five presets VR2 through VR6 (one each connected at Q0 to Q4 output pins) are set for different values and connected to pin 7 of IC3 (NE555) electronically. VR1 is used to change clock pulse rate. IC3 is wired as an astable multivibrator operating at a frequency of nearly 80 kHz. Its output is not symmetrical. IC4 is CD4013, a D-type flip-flop which delivers symmetrical 40kHz signals at its Q and Q outputs which are amplified in push-pull mode by transistors T1, T2, T3 and T4 to drive a low-cost, high-frequency piezo tweeter.

ABSTRAK

Merekabentuk litar penghalau serangga pintar adalah satu projek yang menggunakan sensor ultrasonik kerana ia berdasarkan kekerapan yang terjana yang boleh menghalau serangga di tempat-tempat yang kecil. Ia direka bentuk untuk menjadi penghalau serangga berkos rendah. Manusia tidak boleh mendengar bunyi frekuensi tinggi. Malangnya, semua serangga tidak bertindak balas pada frekuensi ultrasonik yang sama. Oleh itu, untuk meningkatkan keberkesanan, frekuensi pengayun ultrasonik akan terus berbeza di antara had tertentu. Dengan menggunakan reka bentuk litar ini, kekerapan pelepasan bunyi ultrasonik secara berterusan diubah langkah demi langkah secara automatik. Bagi setiap output denyutan jam dari op-amp IC1 CA313, logik 1 output IC2 CD4017 beralih dari Q0 Q4. Lima perintang boleh laras VR2 melalui VR6 (setiap satu yang disambungkan pada pin output Q0 - Q4) yang ditetapkan untuk nilai yang berbeza dan disambungkan kepada pin 7 IC3 (NE555) secara elektronik. VR1 digunakan untuk menukar kadar nadi jam. IC3 berwayar sebagai operasi getar astabil pada frekuensi hampir 80 kHz. Output yang tidak simetri. IC4 adalah CD4013, D-jenis flip-flop yang menyampaikan isyarat 40kHz simetri di Q dan Q output yang dikuatkan dalam mod tolak-tarik oleh transistor T1, T2, T3 dan T4 untuk menghasilkan frekuensi tinggi menerusi piezotweeter.

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CHAPTER 1

INTRODUCTION

1.1 Background

Human, animal or anything can produce sound. This sound is creating by the insect during their movement or anything. Insect can be defined as any of numerous small invertebrate (without a backbone) animals (as centipedes or spiders) that are more or less obviously segmented. Insects can be a nuisance to humans and, under certain conditions, can be a hazard to the health and lives of people. There are many approaches to controlling insects populations, including chemical pesticide control, insect-repelling plants and insect traps. Electronic pest control devices also provide a convenient means for controlling insects in or near your home.

- Ultrasonic Devices

Ultrasonic is a term for the audio frequency range that is too high--more than 20,000 hertz--to be perceived by the human ear, but it can be perceived by insects and animals. Devices that emit ultrasonic sounds have long been used as a way to control misbehaving dogs, repel deer and to discourage insect proliferation. The efficacy of these devices at repelling insects is doubtful at best. The Federal Trade

Commission and the American Mosquito Control Association have both warned consumers that scientific inquiries into the effectiveness of ultrasonic insect control devices have, at best, a temporary and fleeting effect on insect populations.

- Frequencies to Repel Insects

Gardeners and anyone who spends a lot of time outdoors in the spring and summer commonly fight insect on slaughts. Drawn by perspiration and scents, insects swarm during warmer weather. Sprays can stink, and long clothing isn't always a viable option, so some people seek to repel insects through machines that emit high frequencies. The idea is that the ultrasonic sounds bother insects and they will fly away from it. However, scientific studies repeatedly have questioned whether such devices are effective.

- Theory Behind Frequencies to Repel Insects

Machines that emit ultrasonic sounds produce noises so high-pitched that they are undetectable to the human ear. Proponents of machines claim that the devices do several things to repel insects. First, the machines mimic predators, which scare away insects. A mosquito, for example, may think a predatory dragonfly is nearby. Moths may believe a bat is swooping down to feed. Some products also claim that the sound mimics male mosquitoes, and that the biting females will flee, having already mated during the season. High-frequency sound machine manufacturers claim that the frequencies prompt insects to leave the area immediately without harming or inconveniencing humans in the process

1.2 Problem Statement

This project is more focus on mosquito and flies. There is a lot of disease cause by insects. For example:

i. Cockroaches can cause cholera while flies can cause typhoid fever which will be hazard to the health and lives of people.
ii. Many approaches to controlling insect populations, including chemical pesticide control, insect-repelling plants and insect traps does not efficient.
iii. Many advertisement in television and radio such as mosquito coil that use chemical to repel insects which will be hazard to environment.

1.3 Objective

. The objective of this project comprises of the following :

i. To design a circuit using ultrasonic sensors that repelled insects using its frequency hearing range.
ii. The design will be a low cost portable sound frequency detector.

1.4 Scope of Project

This project is widely use depending on situation and places. For this project it is design to meet the following scope.

i. Sound frequency will be detected within the coverage area about 21mm to 37mm.
ii. Condition of room is solid wall

1.5 Thesis Arrangement

To complete this thesis, I must completed 6 requirements which is Introduction, Literature Review, Hardware Design, Software Design, Result and Discussion and the last chapter is Conclusion and Further Development of the project.

Chapter 1 is about the introduction of the project. This chapter is more on basic idea of this project, objective and overall view about the project.

While in Chapter 2, it will discuss more on theory and literature reviews that have been done. Here, theory about the insects, ultrasonic and about insect repeller using ultrasonic sensors itself will explain details such as biological classification of mosquito and flies, classification of sound, types of the physic of ultrasound and the ultrasonic circuit.

Chapter 3 is about the design and methodology of this project. General concept of this project is the component that have been use in this project.

Chapter 4 is about the simulation of the circuit. This chapter will explain the concept idea of simulation.

While in Chapter 5 it will discuss about the analysis all the result and the limitation barrier in completing this project.

Chapter 6 consists of the conclusion and further development of this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In completing this project, some literature reviews have been done on several resources. The theory and description plus details about the project have taken as guidance in completing this project. By this chapter, an overview of some application that similar to the project and related project design is present.

2.2 Cockroaches

2.2.1 Introduction

Cockroaches are one of the oldest groups of insects, indicating how successful they have been in adapting to changes in their environments. One reason for this success may be related to diet--they are scavengers and will eat anything organic. They prefer food sources such as starches, sweets, grease and meat products, but other items may include cheese, beer, leather, glue, hair, starch in book bindings, flakes of dried skin or decaying organic matter (plant or animal). Cockroaches are attracted to warm, moist environments. They spend the daylight hours in dark, secluded sites under refrigerators, stoves, false bottoms in kitchen cabinets, in the backs of cabinets and in crevices between baseboards and floors or cabinets and walls. They may also be found behind pictures or within electronic equipment. A number of these openings will ultimately lead to voids in the stud walls. The insects leave these sites at night to forage for food and water. The presence of cockroaches during the day may indicate a large population. There are about 3,000 species of cockroaches in the world and about 50 occur in the United States. Of these 50 species, the three most common in the Northeast are the German cockroach, the American cockroach and the brownbanded cockroach. Cockroaches are insects of the order Blattaria or Blattodea, of which about 30 species out of 4,500 total are associated with human habitations. About four species are well known as pests. Among the best-known pest species are the American cockroach, *Periplaneta americana*, which is about 30 millimetres (1.2 in) long, the German cockroach, *Blattella germanica*, about 15 millimetres (0.59 in) long, the Asian cockroach, *Blattella asahinai*, also about 15 millimetres (0.59 in) in length, and the Oriental cockroach, *Blatta orientalis*, about 25 millimetres (0.98 in). Tropical cockroaches are often much bigger, and extinct cockroach relatives and 'roachoids' such as the

Carboniferous *Archimylacris* and the Permian *Apthoroblattina* were not as large as the biggest modern species.

2.2.2 Types of Cockroaches

- **German Cockroach :** *Blattella germanica* - The German cockroach is 12 to 17 mm (1/2 to 5/8 inch) long, tan to light brown, and has two dark brown stripes on the body region (pronotal shield) just behind the head. Females will produce four to eight egg capsules during their lifetime, with each capsule containing approximately 40 eggs. The egg capsule is retained by the female until the eggs are ready to hatch, usually in 28 to 30 days. German cockroaches are widespread and can be found in homes, restaurants, hospitals, nursing homes or apartments. Within these areas, the cockroaches prefer sites close to moisture and food, making them common pests in kitchens, bathrooms and food-storage areas. Of the cockroaches which infest structures, the German cockroach is probably found more frequently than other species.
- **American Cockroach :** *Periplaneta americana* - The American cockroach is one of the largest cockroaches in the Northeast. It is about 40 mm (1.5 inches) long with a reddish-brown body. The center portion of the pronotal shield is light brown, while the outer edges are yellow. Even though both sexes are winged, their flight is more of a gliding movement from point to point than active flight. The female American cockroach will not retain the egg capsule for more than a day after its formation, instead dropping the capsule in some suitable site. Under some conditions it may be glued to a surface. The number of capsules produced by a female will range from 6 to 14, with each capsule containing 14 to 16 eggs. The eggs hatch in 50 to 55 days. The American cockroach prefers dark, moist sites where it feeds on decaying organic matter. Such sites include basements, kitchens, clothes

hampers, drains, bathroom plumbing or sewers. High populations have been known to develop in sewers, from where they infest households or other structures.

- **Brownbanded Cockroach :** *Supella longipalpa* - The brownbanded cockroach is 12 mm (1/2 inch) long, light brown, and has two lighter colored bands running across the body. These bands are located at the base of the wings and on the abdomen. The bands are much darker during the immature stages. The brownbanded female carries the egg capsule for 24 to 48 hours before gluing it to a surface. The capsule contains approximately 18 eggs that hatch in 50-74 days. An adult female produces about 18 egg capsules over a life-span of 10 months. The brownbanded cockroach requires less moisture than other cockroaches. It is more prevalent in homes, apartments, hotels and hospital rooms than in restaurants or stores. Evidence of this cockroach may be found behind pictures, in furniture, the underside of chairs and tables, upper kitchen cabinets or the upper shelves of closets and pantries. The brownbanded cockroach often infests electrical appliances such as radios, televisions, telephones and computers.

2.2.2.1 Behaviour

Cockroaches live in a wide range of environments around the world. Pest species of cockroaches adapt readily to a variety of environments, but prefer warm conditions found within buildings. Many tropical species prefer even warmer environments and do not fare well in the average household. The spines on the legs were earlier considered to be sensory, but observations of their locomotion on sand and wire meshes have demonstrated that they help in locomotion on difficult terrain. The structures have been used as inspiration for robotic legs. Cockroaches leave

chemical trails in their feces as well as emitting airborne pheromones for swarming and mating. These chemical trails transmit bacteria on surfaces. Other cockroaches will follow these trails to discover sources of food and water, and also discover where other cockroaches are hiding. Thus, cockroaches can exhibit emergent behavior, in which group or swarm behavior emerges from a simple set of individual interactions. Daily rhythms may also be regulated by a complex set of hormonal controls of which only a small subset have been understood. In 2005, the role of one of these proteins, Pigment Dispersing Factor (PDF), was isolated and found to be a key mediator in the circadian rhythms of the cockroach. Research has shown that group-based decision-making is responsible for complex behavior such as resource allocation. In a study where 50 cockroaches were placed in a dish with three shelters with a capacity for 40 insects in each, the insects arranged themselves in two shelters with 25 insects in each, leaving the third shelter empty. When the capacity of the shelters was increased to more than 50 insects per shelter, all of the cockroaches arranged themselves in one shelter. Researchers found a balance between cooperation and competition exists in the group decision-making behavior found in cockroaches. The models used in this research can also explain the group dynamics of other insects and animals. Cockroaches are mainly nocturnal and will run away when exposed to light. A peculiar exception is the Asian cockroach, which is attracted to light. Another study tested the hypothesis that cockroaches use just two pieces of information to decide where to go under those conditions: how dark it is and how many other cockroaches there are. The study conducted by José Halloy and colleagues at the Free University of Brussels and other European institutions created a set of tiny robots that appear to the roaches as other roaches and can thus alter the roaches' perception of critical mass. The robots were also specially scented so that they would be accepted by the real roaches. Additionally, researchers at Tohoku University engaged in a classical conditioning experiment with cockroaches and discovered that the insects were able to associate the scent of vanilla and peppermint with a sugar treat

2.2.3 Description

Cockroaches are generally rather large insects. Most species are about the size of a thumbnail, but several species are bigger. The world's heaviest cockroach is the Australian giant burrowing cockroach, which can reach 9 centimetres (3.5 in) in length and weigh more than 30 grams (1.1 oz). Comparable in size is the Central American giant cockroach *Blaberus giganteus*, which grows to a similar length but is not as heavy. Cockroaches have a broad, flattened body and a relatively small head. They are generalized insects, with few special adaptations, and may be among the most primitive living neopteran insects. The mouthparts are on the underside of the head and include generalised chewing mandibles. They have large compound eyes, two ocelli, and long, flexible, antennae. The first pair of wings (the tegmina) are tough and protective, lying as a shield on top of the membranous hind wings. All four wings have branching longitudinal veins, and multiple cross-veins. The legs are sturdy, with large coxae and five claws each. The abdomen has ten segments and several cerci.

2.2.3.1 Eggs and egg capsules

Female cockroaches are sometimes seen carrying egg cases on the end of their abdomen; the egg case of the German cockroach holds about 30 to 40 long, thin eggs, packed like frankfurters in the case called an *ootheca*. The egg capsule may take more than five hours to lay and is initially bright white in color. The eggs are hatched from the combined pressure of the hatchlings gulping air. The hatchlings are initially bright white nymphs and continue inflating themselves with air, becoming harder and darker within about four hours. Their transient white stage while hatching and later while molting has led many to claim the existence of albino cockroaches. A

female German cockroach carries an egg capsule containing around 40 eggs. She drops the capsule prior to hatching, though live births do occur in rare instances. Development from eggs to adults takes 3 to 4 months. Cockroaches live up to a year. The female may produce up to eight egg cases in a lifetime; in favorable conditions, she can produce 300 to 400 offspring. Other species of cockroach, however, can produce an extremely high number of eggs in a lifetime; in some cases a female needs to be impregnated only once to be able to lay eggs for the rest of her life.

2.2.3.2 Sounds

Aside from the famous hissing noise, some cockroaches (including a species in Florida) will make a chirping noise

2.2.4 Role as Pests

Cockroaches are one of the most commonly noted household pest insects. They feed on human and pet food, and can leave an offensive odor. They can also passively transport microbes on their body surfaces including those that are potentially dangerous to humans, particularly in environments such as hospitals. Cockroaches have been shown to be linked with allergic reactions in humans. One of the proteins that triggers allergic reactions has been identified as tropomyosin. These allergens have also been found to be linked with asthma.

General preventive measures against household pests include keeping all food stored away in sealed containers, using garbage cans with a tight lid, frequent cleaning in the kitchen, and regular vacuuming. Any water leaks, such as dripping taps, should also be repaired. It is also helpful to seal off any entry points, such as holes around baseboards, in between kitchen cabinets, pipes, doors, and windows with some steel wool or copper mesh and some cement, putty or silicone caulk.

Diatomaceous earth applied as a fine powder works very well to eliminate cockroaches as long as it remains in place and dry. Diatomaceous earth is harmless to humans and feels like talcum powder. Most insects, including bed bugs, are vulnerable to it.

Some cockroaches have been known to live up to three months without food and a month without water. Frequently living outdoors, although preferring warm climates and considered "cold intolerant," they are resilient enough to survive occasional freezing temperatures. This makes them difficult to eradicate once they have infested an area.

There are numerous parasites and predators of cockroaches, but few of them have proven to be highly effective for biological control of pest species. Wasps in the family Evaniidae are perhaps the most effective insect predators, as they attack the egg cases, and wasps in the family Ampulicidae are predators on adult and nymphal cockroaches (e.g., *Ampulex compressa*). The house centipede is probably the most effective control agent of cockroaches, though many homeowners find the centipedes themselves objectionable.

Ampulex wasps sting the roach more than once and in a specific way. The first sting is directed at nerve ganglia in the cockroach's thorax; temporarily paralyzing the victim for 2–5 minutes, which is more than enough time for the wasp to deliver a second sting. The second sting is directed into a region of the cockroach's brain that controls the escape reflex, among other things. When the cockroach has recovered from the first sting, it makes no attempt to flee. The wasp clips the antennae with its mandibles and drinks some of the hemolymph before walking

backwards and dragging the roach by its clipped antennae to a burrow, where an egg will be laid upon it. The wasp larva feeds on the subdued, living cockroach.

Bait stations, gels containing hydramethylnon or fipronil, as well as boric acid powder, are toxic to cockroaches. Baits with egg killers are also quite effective at reducing the cockroach population. Additionally, pest control products containing deltamethrin or pyrethrin are very effective. In Singapore and Malaysia, taxi drivers use Pandan leaves as a cockroach repellent in their vehicles.

An inexpensive roach trap can easily be made from a deep smooth-walled jar with some roach food inside, placed with the top of the jar touching a wall or with sticks (outside the jar) leading up to the top, so that the roaches can reach the opening. Once inside, they cannot climb back out. An inch or so of water or stale beer (by itself a roach attractant) will ensure they drown. The method works well with the American cockroach but less so with the German cockroach. A bit of Vaseline can be smeared on the inside of the jar to enhance slipperiness. The method is sometimes called the "Vegas roach trap" after it was popularized by a Las Vegas-based TV station. This version of the trap uses coffee grounds and water.

2.2.4.1 Avoid Cockroach Disease by Avoiding Cockroaches

Cockroach disease is something that many people are worried about when they see a cockroach in their home. Cockroaches are known to carry disease because they can live on just about anything, meaning they often live on unsanitary substances. When you look at the cockroach anatomy you might only get creepy crawly sensations, but chances are there is a lot more there than that. Cockroach disease can affect humans. Cockroaches are known to carry diseases like dysentery, typhoid and poliomyelitis, as well as gastroenteritis. Cockroaches can live just about anywhere, and can live on fermenting products, septic dressings, hair, leather,

wallpaper, feces, rotting food, and more. Because many of the products that cockroaches feed on are spoiled or simply unsanitary, it's easy to see where cockroach disease comes from. Many of the substances that they feed on are already contaminated, and as the cockroach moves from one location to another it spreads the disease along the way. Not only can people get sick from the diseases that cockroaches contaminate human living space with, many humans are allergic to cockroach feces. Of course, no one exposes themselves to cockroach disease and feces on purpose, but it can happen by inhaling particles of dust in the air that has been left behind by the cockroach. Food can also be contaminated with the smell of cockroaches, which is very distinct. Food can have particles of feces, salivary gland secretions, as well as dead insects if it has not been stored properly. If people eat food that has not been properly stored they can be exposed to all of these things, which can cause asthma as well as other health conditions to those that are sensitive. Cockroach disease is nothing to fool around with. Even if you just don't like bugs, you have to consider the disease and filth that these insects bring into your home. Cockroach control is very important because you cannot always see, smell, or even taste the presence of cockroaches, yet you can ingest these items and become sick. Many people believe that cockroach problems will take care of themselves, or if you haven't seen all that many cockroaches there is no need to worry. The fact is, because you often don't see the cockroaches that live in your home, you always have to worry if you see even one or two roaches. Cockroach disease can spread fast, and when you consider that cockroaches often hang out in the kitchen and places where food preparation takes place, you'll want to nip the problem in the bud.