The pest control repeller

CHAPTER 1: Introduction

The Pest Control Repeller is a device designed to eliminate undesired animals to be appeared in our residential area. These undesired animals are such as rodents, bats and even birds like swallow. Rodents appear in the house not only give rise to hygiene's problem, but also causing damage to the properties; they bite clothes and furniture that reside in the house. Bats, on the other hand produce excrements on the roof which may jeopardize the health of the residents stay inside the house, they also make noises during night time and affect residents to sleep. Apart from rodents and bats, birds like swallow which the amount has increases dramatically recently has also causes problem to the residents in a residential area. The great profit and demand of the bird nest in the market has attracted more and more people to invest in this business. Some of the nest farming even built up illegally in a residential area. This indirectly causes other side effects such as hygiene problem, sound pollution and damage to the property. Besides, it was also found that there are more than 60 different transmissible diseases have been associated with birds and their feces. Droppings cost money, both in the daily cleaning process and in lost of business from customers who prefer a dropping-free environment [1]. With the existence of Pest Control Repeller, the problem mentioned can be solved easily without causing negative side effect to the human. In this chapter, there will be a short introduction regarding to the objectives and overview of this project.

1. 1 Objective

The main objective of the project is to design and construct a Pest Control Repeller which will have the following fundamental features:

- Able to generate a digital harassment sound which will drive away some selected animals such as rodents, bats and birds.
- Able to implement the device in a large coverage area.

Upon successful implementation of these fundamental features, enhancements are added to the device for better efficiency and effectiveness, this include causing the minimum effects to the human during the operation of the device. Besides, the Pest Control Repeller is designed to produces an intermittent sound so that the undesired animals would not get used to the repetitious sound. The developed product also can be used in a large and open outdoor area as well, such as under the bridge or on the telecommunication towers. This is because cliff swallows frequently colonize these structures and their nests cannot be disturbed until the nesting season has passed. As Swallows and their nests are fully protected under the Wildlife Protection Ordinance 1990 in Malaysia and it is unethical to destroy the nest of a swallow, maintenance and repairing process is force to delay to other periods where swallows have migrated to other places. In a nutshell, the designed Pest Control Repeller is having the objective to help mankind in driving these annoying animals away from causing bad sleeping condition, properties damage, health and safety hazards.

1. 3 Project Overview

Basically, the Pest Control Repeller is categorized into three major functions, which are rodent repellent, bat repellent and bird repellent. These functions are then further classified into three different modes; where in the first mode; only the rodent and bat repellent are activated, for the second mode, the rodent and bat repellent are activated together with the bird repellent,

where the bird repellent will only be triggered if the sensor is activated. Whereas for the third mode, the rodent and bat repellent are activated together with bird repellent and control by manual operation of a user.

All of the operations are controlled by a microcontroller named PIC16F877A; the PIC microcontroller generates a series of pulses with different frequencies to drive away certain undesired animals. The series of pulses are formed by a specific period of square wave with alternating high and low condition, by varying the period of this square wave, the desired frequency for the Pest Control Repeller can be achieved. The PIC microcontroller used in the Pest Control Repeller also acts as a media to receive signal from PIR sensor which is later to be processed and produces the respective output signal to trigger the tweeter and strobe light. Besides, the PIC microcontroller also functions to send an output signal to trigger the servo motor which is mounted under the tweeter. Last but not least, the PIC microcontroller also used to produces the alphanumerical character which will be shown on the LCD.

The specific frequency signals produced by the PIC Microcontroller are sending to the amplifiers prior to the tweeters. An amplifier is a device for increasing the power of a signal by taking energy from a power supply and controlling the output to match the input signal shape but with larger amplitude. In the designed Pest Control Repeller, a Class B amplifier is used for amplifying the different frequency signal. Class B amplifier circuits are the most general design type found in the audio power amplifiers. The amplified frequency signals are then send to the respective tweeter to produce the specific frequency sound wave for the pest repelling purpose.

Apart from the frequency sound waves generated, the Pest Control Repeller can trigger a functioning strobe light and flashing super LED when a pest is detected within the device operating range.

A LCD display of 2×16 characters is used in the project to display the operating modes. Besides, the LCD display also shows the numbers of pest detected within a certain period; this function allows a user to make a statistic to measure the effectiveness of the Pest Control Repeller installed in an area.

1. 4 Project Scope and Methodology

This project is a combination of hardware prototype with software implementation. In the hardware prototype construction, Express SCH and Express PCB are used for the designation purpose. Express SCH is used to draw a schematic diagram which represents the electrical component used in the Pest Control Repeller system by using graphic symbols rather than realistic pictures. Whereas, Express PCB is used to design the electrical conductive pathways from copper sheets laminated onto a non-conductive substrate which will then mechanically support and electrically connect all the electronic components require in the Pest Control Repeller system. For the software implementation, MPLAB which serves as a single, unified graphical user interface for C programming is used to program the require instruction into the PIC microcontroller, PICKit 2, which has been an interesting PIC programmer from Microchip, can be use to program the PIC microcontroller.

During the designation of hardware prototype, electronic components and device are chosen base on their cost and effectiveness to ensure that the functionality of the Pest Control Repeller to be optimized at the lowest cost. After the components and devices selection are finalized, a primary configuration of the selected components are done on a bread board, testing and debugging process are then performed to ensure the functionality. After ensuring the functionality, the circuit layout is printed on a PCB and the components are soldered on the respective position, the implementation of circuit on a PCB increase the effectiveness of the circuit and reduce the chance of errors to occur.

After the hardware fabrication, a program is written to tests and calibrates the prototype to make it functions in a precise and accurate mode. At the last stage of project, debugging process is carrying out to alter and correct the errors. Debugging is a methodical procedure of finding and reducing the number of bugs, or defects in an electronic hardware to make it behave as expected [2]. Debugging is very time consuming since it detects and corrects the errors instead of merely writing a program. Debugging process will take longer time if the program is written in an improper way. Thus, following the common established rules and good practice when writing a program will greatly reduce the time use in debugging process. More attention is needed when writing a program to make the subsystems independent of each other; this is because debugging tends to be harder when various subsystems are tightly coupled, and changes in one subsystem may cause errors to emerge in another subsystem.

1. 5 Thesis Overview

The report is divided into 6 chapters where Chapter 1 is a simple introduction that includes with the objective, project overview, project scope and methodology.

The report is then followed by Chapter 2, where the theoretical background for this project is discussed in details, such as the animal's behavior and effect of digital harassment sound to these animals. Literature review of similar project and improvement of these projects will also be discussed in further.

In Chapter 3, the hardware prototype of the components and devices selected are discussed in details. A comparison between similar components and devices is also made to achieve a better effectiveness system at a lower cost. Besides, the function of the selected components and device will be elaborated for better understanding.

For Chapter 4, the process in software development is discussed. Flow chart for the programs is shown and explained in details. Besides, software and tools used in the program writing is described for a better understanding.

Presentation of data and discussion are combined in chapter 5 where the interpretation of data gathered is discussed. Besides, the problems encountered during conducting the project in both hardware and software also will be elaborate in details.

Lastly, conclusion ends the report by providing a summary to the content in the report. It indicates significance, advantages and limitations of the work.

The applications of the project and recommendations for future work are included for further reference.

Chapter 2: Theoretical Background and Literature Review

In this chapter, there will be an introduction to the background of the pests and major issues caused by these pests. Products and techniques used by people in repelling the pests also will be discussed. Their advantages and limitation are being investigated in details so that a comparison can be made between these techniques to further implement the project. Besides, the benefits of the project after the implementation also will be discussed in the last part of this chapter.

2. 1 Classical Animal Behavior

2. 1. 1 Birds

Birds play an important role in balancing the ecology by controlling the number of insects and pests in a particular area. However the increasing amounts of birds in a particular area will bring up problems to the residents, this problems are such as hygiene’s problem, sound pollution, damage to the property and even ecological imbalance. This problem has becomes significant recently when more and more people start to invest in swallow nest farming due to its’ great profit in the market. Swallows are categorized as gregarious bird species, they tend to breed and build nest at a particular area together. This characteristic has made them become a threat for the residents when they breed in a residential area. The problem even becomes worse when the Cliff Swallows build their nest at telecommunication tower and public construction such as bridge and highway structure. As stated by Jaclyn S. C et al, “ Cliff swallows (Petrochelidon pyrrhonota) are migratory

birds that breed in colonies and frequently nest on highway structures” [3]. According to Wildlife Protection Ordinance 1990 in Malaysia, this migrated swallows are consider as endanger species and fully protected under any circumstances. This causes the construction and maintenance process cannot be performed during the nesting season and indirectly leads to economic lost.

Besides, it was also found that the excrements of birds like pigeon are the carrier of most fatal diseases. Coghlan (1990) in his article named Pigeons, Pests and People refers birds as” rats with wings” for the speed of them which can affect an area and transmit diseased spores through their excrements. Diseases such as Toxoplasmosis, Listeriosis, Viral Meningitis, Encephalitis, Salmonella and Paratyphoid are readily spread in places of high pigeon population due to the amount of droppings produced [4]. Apart from causing fatal diseases to mankind, the excrements of birds will also bring down the aesthetic value of buildings due to the large amounts of droppings from the bird habitation and added noise made during the early hours of the morning. Moreover, research also found that bird causes more damage to farms and orchards than any other creature. Each year birds destroy crops and bring significant economic damage to the farmers. For these reasons, humans have been trying to deter birds from building, public structure and farm with devices such as scarecrows which were first used in 1592.

2. 1. 2 Rats

Rats are categorized under the rodent family; they cause problems to mankind since decades ago. Rats are found to be an amazing climber on the roof and have good hearing compared to many species. However, rats are

colour blind and have poor vision, this causes them have to move their eyesight from side to side in order to see better. Rats are found to be a threat for mankind due to their strong vitality and fast fertility. A female rat is only pregnant for about three weeks, yet they can give birth to 12 babies in one time. Though the hairless babies look very weak, they grow up in a very fast rate and can be independent from their mother in about a month. The average female rat can give birth for 4 to 6 times a year [95]. So it is not surprise when they cause damages to the properties in a short period of time. Rats bite everything they see in the house, this is because they need to grind their teeth from preventing the growth of the sharp teeth and injured themselves. This causes great damage to the properties especially for expensive electrical.

Rats are found to be the carrier of most fatal diseases; they are the primary carriers of Murine typhus, Leptospirosis, Trichinosis, salmonella, Ratbite fever and plague [95]. The disease caused by rats can spread in a fast rate and very hard to control in a short period of time. Humans are infected by these diseases when they come into contact with food or water which contains the urine of the infected rats. Besides the disease may also be infected to humans when they are bite by a rat. The symptoms of these diseases are fever, flu and soon will soon develop into liver failure or meningitis. Plague is a rat disease spread to mankind by a sick rat’s fleas or contact with a sick rat’s bodily secretions. Various kinds of plague can attack the lymph glands, blood and lungs of a human. The Black Death which caused by rat’s plague was one of the deadliest pandemics in human history, peaking in Europe between 1348 and 1350. The Black Death is estimated to have killed 30% to

60% of Europe’s population, reducing the world’s population from an estimated 450million to between 350 and 375million in 1400. It took 150years for Europe’s population to recover [94]. Apart from this, rats also causes damage to the agriculture crops, they consume the fruits and crop, such as coconut, cocoa and so forth [93].

2. 1. 3 Bats

Bats are having the same behavior with migrated birds such as swallows; they usually breed in season and nest in the roof for a period of about four to five months of the year. Same like a bird, bats also bring problems to mankind especially when the quantity is significant. Bats stay in the roof causes sound pollution to the resident stay inside the house, the problem of noise can occurs occasionally and this is always the main problems that caused by the bats. The problem even becomes worse when they stay on the roof of a bedroom. Besides, it was found that some bats have been detected with a rabies-like virus named European Bat Lyssavirus, although this virus is not serious, but it will infects human when a human is bite by the infected bats. Sometimes bats that flying around a building can trigger on a burglar alarms, including those that use passive infrared motion detector, light beams, microwave or ultrasonic detectors. Last but not least, bats also causes damage to the agriculture crops like birds, some species of the bats will consume fruits and agriculture crops that planted in a farm.

2. 2 Literature Review

The purpose of the project is to design a Pest Control Repeller system that is effective in repelling the undesired animals to be appeared in the residential area as well as outdoor area such as public structure. In order to achieve the

objectives stated, a study is conducted to examine the cost and effectiveness of the available existing products. The advantages and limitations of these existing products are taken into consideration and the most effective criteria of the system will be selected and combined with other advantages in order to construct a more effective Pest Control Repeller.

2. 2. 1 Bird Repeller

Typically, the types of bird repeller are classified into 4 major classes; there are visual system, audio system, light system and chemical system. Apart from the 4 major classes, there are also other bird repelling techniques like habitat modification, electric track system and so forth. Each of the repeller system will be studied and their advantages and limitations are being reviewed.

Visual bird repeller is a visual object that is designed to represent a predator to surrounding birds as either a human or a larger bird [99]. Normally, the most common items used in the visual bird repeller system are scarecrows, kites and even corpses of birds. A scarecrow is a physical human-like mannequin which dressed in human attire and place in the farm for deter birds like crows from disturbing and consuming the fruits in the farm. Apart from this, it was also found that any species of bird are naturally afraid of predators such as birds of prey. “ Hawk Kites” are then designed to fly in the sky for protection from the bird’s infringement. The use of model or actual dead birds in the farm also target to illustrate the signal of danger to other birds. At first, birds will approach the corpse out of curiosity but usually they leave it when they see the unnatural position of the bird. This approach has

been widely used in the airport to deter sea gull from approaching the flying area. Despite of low cost and common used of the visual systems, it was found that they are inefficient in driving the birds away, especially after a long term of period. Once the birds in the surrounding area realize that there is no danger of the visual system, they start to approach the particular area and soon the visual system becomes useless. As a conclusion, most visual deterrents system is found to be efficient within a short term of period; it is recommended that this device is used in conjunction with other device or techniques to be successful for a significant period of time.

The audio deterrent system is found to be the most common device that use widely around the world. The audio bird repeller system functions by emitting sounds that will cause stress to the birds. These sounds are such as distress sound recorded from the birds, noises that are audible to the birds, or even loud bang with decibel more than 150dB, this loud bang with decibel of 150dB can be produced from a propane cannons, or also referred as propane gas gun which is controlled by a controller or a motion detector. But, the problem with this gas gun is that the loud and irritating sound may disturb the resident living in the nearby area. Besides, birds will also adapt quickly to the sound which has the same magnitude, pitch and time interval all the time. Propane cannons become ineffective after a period. Apart from this, it was also found that ultrasonic devices are used by some of the people in repelling birds from their residential area. An ultrasonic device can emits ultrasonic sound range above 22 KHz, which the frequency is not audible by human being, thus many of the manufacturers claimed that the device is suitable for home use since it is inaudible to human. Despite of the superior

features provided by this system, there is no evidence shows that ultrasonic devices are capable to drive birds away, and there are plenty of studies show that most species of birds are having the same audible frequency range as human, but do not hear the frequencies above 20kHz. This is the reason why human can hears bird chirping everyday in the morning. Therefore ultrasonic systems are ineffective in deterring birds and should be avoided. Compared to the two methods mentioned above, bio-acoustic devices are found to be the most popular and efficient device among the audio deterrent systems. Bio-Acoustic deterrents are devices that transmit biological significant sounds such as bird alarm and distress calls [99]. In nature, birds use alarm calls when they perceive danger, whilst distress calls are used when birds are captured, restrained or injured, each call is species specific, however some distress and alarm calls are known to get a response from other species [98]. Besides from using distress call from birds, noises with vary frequencies may also be used as the audio deterrent system.

The light deterrent system is widely used in the airport for bird repelling purpose; this system can be classified into strobe light system and laser light system. For strobe light bird deterrent, a rotating or flashing search light is used to stimulus the visual of a bird and causes an unwanted situation for them. Although a static light in the night may attract birds to approach the particular area, a flashing one, however will causes confusion to them and thus achieve the purpose in repelling birds. Studies conducted on light systems have shown that high intensity strobe lights caused birds to take evasive action and move away from some airfields. In the same study it was found that a randomized selection of two strobe frequencies increased the

effectiveness over a range of species and that the strobes stopped all bird habitation [99]. The laser light system, on the other hand also represents a well-established method in deterring birds. Diode laser is ideal for bird repelling because of many of its advantages, such as small size, lower power consumption and lower cost [96]. Although the laser repelling system is efficient in drive away the birds, but the equipments needed are expensive. And also, the effectiveness of the lasers are found to be decreased with the increase of light levels, therefore, this repelling method is suitable to use during night time or at a place which is not cover by sunlight.

Chemical deterrent system drive birds away by causing an unwanted living environment for birds or by killing them in a direct way by using poison. For the first method, chemical substance is placed at the habitat of birds to make them feel offensive or causes irritation to them. This can be in the form of tactile or in the form of odor. After a period of time, these birds will find that the place is not suitable for habitation or nesting and will soon move to another habitat. For the second method, poison is used to kill the birds from nesting in a particular area and scare away other birds in the same habitat. However, both of the methods are found to be inefficient for a long term period and may lead to other environmental issue. Therefore, the chemical deterrent system is not encouraged to be used in repelling birds either in a housing area or at outside an outdoor area.

There are many more other repelling techniques being implement throughout the world, such as habitat modification, electric track, water sprayer and so forth. For habitat modification technique, Spikes deterrents made of strips of plastic or metal with upward pointing stainless steel or

plastic spikes can be attached to ledges of buildings [99]. Besides, habitat modification for bird deterrent also often involves in eliminating the roosting or nesting locations of birds. For example, in the control of cliff swallow at public structure like bridge, the habitat of interest is the nesting location. Cliff swallows prefer a nesting place with rough and unpainted surfaces. So, modification can be done based on these criteria, such as anti-perching spines, smooth strips mounted at an angle of at least 45 degree, panels of glass, sheet metal, or paint to create a surface unfavorable for cliff swallow nesting [3].

An evaluation had been carry out by Timothy L. C. in his report named " An Autonomous Bird Deterrent System" to evaluate the effectiveness of these deterrent system based on their cost, physical requirements, stealth, automation ability and area covered. A ranked positional method was used in the evaluation with each category being weighted out of a total of ten points by its importance and then a rating being given under each category out of five for each individual deterrent. In the result shown below, it was found that the light deterrent system is having the highest score compared to other system with laser deterrent represent the most effective repeller. The ranking is then followed by the audio deterrent system.

2. 2. 2 Mouse Repeller

Typically, People use mouse trap to catch mouse appears in the house, however, it is not the efficient way to repel them away if the quantity is significant, since the mouse trap only can trick them for once but not for a long term period. Mouse poison, on the other hand, also use widely by people in controlling the undesired mouse. Poisons works fine in killing

mouse since it plays to what a mouse is searching for, such as food and water. There are two types of mouse poison available in the market; with the first type are having the immediate reaction and the second type that takes effect after some time. However, both kinds of poisons contain fatal elements such as warfarin, diphacinone, pival, chlorophacinone, or fumarin. Besides, chemical substances also used to drive mouse away by causing them an unwanted situation in their habitat. These chemical substances will make them feel offensive or irritating and soon they will leave the habitat due to the unpleasant living environment.

In the farm or some agriculture land, predators are used by the farmer to reduce the consumption of agriculture crops by mouse and thus repelling them away. Predators are one of nature’s methods in control and repel mouse away from the farm. There are many native and domestic predators that feed on rat and mouse, such as snake, owl, hawk and so forth, it was found that hawk and owl parents kill many more rodents when they are feeding their hungry broods [92]. Domestic cats, dogs, and ferrets help in controlling and repelling rodents in some situations. In general, dogs and cats are the most effective predator at preventing an infestation than eliminating a current population. This is because they are better able to catch and kill an invading rodent that does not know any escape routes, than an established animal that knows various escape points [92].

Recently, the ultrasonic mouse repeller has becomes popular for home use application. These ultrasonic mouse repellers are selling like hot cake in the market due to their advantages compared to other traditional repellers. It is well know that pests such as rats and mouse are repelled by ultrasonic

frequency in the range of 30 kHz to 50 kHz. An Ultrasonic mouse repeller utilizes “ advanced state of the art technology” and functions by transmitting an influential range of ultrasonic sound in the frequency of 45 KHz. The intermittent, high intensity frequencies and pulse sequences were created to output at known hearing sensitivity ranges of pests, such as rat and mouse. It was found that rodents, like mouse or rat, will leave the environment where the ultrasonic device is installed for a less stressful area. These sound wave frequencies are inaudible to humans and pets like cat and dog [91].

A research named “ Efficacy Test Protocols for Evaluation of Ultrasonic Rodent Repellent “ was conducted by Stephen A. Schumake et al. from Denver Wildlife Research Center in examining the efficiency of the ultrasonic device. In the test mentioned, controlled laboratory and field test protocols were developed to assess the repellent efficacies of six commercially manufactured ultrasonic rodent repellent devices. The laboratory test structure (68. 7 sq m) was divided into two rooms (32. 5 sq m each) with a central harborage area (3. 5 sq m) containing a colony of 12 wild Norway rats (Rattus orvegicus). For each test, an ultrasonic device was attached to the end of one room and rat activity (oat consumption, packet damage, photocell counts) is measured during 1-week baseline and 2-1/2-week test periods. Field test structures varied in floor area (6. 5 to 197 sq m) and were either made by metal or wood construction. All contained existing Norway rat, house mouse (Mus musculus), or field mouse (Peromyscus maniculatus) infestations. No other rodent control techniques were conducted at these sites other than the application of selected ultrasonic devices. Rodent activities (packet damage, food consumption, rodent tracks) were measured

twice per week during three successive 3-week intervals with devices operating only during the second interval. Repeated measurement of variance and chi square were used to statistically evaluate the reliability of ultrasound effects. In the end of the test rodents under test could either leave the buildings or move to alternate non-ultrasonically treated areas in all the cases stated [90].

Apart from that, light system or strobe light may also repel the mouse away from the house since rodent families prefer a darker living environment and they usually move in darkness. As a conclusion, an ultrasonic mouse repeller works more efficient and better compared to other repelling method. The use of poison which causes the death of the mouse may lead to environmental issue when a predator or a pet consume the death mouse. Additionally, neither traps nor poisons provide a long-term solution; mouse will simply increase breeding to replace rodents lost to poisons or traps.

2. 2. 3 Bats Repeller

The generally accepted method to prevent bats from invasion is exclusion by netting or trapping. Netting and trapping, however, has resulted in the occasional inadvertent killing of bats. Similar to bird and mouse’s repelling cases; chemical repellent is also used by people in repelling bats. Naphthalene (crystals or flakes) is the only registered chemical which can be used as a bat repellent for indoor roosts. Naphthalene should be spread on the floor or applied between the walls, using about 2. 3 kg (5 lb) for every 60 m^3 (2, 000 ft^3) which should be adequate to treat an average attic [89].

Light illumination, on the other hand also shows a better effect in repelling the bats away from the house. This is because bats need a gloomy place for habitation during day time. This characteristic of bats makes them easily get repelled by a strong flashing light or strobe light. Last but not least, an ultrasonic device also being used by people in repelling bats. It is believed that the ultrasonic high frequency sound waves can interfere the bats' ability to navigate and causing confusion to them. It was evident to shows that an ultrasonic bats repeller did agitate, confuse and disorient the bats causing them to fly more erratically and to relocate away from the device [89]. As a conclusion, light illumination and ultrasonic devices are found to be an efficient wa