BIRD DETERRENT SYSTEM: MOTION DETECTION - ULTRASONIC SENSOR

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UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF AVIATION TECHNOLOGY

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THIS THESIS IS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE BACHELOR OF AIRCRAFT ENGINEERING TECHNOLOGY (HONS) MECHANICAL

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JULY 2013

DECLARATION PAGE

I declared that this thesis entitled “BIRD DETERRENT SYSTEM: MOTION DETECTION - ULTRASONIC SENSOR” is the result of my own research except as cited in the references all references have been cited adequately as required by the University.

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APPROVAL PAGE

I have examined this thesis and verify that it meets the programme and University' requirements for the BACHELOR OF AIRCRAFT ENGINEERING TECHNOLOGY (HONS) MECHANICAL.

Date : **05 DEC 2013**

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ABSTRACT

The research for BIRD DETERRENT SYSTEM: MOTION DETECTION - ULTRASONIC SENSOR is a Final Year Honors' thesis being developed from the Bachelor Of Aircraft Engineering Technology (Hons) Mechanical of Universiti Kuala Lumpur, Malaysian Institute of Aviation Technology. The thesis involves the design, manufacture and testing of such a prototype of a Motion Bird Detection System.

The need for an effective bird deterrent system is important in many of today's industries. In the past there have been many attempts to develop a successful system with few achieving adequate results. The aim of this project was to develop and design a motion detection system that creates minimal disturbance whilst being effective in bird deterrence.

An initial investigation and evaluation into the current types of bird deterrent systems was performed and from this the method of deterrence for the designed system was selected. Once the conceptual design was completed the mechanical, electrical and software sections of the system were designed in detail and partially constructed to discover the effectiveness of the system.

During the initial implementation of the system, expected and unexpected problems in the design arose that needed dealt with. The encountered problems were then listed in each of their relative sections and supplied with solutions and suggestions for a design revision. Once this system has been fully developed, it will provide a frame work for multiple types of detection with the possibility for use in a variety of applications. The thesis has been managed using a series of regular meetings each week with and without the project supervisor.

CHAPTER

I

INTRODUCTION

1.0 Background of the project

The need for an effective bird deterrent is important in many of today's industries. In the past, there have been many attempts to develop a successful system with few achieving adequate results. The aim of this project was to develop and design an detection system that creates minimal disturbance whilst being effective in bird deterrence.

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1.1 Motion Bird Detection System

AVITROL is prototype of bird detection system is a method to detect bird within enclosed area, this has many potential applications for the future. AVITROL bird detection system that is equipped with several features to enhance its effectiveness and its ability to provide both immediate and long-term bird control. For this reason, it is an ideal design for Motion Bird Detection System is capable of detect the bird.

This prototype is an electronic system using motion detection. It is powered by direct current between 3 and 5 volts. It produces motion detection in circular area. This particular small prototype is quite unique in that is electronic powered and will be safe and easy to operate and could potentially be used for a civil or urban application. For this reason, the prototype of AVITROL will detect the bird to successfully meet the project objectives.

1.2 Problem statement

Ever since the recognition of birds as hazards to aircraft safety, there has been serious interest in techniques and products that could control this hazard. Indeed, the need for effective bird control measures at airports and elsewhere has only increased over the years. The constantly expanding level of air traffic, and the development of larger, faster, and quieter jet-engine aircraft, has raised the risk of serious bird strikes (Bird Strike Website).

This amount of damage has made the aircraft place a high priority on the development of a successful bird deterrent system to ensure the safety of its aviation industry. For these reasons, humans have been trying to deter birds with devices such as scarecrows, which were first used in 1592 with varying success. Since then there have been significant improvements in bird deterrent technology, however an equal improvement in bird deterrence is yet to be seen (Bird Deterrent Website).

1.3 Objective

- ✓ Design technique a Motion Detection System using ultrasonic sensor for detect object sample within enclosed area that is effective.

1.4 Scopes and limitation

The scope of the study of different types of bird deterrent systems available and evaluation their effectiveness based on the advantages and limitation of each system. Once this is finished, the most effective system will be selected from criteria and combined with a tracking system to create an autonomous deterrent. Finally is to design a motion bird detection system for detect bird within enclosed area that is effective. The scopes of work for this project are shown as the following and being divided into two parts for two sections as follows:

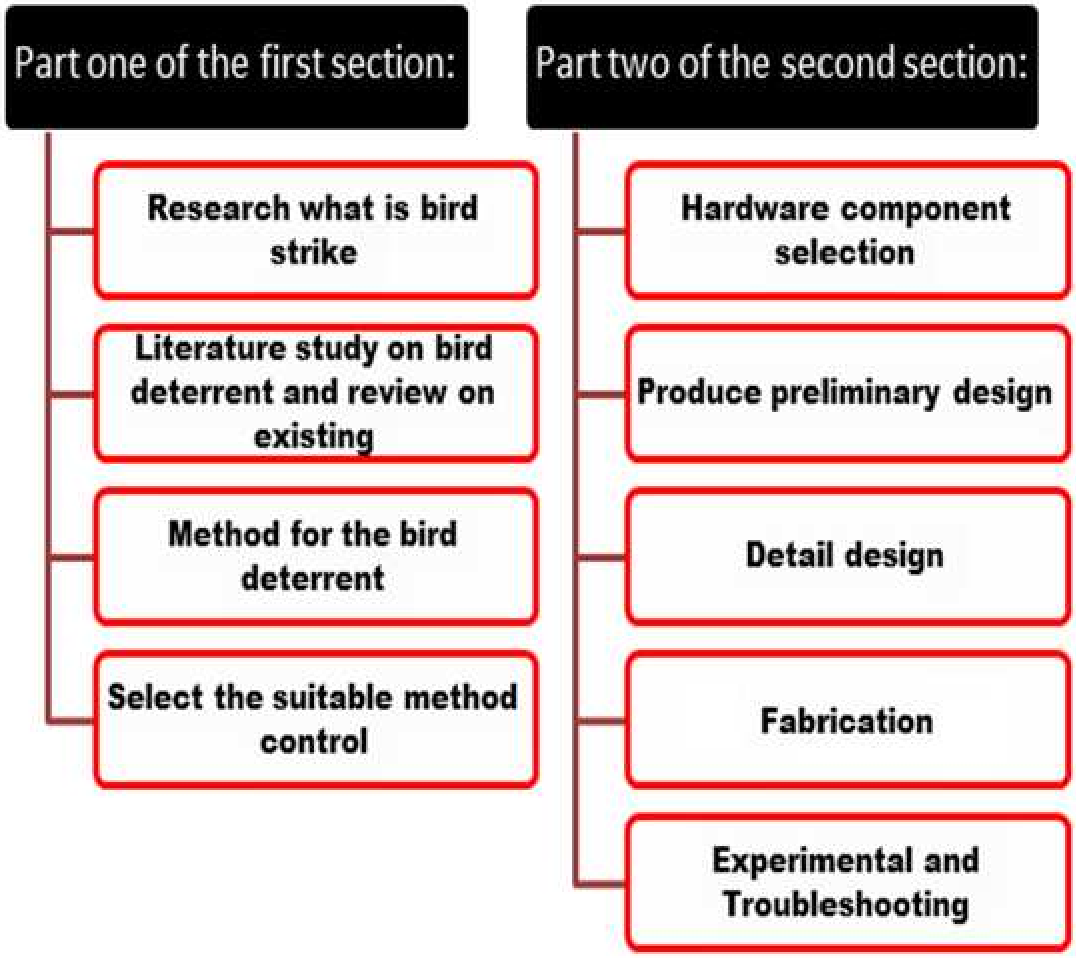


Table 1.4.1: Scope of work

1.5 The significant of this research

The project aim to design and build a model of a Motion Bird Detection System that is capable of detects the bird used motion application. The project also increases our knowledge about airport management and control instead of developed qualities of leadership, teamwork and responsibility.

CHAPTER

II

LITERATURE REVIEW

2.0 Introduction

In this chapter, the study about the history, development and research that had been done of several bird deterrent systems will be discussed and viewed. Besides, the common terms in aircraft bird strike and bird deterrent system also will be discussed. Nowadays, there are many research and studies had been carried out on bird deterrent systems. However, this field is a new one in aviation industry, so there are not too many books regarding bird deterrent systems that be published. Most of the sources and articles were found in internet.

2.1 Aircraft bird strike

A bird strike is a collision between an airborne animal usually a bird or bat and a man-made vehicle, especially aircraft. The term is also used for bird deaths resulting from collisions with man-made structures such as power lines, towers and wind turbines. Bird strikes are a significant threat to flight safety, and have caused a number of accidents with human casualties. Major accidents involving civil aircraft are quite low and it has been estimated that there is only about 1 accident resulting in human death in one billion flying hours. The majority of bird strikes (65%) cause little damage to the aircraft; however, the collision is usually fatal to the bird. Bird strikes happen most often during takeoff or landing, or during low altitude flight. (Bird Strike Website)

Figure 2.1.1: Aircraft bird strike incidents (Bird Strike Website)

2.1.1 Situation analysis

Research done state that aircraft usually involved with bird strike incident at two period time that are when aircraft during take off and landing. Situation of bird strike was creating to determine the impact force to the experimental empennage structure. This analysis all data were collected or gain from kinetic energy that involved two type of speed, take off speed and landing speed while maintaining weight of the bird.

	Force, F	Area of bird, A
Aircraft during Take off	8670 lbs	12 × 12 in
Aircraft during Landing	4950 lbs	12 × 12 in

Table 2.1.1: Force and Area of impact (Bird Strike Website)

Stress is obtained by dividing the force, F that acting to aircraft surface section by area, A of the cross section, rather than stress at a specific point of the cross section, mean the area of the bird impact as shown from the table above.

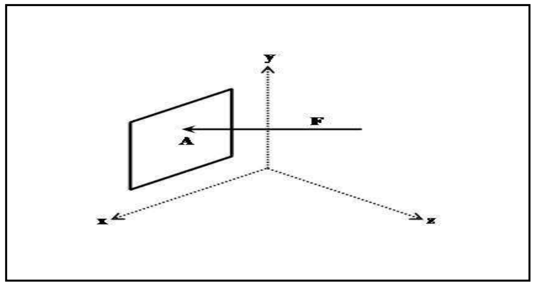


Figure 2.1.2: Plane axis of force impact (Bird Strike Website)

The analysis provides the data of the material Young Modulus, the force acting during the impact, F. From the Z - axis shown the force that the bird strike impact to aircraft surface. The bird area has assumed for 12 in (length) × 12 in (width) that is 144 in^2, by doing this calculation, the exact amount of stress that create from the impact were get big it is not exceed from the Young Modulus of the material.

2.1.2 Critical surface

This experimental aircraft required an aerodynamically shape smooth exterior for high performance. If not, the performance of the aircraft will be affected. Because of that, they must have effort to maintain original contour and exterior surface smoothness. Exterior surface aerodynamic smoothness classified in two categories that is critical surface, required high degree of smoothness and non critical surface.

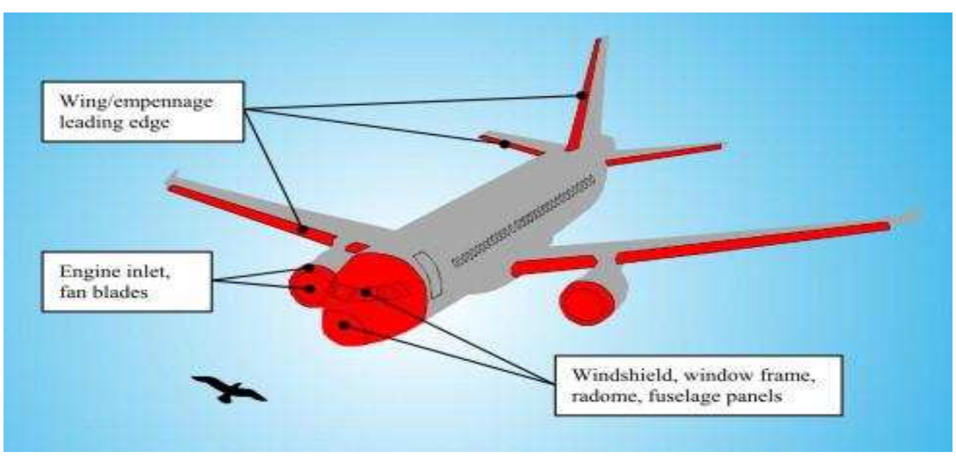


Figure 2.1.3: The Critical Smoothness Area of the aircraft (Bird Strike Website)

2.2 Bird Deterrent Systems

This standard identifies different types of bird deterrent systems available and includes a brief description of how each system is intended to work by outlining their advantages and limitations. All of the methods described here have limited effectiveness making the selection of a suitable bird deterrent system difficult. Issues of aesthetics and ethics limit the choices even further. Important factors to consider when selecting a bird deterrent system for a particular building include the following:

- ✓ Bird species (including size, behavior and habits)
- ✓ Location of building
- ✓ Climatic conditions
- ✓ Time of year
- ✓ Time of day

2.2.1 Visual Systems

2.2.1.1 Scarecrows

Visual bird deterrents are visual objects that are designed to represent a predator to surrounding birds as either a human or a larger bird. The most common visual deterrent and the oldest is a simple scarecrow. Scarecrows are designed to mimic the appearance of a predator to cause birds to leave their current habitation. Most scarecrows are human shaped, and are constructed from inexpensive materials. In general, because scarecrows are motionless they only provide short term protection due to the fact that the threat they create is perceived rather than real. Once the birds in the surrounding area realise that there is no danger the scarecrow loses all its effect so much so that some birds have been found to associate with them favourably (Inglis 1980).

To achieve the greatest effectiveness, scarecrows must appear to be life like, be highly visible and must constantly change location to extend the length of their effectiveness (Bishop, McKay, Parrott, Allan, 2003). In the last few years several types of moving scarecrows have come into the market. An example of these is the spinning scarecrow as seen in figure 2.1.1. These “Whirly Ozidge” scarecrows are constructed of a reinforced PVC skin which is stretched over the aluminium frame and rotate in the wind around their central axis. The PVC skin is printed with an image of a human and a bright red and yellow panel to try to create the illusion of a threat to surrounding birds.

Figure 2.2.1: Rotating Scarecrows (Bird Gone Website)

Another type of moving scarecrow is the Scary Man® made by Clarratts. The “Scary Man” is an 165cm plastic scarecrow that runs off a 12 volt car battery. The scarecrow rapidly inflates about every 18 minutes and lasts for 25 seconds. During its inflation period the Scary Man® emits a high pitched wail, and if at night illuminates.(See Figure 2.1.2).

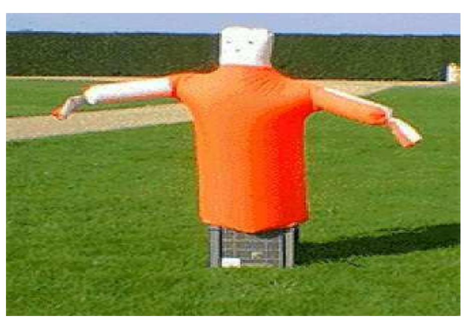


Figure 2.2.2: Scary Man (Bird Gone Website)

Ultimately, however lifelike scarecrows are, they do not pose a significant enough threat to scare birds. Therefore to improve the threat that scarecrows create it is recommended that these devices are combined with actual human activity or audio deterrents (Bishop, McKay, Parrott, Allan, 2003).

2.2.1.2 Corpses

An alternative method used to deter birds has involved deploying replicas or even actual corpses of birds in a way that signals danger. Birds often approach the corpse out of curiosity but leave when they see the unnatural position. Although this technique is inexpensive, it's effectiveness varies depending on whether the corpse is continually moved and the availability of alternative sites for the birds to relocate. As with most visual deterrents it is recommended that this device is used in conjunction with others to be successful for a significant period of time.

2.2.1.3 Kites

Hawk kites are mobile devices that act as a predators to create a threat to birds in the surrounding area. Most kites bear the image of a soaring eagle outline and are tied to the ground. Studies have shown that hawk kites are ineffective in deterring birds from crops (Conover, 1983) but however, are effective when flown beneath helium balloons to create a sufficient threatening movement. Kites are generally easily damaged by strong winds and have difficulty staying airborne in air speeds that exceed 8 km/h (Hothern and Dehaven 1982). They also are only effective for a short period of time and over a small area. There are also several other visual deterrents that are on the market today including mirrors, hawk-eyed balloons, large hawk eyes. These deterrents however are not as common or effective and are only suited to smaller areas.

2.2.1.4 Advantages

- ✓ This can be a safe and unobtrusive method of bird control.

2.2.1.5 Limitations

- ✓ This system is generally not effective, because birds are able to recognize the artificiality of these devices.
- ✓ A reaction to this system is temporary at best, if there is even a reaction at all.
- ✓ The birds eventually become habituated to these devices and may use their artificial adversaries as comfortable perches.
- ✓ The effective use of this system requires significant human involvement. These devices must be frequently and repeatedly moved from one location to another.

2.2.2 Audio Systems

Audio deterrents are the most commonly used device in avian pest management. They operate by omitting either bird calls or ultrasonic sound waves to rid the surrounding area of birds. Most audio devices use either bird distress calls or predator calls and generate them randomly from different locations around the area.

2.2.2.1 Bio-Acoustic Devices

Bio-Acoustic deterrents are devices that transmit biological significant sounds such as bird alarm and distress calls. In nature, birds use alarm calls when they perceive danger, whilst distress calls are used when birds are captured, restrained or injured(Bishop, McKay, Parrott, Allan, 2003). Each call is species specific, however some distress and alarm calls are known to get a response from other species. A number of different types of bio-acoustic deterrents are in the market today making them a common choice in bird control with some producing noise levels up to 110dB and having an effective distance of 300 m (Scarecrow Bio-acoustic Systems website). Bio-acoustics are seen as the most effective and cheapest ways of dispersing birds from airfields, once the equipment has been bought and staff trained (CAA 2002). In deterring birds from airports, the distress call is emitted for 90 seconds from a distance of 100 m from the target flock to keep reactions predictable. Figure 2.2.1 is an example of the "Bird Chaser" system that uses a motion sensor to trigger distress and alarm calls.

Figure 2.2.3: Bird Chaser (Bird Gone Website)

Bio-acoustics are the some most effective tools in bird control because the use the birds natural instinct to avoid danger as a deterrent. Their effectiveness is based on species calls and the amount of alternative areas to move to that are in the area (Bishop, McKay, Parrott, Allan, 2003). However as with most bird deterrents systems such as these, they lose their effectiveness if they are not moved regularly and have their best results in combination with a variety of techniques.

2.2.2.2 Ultrasonic Devices

Other such bird deterrents such as ultrasonic systems which emit frequencies 21-26kHz in order to deter birds from areas such as warehouses, manufacturing plants, arenas, and loading docks. One of the current systems on the market is the Bird Chase Ultrasonic from Bird-B-Gone (Figure 2.2.2).

Figure 2.2.4: Bird Chase Ultrasonic (Bird Gone Website)

This system comes with 5 different program modes of ramp, blast, steady, sweep and random to discourage birds from the surrounding area. It also has 6 separate speakers and a claimed range of 500 square metres. Despite the superior features of this system the is no evidence that ultrasonic devices deter birds, with studies showing that most species of birds do not hear frequencies above 20kHz (Harris and Davis, 1998) giving no biological reason to use ultrasonics. Therefore ultrasonic systems are ineffective in deterring birds and use should be avoided.

2.2.2.3 Advantages

- ✓ Does not obscure the building aesthetics
- ✓ Does not impact, alter or damage the building

2.2.2.4 Limitations

- ✓ Noise pollution: The distress signals are generally very loud, thus disturbing the human inhabitants as well.
- ✓ There is a possibility of habituation towards the noise.
- ✓ The effects are temporary in that birds may return after the distress signal is turned off.

2.2.3 Light Systems

2.2.3.1 Strobe Lights

Flashing, rotating, strobe and searchlights are novel stimulus to birds, which encourage an avoidance response (Harris and Davis 1998). Although stationary lights are known to attract birds at night, bright, flashing, revolving lights cause a blinding effect which causes confusion. Light systems are designed for deterring birds from roosting and feeding in specific areas and are most effective between dusk and dawn (Blackwell, Bernhardt, Dolbeer, 2002). Studies conducted on light systems have shown that high intensity strobe lights caused birds to take evasive action and move away from some airfields (Pilo 1988). In the same study it was found that a randomised selection of two strobe frequencies increased the effectiveness over a range of species and that the strobes stopped all bird habitation.

Figure 2.2.5: BirdLite (Bird Gone Website)

The above Figure 2.3.1 is the BirdLite, which generates coloured flashing light by rotating at various speeds and illuminating different sections of its outer case. Light deterrents such as the BirdLite are easy to deploy and require little maintenance, however should not be used in areas where they might cause a visual nuisance to surrounding properties. They are also no very effective during daylight hours and their ability to deter birds is species dependent. Light deterrents are best used with a combination of other methods.

2.2.3.2 Lasers

As the demand for non-lethal, environmentally safe methods of bird scaring has increased, interest has grown in the use of lasers, particularly low-power lasers that work under low light conditions (Bishop, McKay, Parrott, Allan, 2003). The low power levels, distance, accuracy and silence makes lasers an attractive choice when choosing a method of bird control. The typical laser used in this deterrent type is a Class III B laser which has been found to be safe to use by the United States Department of Agriculture (Blackwell, Bernhardt, Dolbeer, 2002). The classification Class III B refers to lasers that have a power rating between 5 and 500 mW and are generally not capable of producing hazardous diffusion unless directly pointed at the eye. Up until recently laser systems we used as either a human guided torch like the Avian Dissuader in Figure 2.3.2 or a laser field that covered a large area with little accuracy.

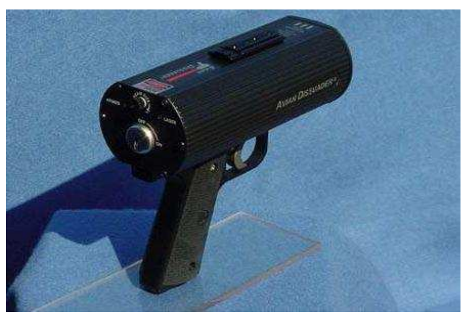


Figure 2.2.6: Avian Dissuader (Bird Blaster Website)

Since then spinning and scanner laser systems are being and have been developed with a line scanning system currently being used at the Montpellier Airport in France. SEA Tech the developers of the Avian Dissuader are also conducting trials on a rotating laser in conjunction with the University of South Dakota and should have a commercial product in the near future (See Figure 2.3.3).

Figure 2.2.7: Prototype Rotating Laser (Bird Blaster Website)

The use of lasers can be an effective method of bird scaring, although there is some evidence to suggest some birds are laser-resistant (McKay, 1999). Laser equipment is expensive and specialized training and safety precautions need to be in place in order for sound bird deterring practice to be achieved. As the effectiveness of the lasers decrease with increased light levels, their use in bird deterrence is only feasible from dusk till dawn and with hand held lasers requiring a user the overall cost of the deterrent is increased. New technology such as rotating and scanning laser systems has made obsolete, however these systems lack accuracy and the ability to keep non-target disturbance to a minimum.

2.2.3.3 Advantages

- ✓ Does not obscure the building aesthetics
- ✓ Does not impact, alter or damage the building

2.2.3.4 Limitations

- ✓ The effects are temporary in that birds may return after the distress signal is turned off.

2.2.4 Chemical Systems

2.2.4.1 Taste Repellents

Taste repellents can be divided into primary and secondary repellents. Primary repellents are agents that are avoided upon first exposure because they smell or taste offensive or cause irritation. Secondary repellents are not immediately offensive, but cause illness or an unpleasant experience. Following the ingestion of the secondary repellent, the bird then relates the taste to a unpleasant experience and avoids future encounters(Bishop, McKay, Parrott, Allan, 2003). Using taste repellents is relatively expensive when compared to other deterrent devices due to the high cost of the chemicals needed and the labour and time needed to apply them. Taste repellents may however be an economically viable solution for small crop areas with studies showing that they are effective in lowering the level of bird damage. For taste repellents to be effective regular spraying and persistence is required (McKay and Parrott, 2002).

2.2.4.2 Tactile Repellents

Tactile repellents involve the use of sticking substances that discourage birds because of their 'tacky' feel. They can be applied as clay-based seed coatings, or as pastes and liquids on ledges and other roosting structures to deter settling birds (Bishop, McKay, Parrott, Allan, 2003). An example of a tactile repellent is the Hot Foot Repellent Gel (See Figure 2.4.1). It is opaque in appearance and has a lower toxicity than table salt.

Figure 2.2.8: Hot Foot Repellent Gel (Bird Blaster Website)

Tactile Repellents are time consuming to apply and although are not weather resistant can last up to a year in sheltered areas (Transport Canada 1994). They have found to be effective in preventing larger birds from perching on antennas but are less effective on smaller birds who require only a small area to perch.

2.2.4.3 Advantages

- ✓ Used for long term
- ✓ Far away for human activity

2.2.4.4 Limitations

- ✓ Potentially dangerous to those who handle the chemicals.
- ✓ Environmentally dangerous.
- ✓ Tends to absorb airborne pollutants which cause it to harden and become ineffective.
- ✓ Have a short-term effectiveness, lasting from 18 months to 2 years.
- ✓ Removal is very difficult and sometimes damaging to buildings.

2.2.5 Structural Systems

2.2.5.1 Wires

A common problem in large cities is the number of birds that roost on buildings and cover them in droppings. For this reason static structural deterrents have been developed and are used on many modern buildings. The main criteria in structural deterrents apart from deterring birds, is to be subtle and unnoticeable. Overhead wires can be an effective method and low cost method of deterring birds. Many types of lines can be used but it is their spacing and height that appear to determine the bird species against which they are most effective (Bishop, McKay, Parrott, Allan, 2003). Wire systems can be relatively cheap to install and maintain, however require constant checking for broken lines that will be exploited by bird pests. They are a successful means of bird deterrence on large sites but are probably more effective on roof tops and ponds and small open areas.

2.2.5.2 Spikes

Spikes deterrents are made of strips of plastic or metal with upward pointing stainless steel or plastic spikes attached to ledges of buildings (See Figure 2.5.1).

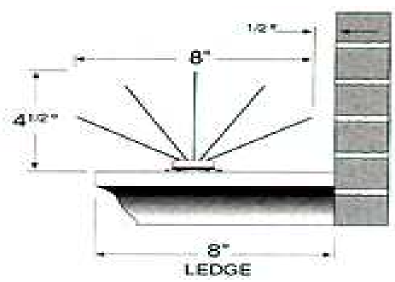


Figure 2.2.9: Bird Spike (Bird Blaster Website)

The spikes on these systems vary in length and orientation but act as a physical barrier to prevent birds from landing in all cases. These systems are relatively expensive and are easy to install however as with wires require constant checking to remove debris which may cover the spikes. Due to the sharpness of the tips and the danger they create this deterrent is illegal for use in some countries (Turner 1998).

2.2.5.3 Electric Track

Another commonly used deterrent is an electric shock track. The shock track works similarly to an electric fence with the track placed around the ledges of a building whilst an intermittent electric charge is passed through it. When a bird lands on the cable it completes the electric circuit and receives a mild shock. Manufacturers claim that the shock created induces the bird into giving a distress call which helps distress other birds (Transport Canada 1994). The effectiveness of electric shock tracks is similar to tactile repellents with a greater degree of success found with larger birds. Electric track systems are only effective over a small area and because of their dangerous nature are also illegal in some countries (Turner 1998).

2.2.5.4 Advantages

- ✓ Easy to install
- ✓ Long life-span
- ✓ Environmentally safe

2.2.5.5 Limitations

- ✓ Tend to collect debris between the spikes such as bird droppings, feathers and nesting material.
- ✓ For better effectiveness persistent cleaning is required.
- ✓ Ineffective against smaller birds such as starlings whose size allows it to use the spaces in between the spikes as a nesting site.

2.2.6 Hybrid Systems

2.2.6.1 Gas Cannons

Gas Cannons are devices that produce loud banging noises by igniting flammable gases. The scaring effect they create is similar to the effect that firing a shot gun has on birds. The unexpected bang causes a 'startle' reflex and promotes the bird to panic and fly away (Harris and Davis, 1998). Inside the cannon the mixture of gas and air pressure is ignited at a frequency adjusted by the gas feed, or and electric timing device. Most gas cannons produce noise levels up to 130dB at regular intervals, with some having additional features such as a double detonation or a rotator to change the direction of sound. They are commonly used in agricultural areas, but have been known to be used in aquaculture operations and on aerodromes (Bishop, McKay, Parrott, Allan, 2003).

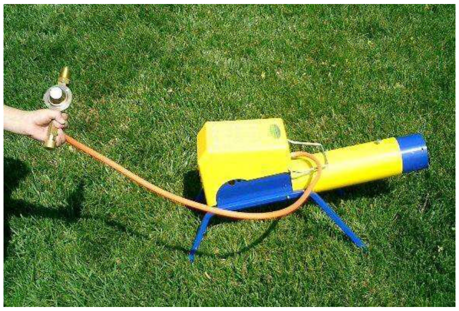


Figure 2.2.10: Propane Gas Cannon (Bird Blaster Website)

Gas cannons can be an effective means of bird deterrence if firing frequency and direction is varied and there is no noise nuisance concern in surrounding areas. Inglis (1993) found that the intensity of sound output from gas cannons was highly variable between guns, and between explosions of an individual device. Conditions such as wind strength and direction played a large part in the intensity of the cannons. Despite the amount of sound these devices produce they are relatively ineffective in deterring birds if they are moved or fired randomly and are not recommended for bird control by the Civil Aviation Authority (2002).

2.2.6.2 Other Devices

Another type of hybrid deterrent is the "Scarecrow" (See Figure 2.6.2). This deterrent is controlled by a motion sensor that sprays a jet of water once movement is detected. The shape of the "Scarecrow" is also designed to resemble a large predator bird to act as an additional visual deterrent. This device is relatively ineffective in scaring birds because its effective area is governed by how far the water jet can spray, and how far the sensor can detect movement. This device is best used very small areas such as residential gardens.

Figure 2.2.11: The Scarecrow (Bird Gone Website)

One of the most complex bird deterrents on the market today is the “Bird Blaster” deterrent. This system uses a network of pressurised tubes that surround a Doppler radar that is used to sense birds in the surrounding area. At various locations in the tube are t-sections that have short pieces of tube that are controlled by solenoids. When a bird comes into the radar, the system controls the closest solenoid to the bird to open which in turn lets the pressurised air escape creating a hissing noise and a 'waggling' motion. This system tries to imitate a snake to induce a 'startle' reaction from the bird. Despite the autonomous nature of this deterrent system it is relatively ineffective in scaring birds because the length of the tubes do not create a significant enough threat.

2.2.6.3 Advantages

- ✓ Suitable for large areas
- ✓ Environmentally safe
- ✓ Effective against most species of birds
- ✓ Can last up to 15 years

2.2.6.4 Limitations

- ✓ Ineffective if there are gaps or holes in the netting. Birds can easily fly through them.
- ✓ Limited in its protection to certain portions of the building.
- ✓ Accurate installation is very difficult, time consuming and expensive
- ✓ Obscures some architectural elements

2.3 Evaluation of Current Bird Deterrent Systems

2.3.1 Method of Evaluation

To evaluate current bird deterrent systems a set of criteria needs to be determined with a corresponding grading scale. As mentioned in the introduction the aim of this project is to design a system that is effective, and yet non-intrusive which makes these two criteria the most important. In this evaluation other factors such as cost, physical requirements and area covered will also be used to determine the best deterrent to undergo automation. A ranked positional method will be used in this 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.

The rating under each category is then multiplied by then importance factor at the top of the column, and the results summed for each deterrent. Once this is completed, averages can be calculated to determine the deterrent that best meets the criteria. Due to the lack of testing and information of some types of bird deterrents the below table only takes into account 17 of the current commercially available deterrents with many values of area covered and cost being taken from suppliers documentation. In cases where little or no information was available the effectiveness and area covered results are only hypothesized values in comparison to the other deterrents. The results of this evaluation are recorded in the Table 2.1.

Name	Cost (1)	Requirements (1)	Area Covered (2)	Stealth (2)	Effectiveness (3)	Automation Ability (2)	Total (10)
Motion Sensing Water Spray	$74.95 4	Electricity, Water 2	140 m^2 2	Good 2	Poor 2	Fair 3	
Score	4	2	4	4	6	6	26
Taste Repellent Gel	$16.00 5	None 5	NA 2	Good 4	Poor 2	Very Poor 1	
Score	5	5	4	8	6	2	30
Wires	NA 3	None 4	NA 3	Good 4	Fair 3	Very Poor 1	
Score	3	4	6	8	9	2	32
Ultrasonic System	$225.00 3	Electricity 3	557 m^2 4	Good 4	Very Poor 1	Poor 2	
Score	3	3	8	8	4	4	30
Shock Track	Various 3	Electricity 3	NA 3	Excellent 5	Poor 2	Very Poor 1	
Score	3	3	6	10	6	2	30
Spikes	$220.20 3	None 4	NA 3	Fair 3	Poor 2	Very Poor 1	
Score	3	4	6	6	6	2	27
Hawk Kite	$59.95 4	None 4	NA 3	Poor 2	Fair 3	Poor 2	
Score	4	4	6	4	9	4	31
Hot Foot	$50.50 4	None 4	NA 2	Good 4	Fair 3	Very Poor 1	
Score	4	4	4	8	9	2	31
Corpses	$7.50 5	None 5	NA 1	Fair 3	Poor 2	Very Poor 1	
Score	5	5	2	6	6	2	26
Revolving Hawk Eyes	NA 4	None 5	NA 3	Poor 2	Fair 3	Poor 2	
Score	4	5	6	4	9	4	31
Movement Activated Audio Deterrent	$75.00 4	Electricity 3	100 m^2 2	Poor 2	Good 4	Fair 3	
Score	4	3	4	4	12	6	33
Doppler Radar Controlled Compressed Air Tube	Varying 2	Electricity, Air Compressor 2	930 m^2 4	Poor 2	Fair 3	Good 4	
Score	2	2	8	4	9	8	33
Propane Cannon	$790.00 2	Propane Gas, Spark Plug 2	NA 4	Very Poor 1	Good 4	Good 4	
Score	2	2	8	2	12	8	34
Scarey Man	$1240 1	12 Volt Battery 4	6 Ha 5	Very Poor 1	Good 4	Very Poor 1	
Score	1	4	10	2	12	2	31
Laser Deterrents	$1300.00 1	Electricity, Operator 2	500 m 4	Excellent 5	Fair 3	Good 4	
Score	1	2	8	10	9	8	38
Strobe Light	$250.00 3	Electricity 3	930 m^2 4	Poor 2	Good 4	Fair 3	
Score	3	3	8	4	12	6	36
Revolving Scarecrows	NA 4	None 5	NA 3	Poor 2	Fair 3	Very Poor 1	
Score	4	5	6	4	9	2	30
						Average =	530/17= 31.17

Table 2.3.1: Evaluation of Bird Deterrents

2.3.2 Results of Evaluation

From the above table, the two bird deterrent systems that best matched the criteria were the strobe light and the laser deterrent. Both deterrents scored above the average of 31.17 and scored well in most areas with the cost of the laser system being lowest scoring category. Therefore the decision on what deterrent to automate for this project was between the laser deterrent and the strobe light with each having its advantages and disadvantages.

Laser deterrents are an effective, silent, highly directionable and almost undetectable form of bird deterrent which could be easily automated. However this technology comes at a high financial cost of around $2000 per unit and also creates many safety issues when being used around humans due the Class III B power rating. It would also be very difficult to create an effective laser deterrent that could achieve the accuracy of a birds eye and to compensate for this a larger laser would be required which would also greatly increase the cost.

Therefore the strobe light has been chosen as the best deterrent to automate due to its relatively low cost, effectiveness and area covered. Due to the fact that strobe lights can cause a nuisance to neighbouring properties in open areas (Bishop, McKay, Parott, Allan, 2003) a directional strobe will be used in order to only effect desired areas. To achieve this, the strobe light will be placed at the focal point of a parabolic concave mirror in order to produce light only in one direction.

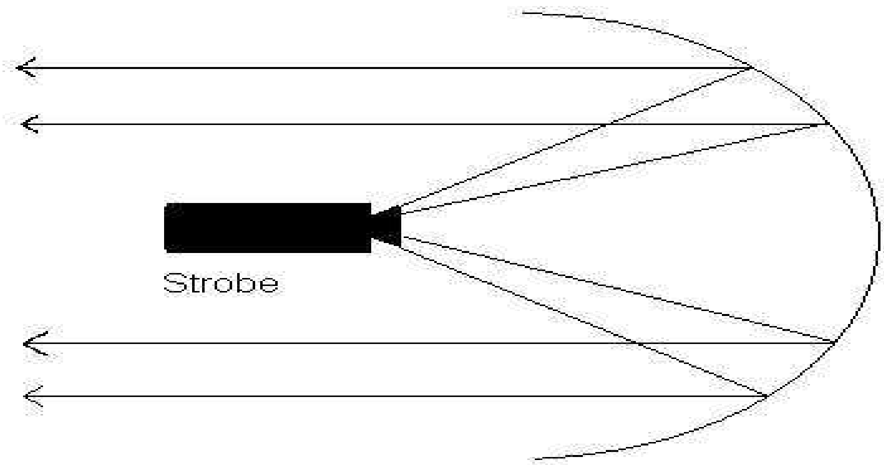


Figure 2.3.1: Directional Strobe Light (Bird Blaster Website)

This strobe device will be main deterrent in the designed system and will be combined with motion detection on a set of rotating panning axes and tilting axes to track a moving bird. The attachment of the strobe will be the final step in the construction of the deterrent before preliminary tests can be made.

2.4 Theory Motion Detection

Motion can be detected by measuring change in speed or vector of an object or objects in the field of view. This can be achieved either by mechanical devices that physically interact with the field or by electronic devices that quantify and measure changes in the given environment. When motion detection is accomplished by natural organisms, it is called motion perception. Motion can be detected by: sound (acoustic sensors), opacity (optical and infrared sensors and video image processors), geomagnetism (magnetic sensors, magnetometers), reflection of transmitted energy (infrared laser radar, ultrasonic sensors, and microwave radar sensors), electromagnetic induction (inductive-loop detectors), and vibration (triboelectric, seismic, and inertia-switch sensors). Acoustic sensors are based on: electret effect, inductive coupling, capacitive coupling triboelectric effect.

2.4.1 How the motion detector work

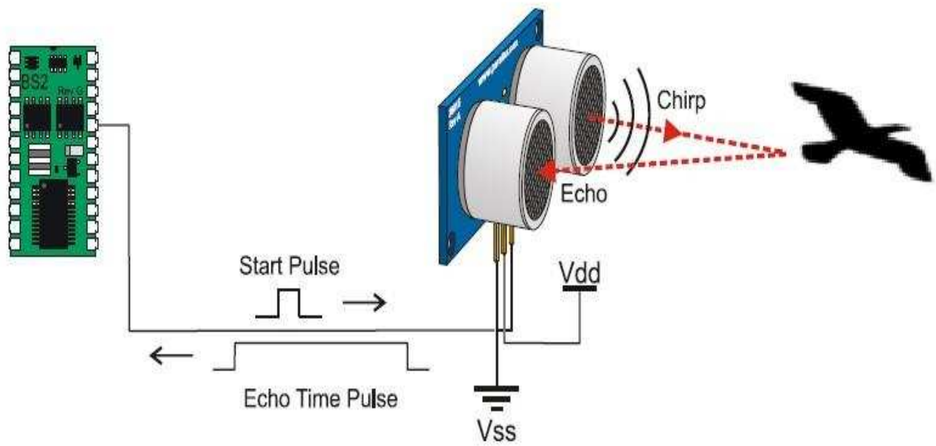


Figure 2.4.1: Motion detector simulation (HCSR04 Sensor Website)

The HCSR04 Ultrasonic Sensor uses sonar to determine distance to an object like bats or dolphins do. It offers excellent noncontact range detection with high accuracy and stable readings in an easytouse package. From 2cm to 400 cm or 1" to 13 feet. It operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). It comes complete with ultrasonic transmitter and receiver module.

CHAPTER

III

METHODOLOGY

3.0 Introduction

The AVITROL has been created as the bird control and improving old methods to detection the bird including combination with Laser deterrents and strobe light deterrents. As a result, from my research I am able to analyse problems and make recommendations based on other bird deterrent systems. In addition. A Motion Bird Detection System both immediate and long-term bird control.

The project method is divided into many phases. Phase one is to go through literature review to evaluate current bird deterrent systems. A set of criteria needs to be determined with a corresponding grading scale. The aim of this project as mentioned earlier is to design a system that is effective, and yet non-intrusive which makes these two criteria the most important, other factors such as cost, physical requirements, social and environmental effect should also be used to determine the best detection. Next, it is required to identify the appropriate components and associated logic needed. The following Phase focuses on the design and planning of system modules. The next phase will involve the integration of all these parts together. After that, experimental design phase is the part that finalized the prototype before phase five. Phase five is testing and verification stage.

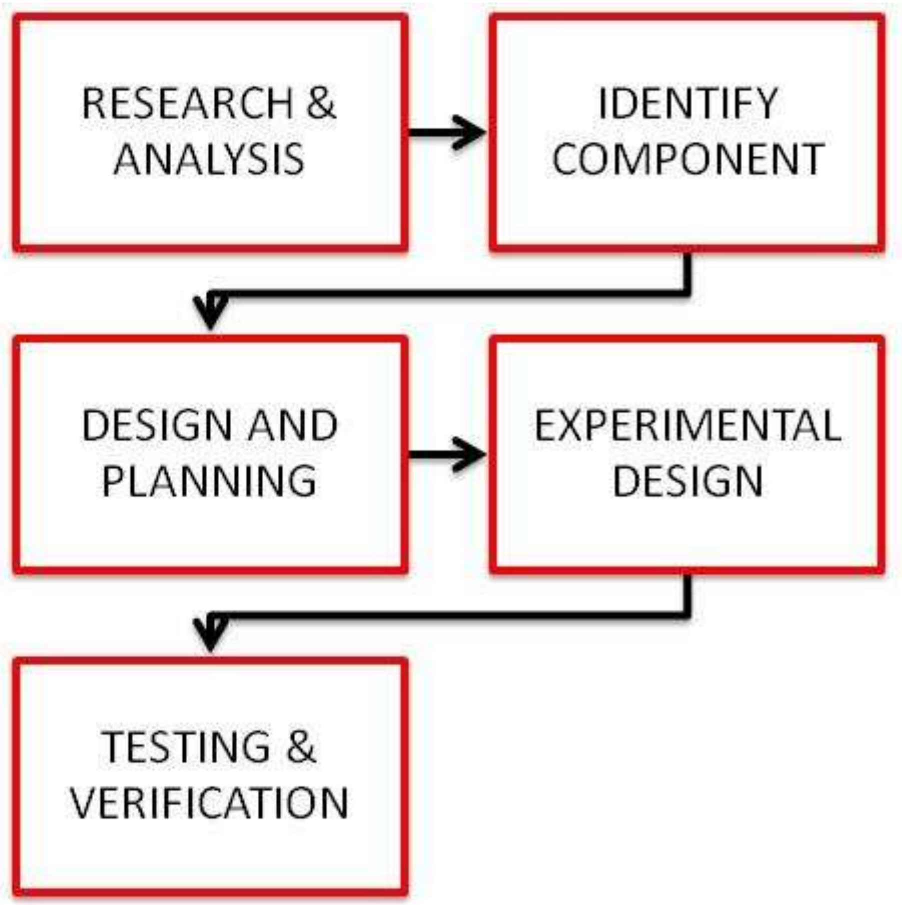


Figure 3.0.1: Project Method

3.1 Data collect from discussion for project method

In this topic, all the information about the detection system gathers from suggested made by lecture form the Electronic in Universiti Kuala Lumpur, Malaysian Institute of Aviation Technology (UnKL MIAT). The person is Mr. Zulhilmy Sahwee he said that, the best method to detect the bird is using the motion detector. A Motion Detection System that can detect base on moving objects. This is because a Ultrasonic Sensor is often integrated as a component of a system that automatically performs a task or alerts a user of motion in an area. He said we can meet the project objectives by research based on previous bird deterrent systems.

3.2 Motion Applications in Bird Detection

As seen already there are large numbers of different tools and techniques that can be useful in the area of bird scaring. For this project however the focus will be first on motion detection and the later on edge detection and movement. The device chosen for motion was the HCSR04 Ultrasonic Sensor because it connects directly to a microcontroller Arduino via a USB cable and has a digital output. Sensor works by transmitting an ultrasonic (well above human hearing range) burst and providing an output pulse that corresponds to the time required for the burst echo to return to the sensor. By measuring the echo pulse width, the distance to target can be detected. In our case, we set it to be 30 seconds for the sensor to be stable. Once detected, an electronic signal can activate the bird detection of the motioned.

3.3 Conceptual Design and Requirements

The main conceptual design of this deterrent is to have a motion detector that is mounted on a mechanical system that can rotate and tilt to constantly have its target centred. It must easily adapt to different types of deterrents such as the directional strobe light and laser deterrent and be able to connect to a PC. The movement required to move the motion detector and deterrent device must be able to be controlled by the computer and have switches that indicate the limits of movement. From these requirements the following device was conceptualised.

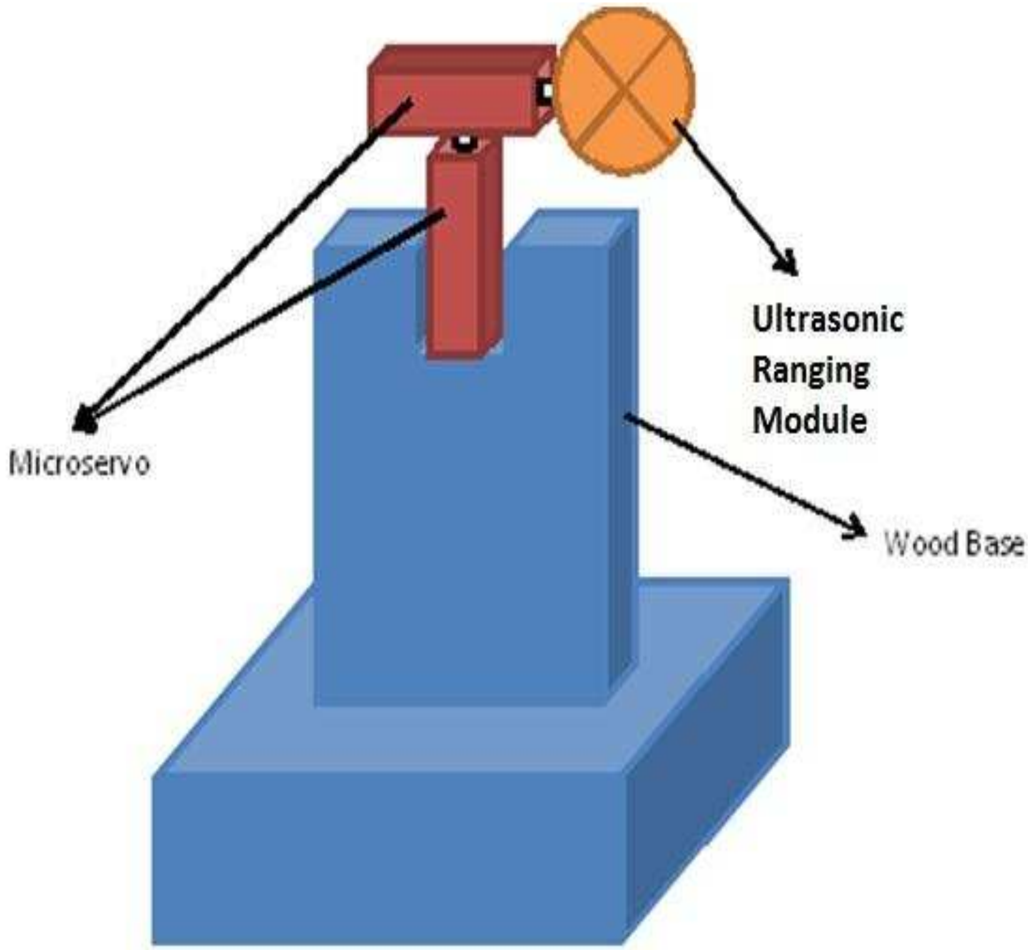


Figure 3.3.1: Conceptual Design for AVITROL

The motion detection and transmits them via the USB cable to the computer. After the microcontroller preprocessing, then outputs a signal via the microservo that drives the motion detector to the desired direction (2 axis).

3.4 Design Diagram AVITROL

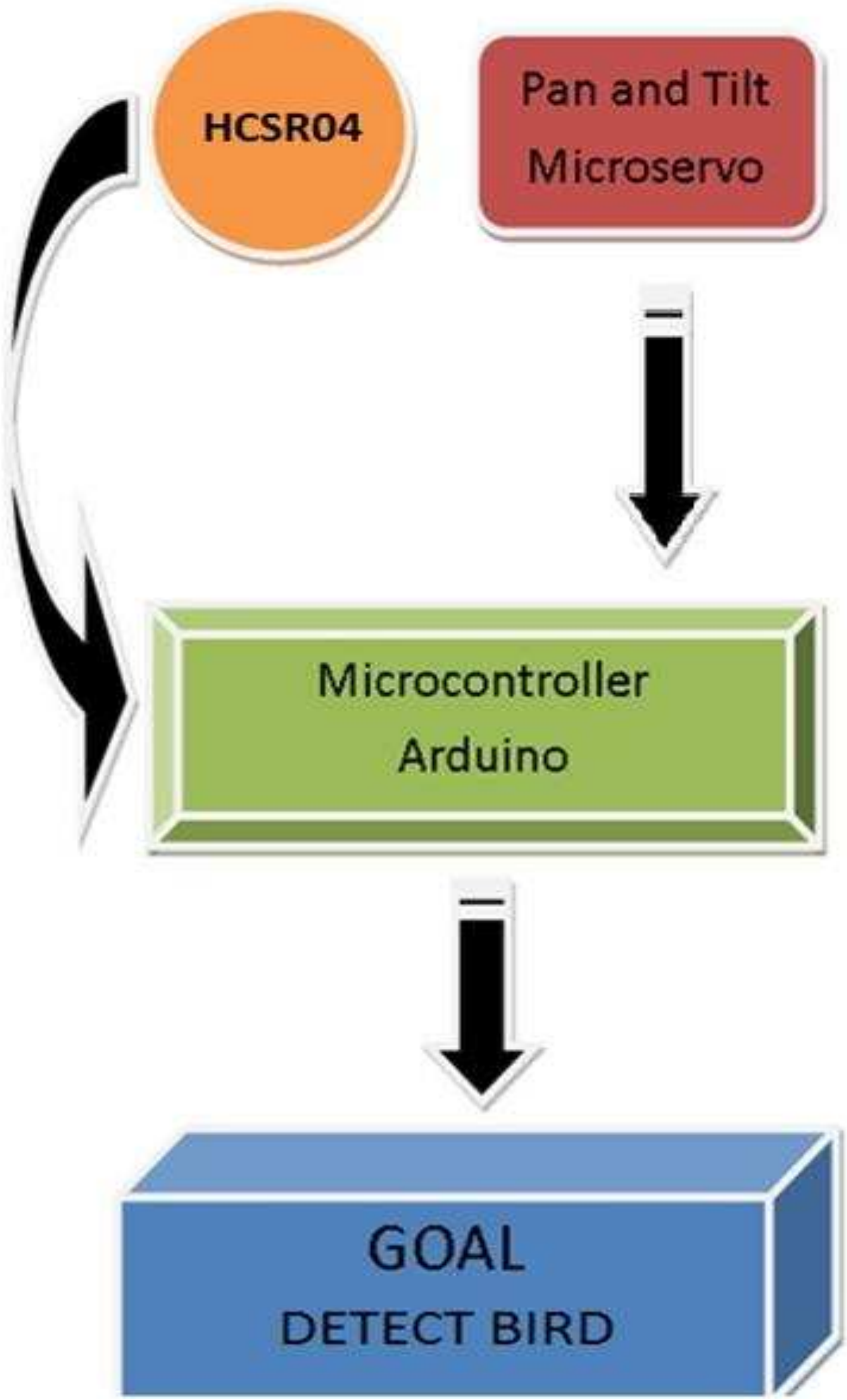


Figure 3.4.1: Block Diagram

3.5 HCSR04 Ultrasonic Sensor

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit.

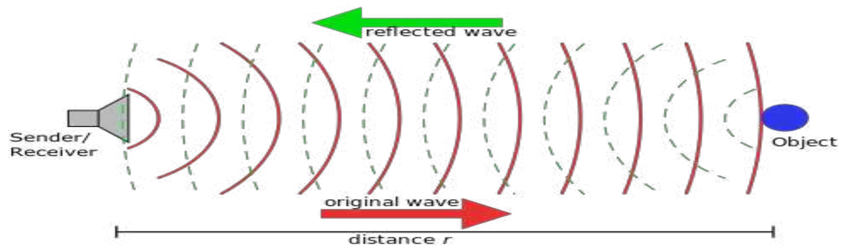


Figure 3.5.1: Ultrasonic ranging module HC - SR04 (HC - SR04 Sensor Website)

3.5.1 Working Principle

a) Adopt IO trigger through supplying at least 10us sequence of high level signal.
b) The module automatically send eight 40khz square wave and automatically detect whether receive the returning pulse signal.
c) If there is signals returning, through outputting high level and the time of high level continuing is the time of that from the ultrasonic transmitting to receiving.
d) Test distance = (high level time × velocity of sound (340M/S) / 2
   i. Model: HC-SR04
   ii. Working voltage : 5V(DC)
   iii. Static current: Less than 2mA.
   iv. Output signal: Electric frequency signal, high level 5V, low level 0V.
   v. Sensor angle: Not more than 15 degrees.
   vi. Detection distance: 2cm~450cm.
   vii. High precision: Up to 3mm
   viii. Mode of connection: VCC / trig(T) / echo(R) / GND

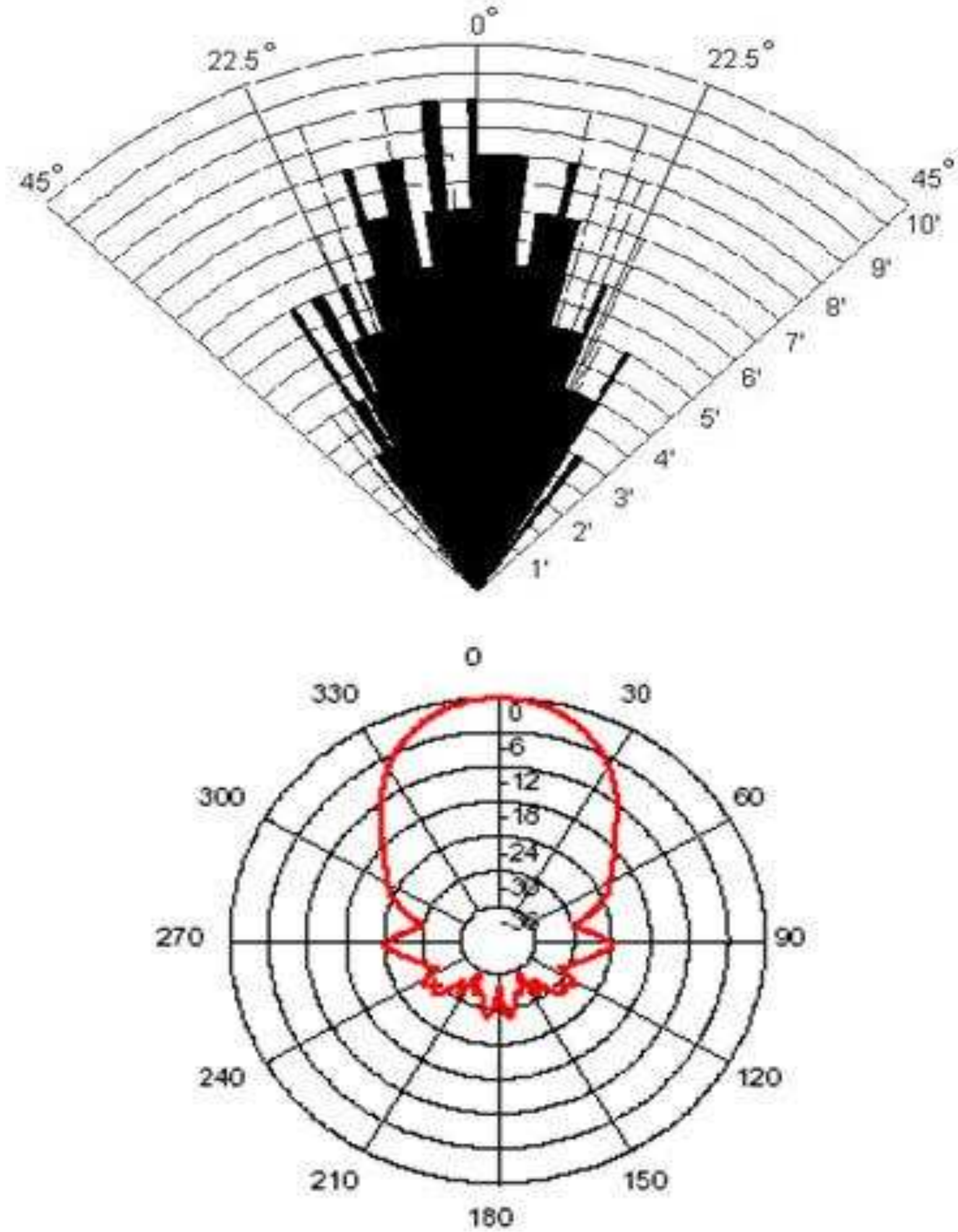


Figure 3.5.2: Propagation area of Sensor

3.5.2 Advantages

a) Ultrasonic Sensors will itself recover its cost by reducing electricity bills and will further save electricity cost for the future.

b) Very easy installation and can be installed by in – house technician itself.

c) No separate wiring is required hence no additional installation cost.

d) No modification is required and complies with current aesthetics.

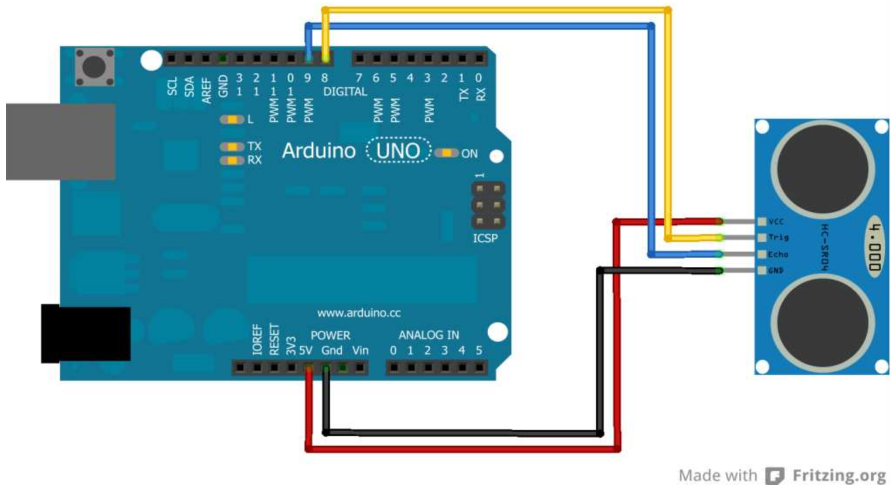


Figure 3.5.3: Connections of HC - SR04 Sensors

3.6 Microservo

A device used to provide control of a desired operation through the use of feedback. To control the movement of the motion sensor, will use two microservo. The "pan" servo controls the side-to-side (x-axis) movement of the motion sensor. The "tilt" servo controls the up-down (y-axis) movement of the motion sensor.

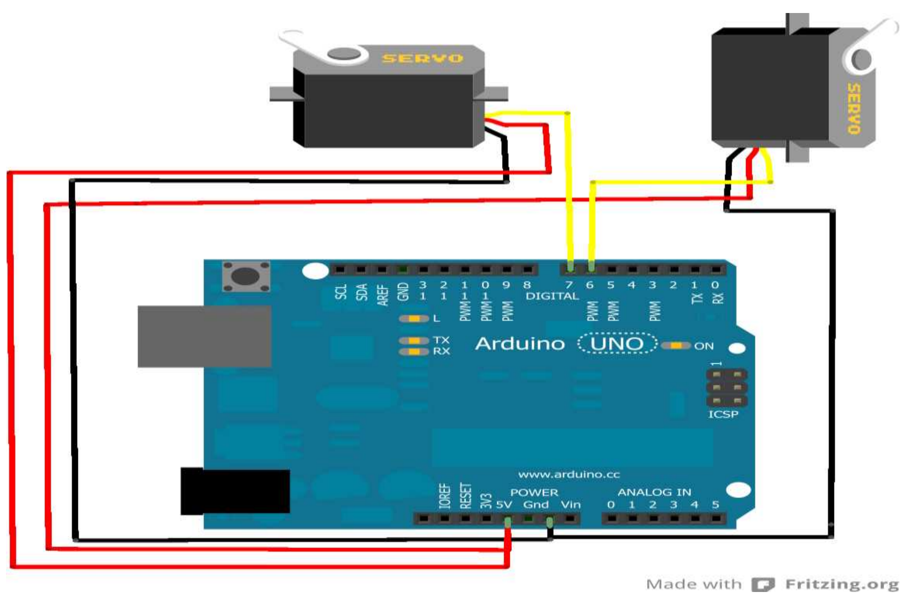


Figure 3.6.1: Connections of Microservo

3.7 Pan/Tilt Bracket

This pan/tilt bracket consists of two brackets and all the hardware need to attach them to make a pan/tilt mechanism using two microservo. Find the motion detector center of gravity, and mount it at that point. This is so the servo doesn't have to waste energy trying to keep the gun level. Important, when the servo has no power supplied to it, the gun should tilt freely, and when move it with it should not return to level - rather it should stay right where it let go. Spend a lot of time getting this balance just right, it is a major factor in the effectiveness of finished sentry.

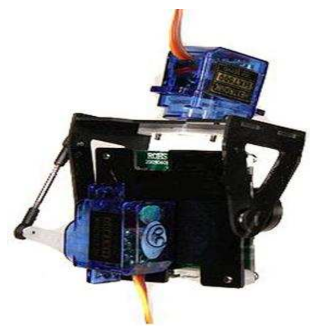


Figure 3.7.1: Pan/Tilt Bracket and Microservo

3.8 Jumper Wire

Jump wires can be obtained in ready-to-use jump wire sets or can be manually manufactured. The latter can become tedious work for larger circuits. Ready-to-use jump wires come in different qualities, some even with tiny plugs attached to the wire ends.

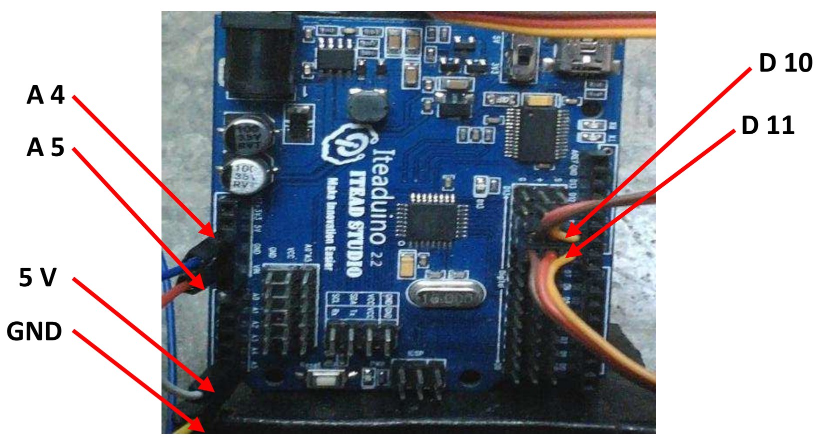
3.9 USB A to B cable and plug

Universal Serial Bus (USB) is a cables, connectors and communications protocols used in a bus for connection, communication, and power supply between computers and electronic devices. USB in this project was used to connecting two proses which, first is connecting the arduino board to computer in uploading process and second for connecting the arduino board to power supply USB plug converted 240VAC to 5VDC.

3.10 Hardware Connection

The Arduino connects to the computer through the USB A to B cord. This also powers the Arduino board itself (but not the servos). I will need a separate power source for my servo's. Check the data sheet to find the power consumption for my servos.

1. Servo motors have three wires: power, ground, and signal. Each servo's power wire is typically red, and should be connected to the (+) wire from my servo power source. Some users add a switch in series with this wire so they can turn the power to the servos on and off .
2. The ground wire is typically black or brown and should be connected to a ground pin on the Arduino board, and to the (-) wire of my power source.
3. The signal wire is typically yellow, blue, black, or red and should be connected as follows:
   a) x-axis servo's signal wire goes to the Arduino's digital I/O pin 10
   b) y-axis servo to pin 11
   c) Trig of Ultrasonic ranging module HC - SR04 signal wire goes to the Arduino's pin A4
   d) Echo Ultrasonic ranging module HC - SR04 to pin A5
4. Make sure that the (-) wire of the servo power source is also connected to the GND pin on the Arduino board.



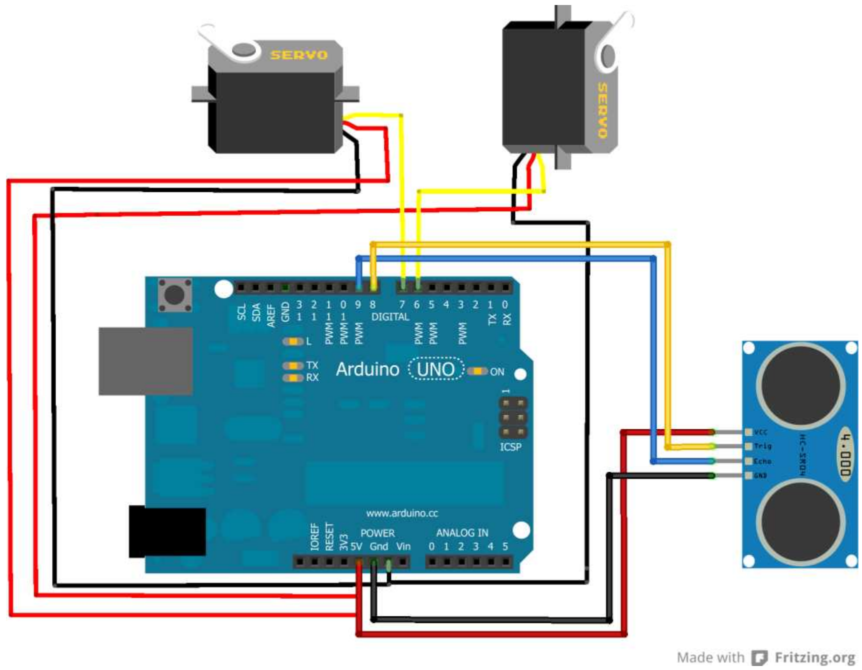


Figure 3.10.1: Wiring Diagram mock up of AVITROL

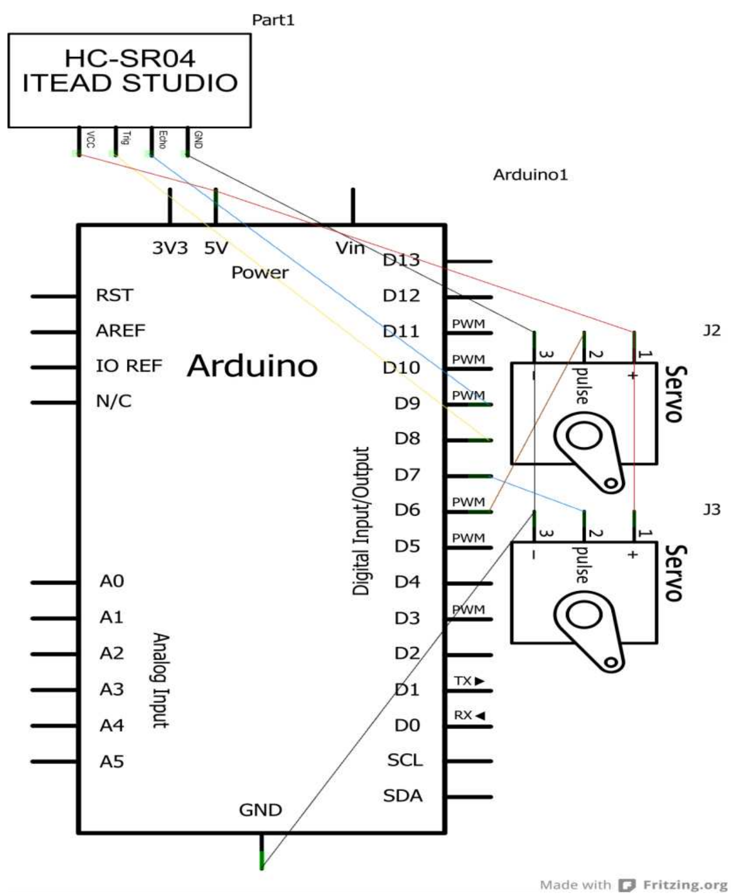


Figure 3.10.2: Schematic Diagram mock up of AVITROL

3.11 Software Development

Arduino is a single-board microcontroller designed to make the process of using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open source hardware board designed around an 8-bit Atmel AVR microcontroller, though a new model has been designed around a 32-bit Atmel ARM. The software consists of a standard programming language compiler and a boot loader that executes on the microcontroller. Iteaduino is an Arduino compatible board. It’s designed based on Duemilanove scheme, 100% compatible to its existing program, shield and IDE. On the hardware part, remarkable changes are taken to improve the flexibility and user experience.

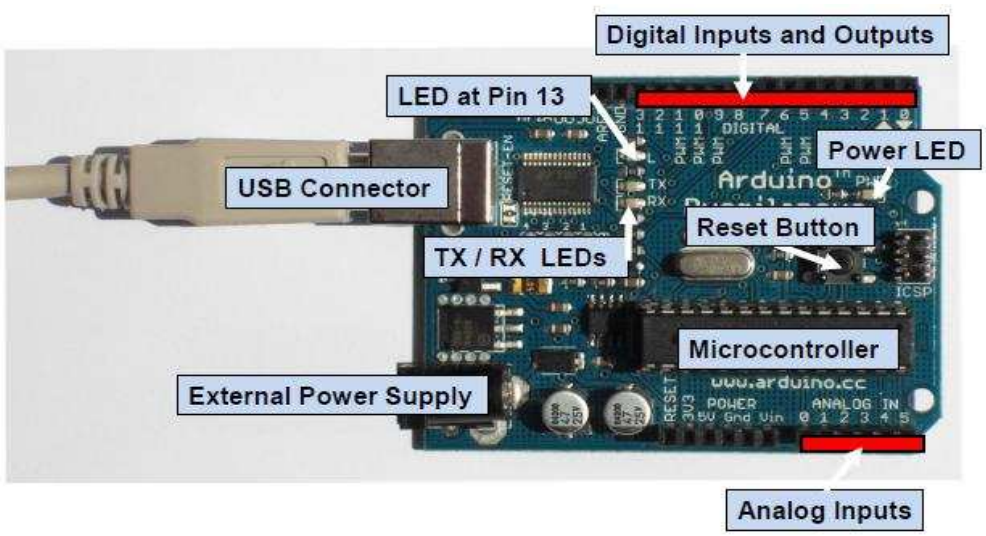


Figure 3.11.1: Arduino Iteaduino (Arduino Website)

3.11.1 Basic features

a) Inherits all of Arduino Duemilanove’ s features.
b) Compatible with Arduino UNO/Duemilanove pins, holes and dimensions.
c) 3.3V/5V Operating Voltage selection
d) More visible location of Indicator LEDs
e) Wide range external input from 7~23V DC
f) All pins out for Sensor and Servo
g) UART/IIC interface breakout

The Arduino integrated development environment (IDE) is a cross-platform application written in Java, and is derived from the IDE for the Processing programming language and the Wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. There is typically no need to edit make files or run programs on a command-line interface. A program or code written for Arduino is called a sketch.

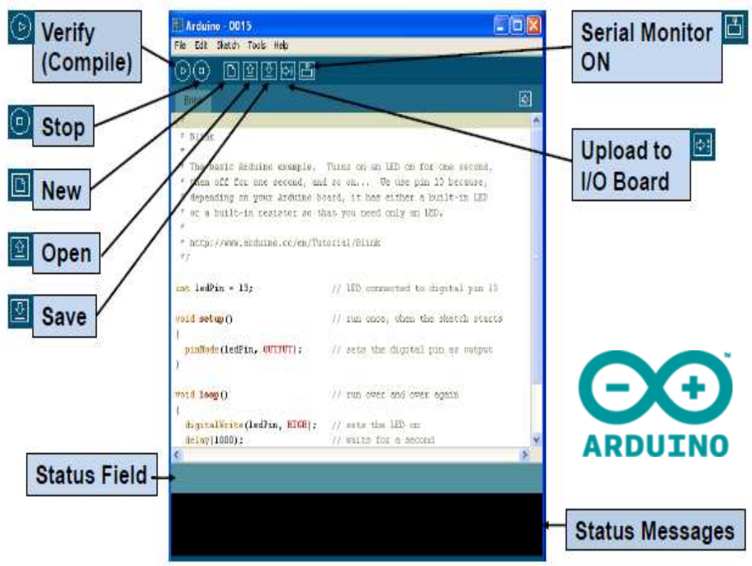


Figure 3.11.2: Arduino Program Software (Arduino Website)

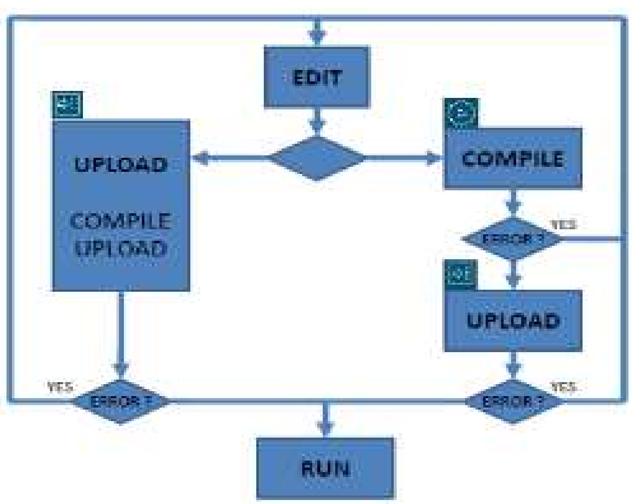


Figure 3.11.3: Cycle of Development (Arduino Website)

3.12 Program Flow Chart

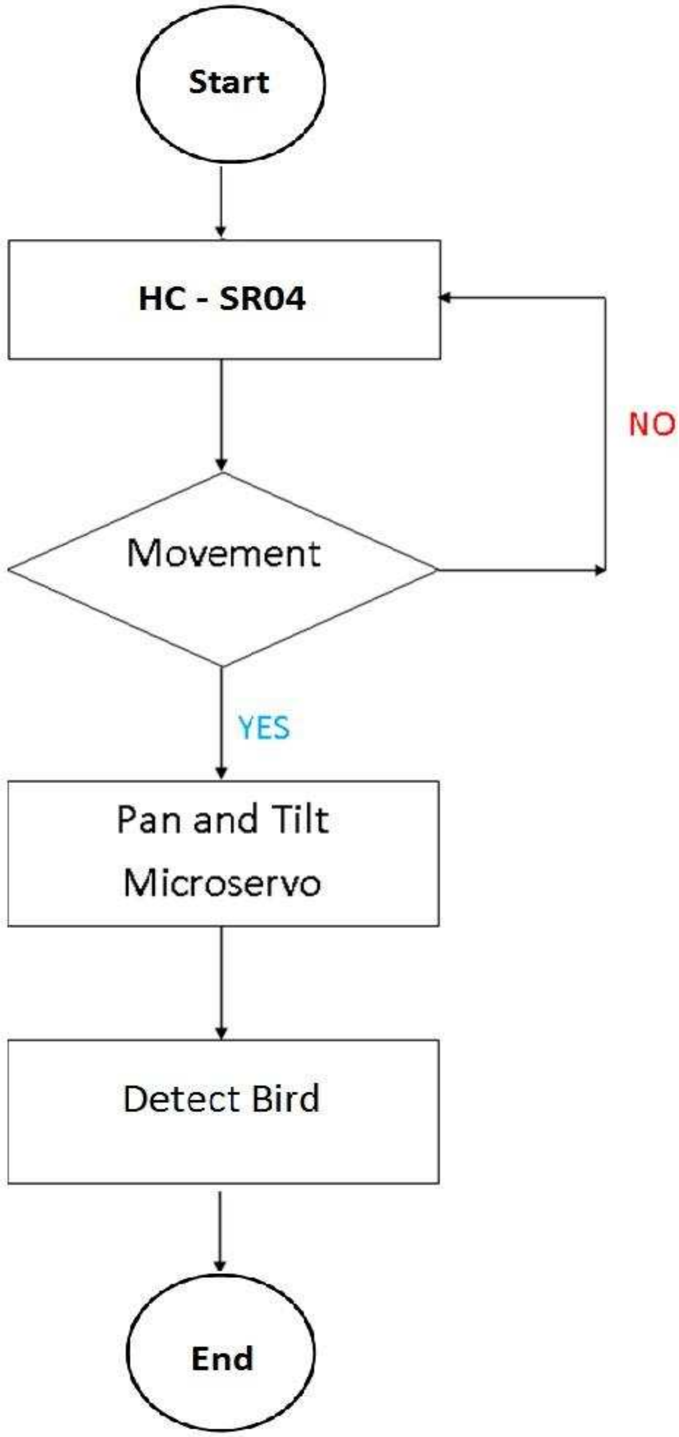


Figure 3.12.1: AVITROL Flow Chart

3.13 Source IDE Code for AVITROL

```
#include <Servo.h> // need the standard Arduino servo library
int panPin = 10;  // this is Servo used for panning (horizontal plane movement)
int tiltPin = 11; // This is Servo used for tilting (vertical plane movement)
Servo panServo, tiltServo;
int trigPin = A4;   // Analog pin 0 used for the Ping Pin (Trig)
int echoPin = A5;   // Analog pin 1 used for the Echo Pin (Echo)
unsigned long duration, inches;
int indec, cmdec;
int inchconv = 147; // ratio between pulse width and inches
int cmconv = 59;    // ratio between pulse width and cm
int panCentre = 110;
void setup()
{
 Serial.begin(115200); // initialize the ultrasonic sensor pins and centre the servos
 pinMode(trigPin, OUTPUT);
 pinMode(echoPin, INPUT);
 panServo.attach(panPin, 1000, 2000);
 tiltServo.attach(tiltPin, 1000, 2000);
 pointCentre();
 tiltServo.write(90);
}
void loop()
{
 int cm, lcm, rcm;
 forward(100, 200);
 cm = getDistance();
 if(cm < 30)
 {
  halt(0);
  pointLeft();
  lcm = getDistance();
  pointRight();
  rcm = getDistance();
  pointCentre();
  reverse(400, 255);
  halt(0);
  if (rcm < lcm)
   rightSpin(200);
  else
   leftSpin(200);
  halt(0);
 }
}
void pointLeft()
```

```
{
  panServo.write(panCentre - 60);
  delay(150); // wait for servo to get there
}
void pointRight()
{
  panServo.write(panCentre + 60);
  delay(300); // wait for servo to get there
}
void pointCentre()
{
  panServo.write(panCentre);
  delay(150); // wait for servo to get there
}
int getDistance()
{
  int rval;
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH, 38000L);  // Set timeout to 38mS
  rval = microsecondsToCentimeters(duration);
  Serial.println(rval);
  return rval;
}
long microsecondsToCentimeters(long microseconds)
{
  return microseconds / cmconv;
void reverse(int wait, int vSpeed)
{
  Serial.println("Moving backward");
  robMove(255-vSpeed, HIGH, 255-vSpeed, HIGH);    // when reversing, the speed
needs to be opposite, so subtract from 255
  delay(wait);
}
void forward(int wait, int vSpeed)
{
  Serial.println("Moving forward");
  robMove(vSpeed, LOW, vSpeed, LOW);
  delay(wait);
}
void rightSpin(int wait)
{
  Serial.println("Spinning right");
  robMove(255, LOW, 0, HIGH);
```

```
 delay(wait);
}
void leftSpin(int wait)
{
 Serial.println("Spinning left");
 robMove(0, HIGH, 255, LOW);
 delay(wait);
}
void rightTurnFd(int wait, int lSpeed, int rSpeed)
{
 Serial.println ("Turning right forward");
 robMove(lSpeed, LOW, rSpeed, LOW);
 delay(wait);
}
void leftTurnFd(int wait, int lSpeed, int rSpeed)
{
 Serial.println("Turning left forward");
 robMove(lSpeed, LOW, rSpeed, LOW);
 delay(wait);
}
void rightTurnBd(int wait, int lSpeed, int rSpeed)
{
 Serial.println("Turning right backward");
 robMove(255-lSpeed, HIGH, 255-rSpeed, HIGH);
 delay(wait);
}
void leftTurnBd(int wait, int lSpeed, int rSpeed)
{
 Serial.println("Turning left backward");
 robMove(255-lSpeed, HIGH, 255-rSpeed, HIGH);
 delay(wait);
}
void halt(int wait)
{
 Serial.println("Stopping");
 robMove(0, LOW, 0, LOW);
 delay(wait);
}
```

3.14 Material Selection

The material selection for this project is not of a great importance because no critical loads are being carried and no significant force is created. The selection of the material was then mostly based on categories such as cost, availability, weight and workability. Light metals such as aluminium were considered but however, were not selected because of their ability to create electrical interference. Therefore wood was chosen as the construction material because of its low cost and inert nature. It is dense, flat, stiff, has no knots and is easily machined. It is a hard, fibrous structural tissue found in the stems and roots of trees and other woody plants. In addition, rubber tape was been cover on the wood surface to minimize the vibration due to movement of microservo.

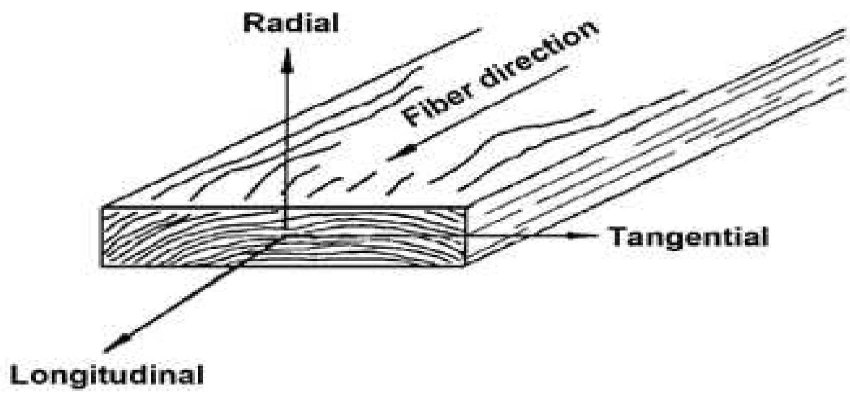


Figure 3.14.1: Physical and Mechanical Wood Properties (Material Website)

3.15 How Mock Up of AVITROL work

Sensor will tie to the Pan and Tilt bracket. When it detects any background movement, it will send signal to microcontroller. When microcontroller receives the signal from the Ultrasonic ranging module HC - SR04. Its inside logic will analyse and process the signal. Then it will send command signal to the Servo Controller and Microservo. The Microservo will be triggered by the signal from the Servo Controller. It will start moving Y and X axis following the movement and finally alert the bird repeller to generate.

3.16 Calibration

After the turret is built, I have to go through a “calibration” process, which matches the motion by make the microcontroller work correctly together with the PIR Sensor and microservo to moving as motion detector is inverted on either the horizontal (pan) axis or on the vertical (tilt) axis.

3.17 Mounting instructions

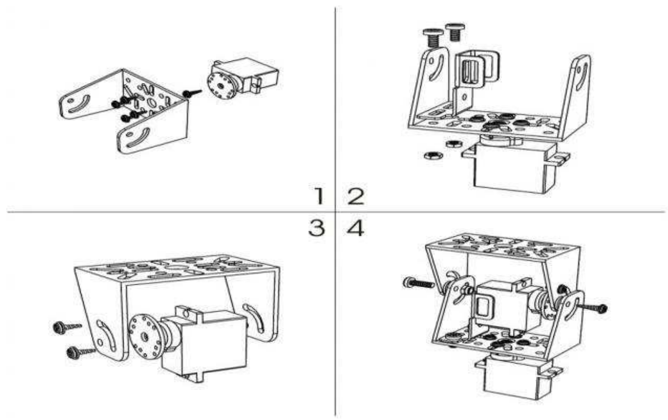


Figure 3.17.1: Microservo Bracket (Hobby King Website)

3.18 Motion Bird Detection System (AVITROL)

I. For this project will need components:

a) Ultrasonic ranging module HC - SR04
b) Microservo
c) Pan/Tilt Bracket
d) Wood Base
e) Solderless Breadboard
f) Jumper Wire
g) USB A to B cable
h) USB Plug
i) Arduino Iteaduino 2.0 Board

II. The breadboard is prepared, the power is connected and grounded to the power from the microcontroller. On the Arduino module the 5V and any of the ground connection are used

III. An x axis servo signal wire is connected to the Arduino digital pin 10, y-axis connected to pin 11, Trig of Ultrasonic ranging module HC - SR04 signal wire goes to the Arduino digital pin A4 and Echo Ultrasonic ranging module HC - SR04 connected to Digital pin A5.

IV. The microcontroller is programmed, then opened the code in the Arduino IDE software and uploaded it to the Arduino using a standard USB cable. The USB cable from Arduino is unplugged before proceeding

V. The complete project is tested and described below

Figure 3.18.1: Component preparation

Figure 3.18.2: Microservo attach to wood base

Figure 3.18.3: HC - SR04 bonding on Pan/Tilt Bracket

Figure 3.18.4: Motion Bird Detection System (AVITROL)

3.19 Testing and modification

The testing of the prototype was vital in achieving the project objectives. A comprehensive test procedure was developed for each test. This involved an aim, procedure, safety checklist, risk assessment, results and conclusion. The tests were performed in the following order.

3.20 Oscilloscope Voltage Measure

Figure 3.20.1: Distance Testing Procedure

The Arduino board is attach with an ultrasonic distance sensor, measuring distances up to 80cm. Signal will send a 10 us pulse on Trig In reaction to this, the sensor will send 8 sonic bursts to measure the distance. After sending the burst, the sensor will raise the Echo signal until it receives the echo back. That means the length of the Echo signal corresponds to time the burst was travelling forward and echoed back.

Figure 3.20.2: How the HC - SR04 Sensor work

The oscilloscope displays waveforms on a graph that shows the shape, voltage, and frequency of an electrical signal. When it displays a sine wave, the scope is capable of measuring its frequency by using the graph on the screen and the SEC/DIV (seconds per division) control located in the horizontal section of the oscilloscope face. The display screen below consists of a grid with vertical and horizontal lines. When reading voltage, the horizontal space between the vertical lines is used. After the 10 us Trigger signal, the sensor sends the burst during ’1′ and ’2′ (around 456 us), followed by the Echo signal duration of 756 us. The 756 us corresponds to the time it took for the burst to come back.

The speed of sound is about 340 m per second (depends on temperature and air relative humidity). A good approximation is 29 us per cm (or 58 us per cm as it is for back and forward). With the above example, the 756 us would result in 756/29/2 = 13 cm distance.

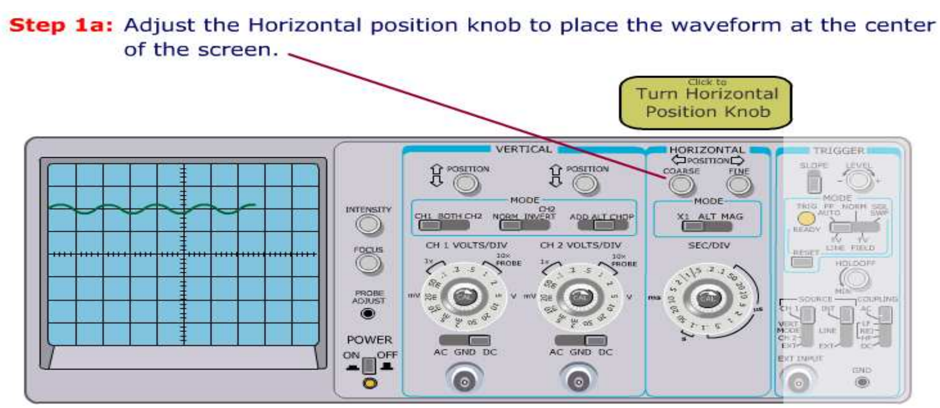


Figure 3.20.3: Horizontal adjustment

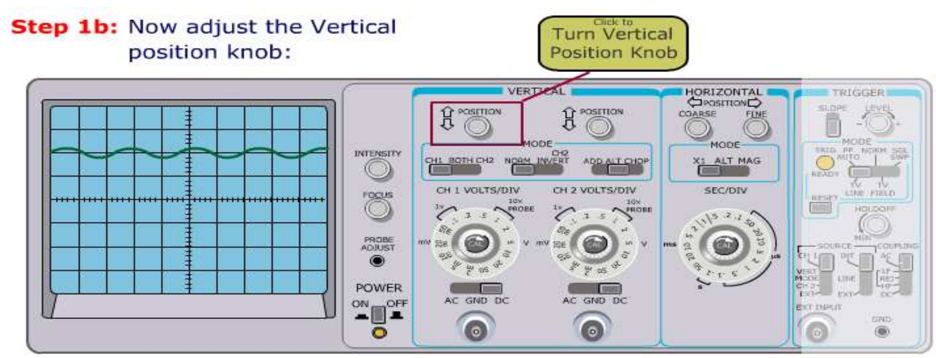


Figure 3.20.4: Vertical adjustment

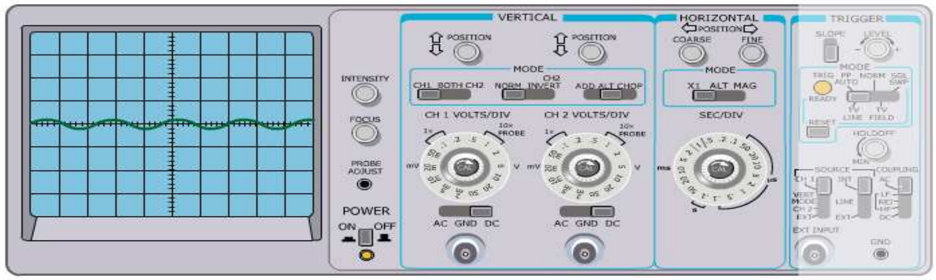


Figure 3.20.5: After preliminary adjustments

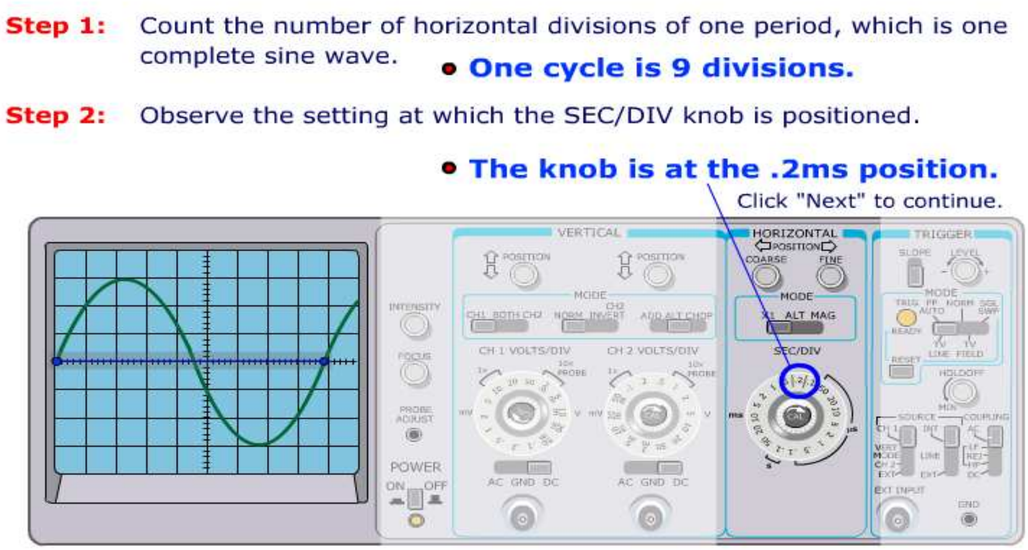


Figure 3.20.6: Voltage calculation

Distance Object, cm	Output Voltage, v
10	2.3
20	1.3
30	0.9
40	0.7
50	0.6
60	0.5
70	0.4
80	0.3

Table 3.20.1: Data of Distance Testing

CHAPTER

IV

RESULT AND DISCUSSION

4.0 Introduction

My part is calculated the important factor, range distance requirement and area coverage before and after completed design. In the previous chapter III have done calculations to determine the range distance requirement and area coverage that the prototype of **Motion Bird Detection System** needs to have and a few test that will occur once the prototype is completed. There were some changes that were done in terms of electronic components which changed the earlier range distance requirement and area coverage which was calculated in the chapter IV.

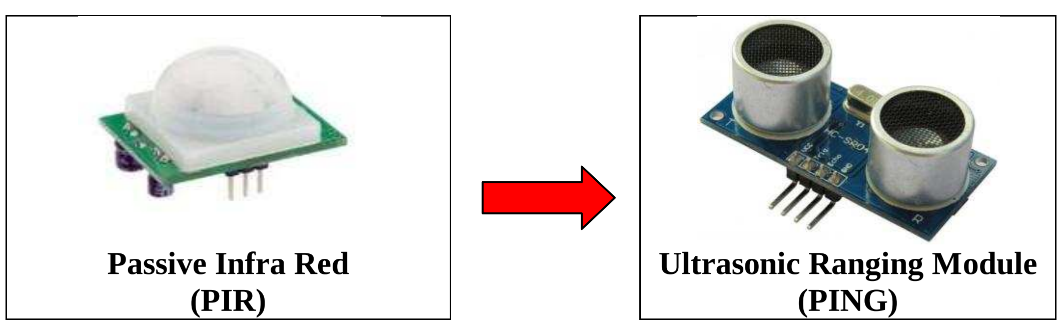


Figure 4.0.1: Electronic components which changed

4.1 Results

As a result, I found that the detection from my prototype need to be Ultrasonic Ranging Module not Passive Infrared Sensor is because the PIR sensor only give output 1/0 binary code does given sense to servo to move. Then after few discussion, I decide change the sensor method.

The Timing diagram is shown below. You only need to supply a short 10uS pulse to the trigger input to start the ranging, and then the module will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo. The Echo is a distance object that is pulse width and the range in proportion .You can calculate the range through the time interval between sending trigger signal and receiving echo signal. Formula: uS / 58 = centimeters or uS / 148 =inch; or: the range = high level time * velocity (340M/S) / 2; we suggest to use over 60ms measurement cycle, in order to prevent trigger signal to the echo signal.

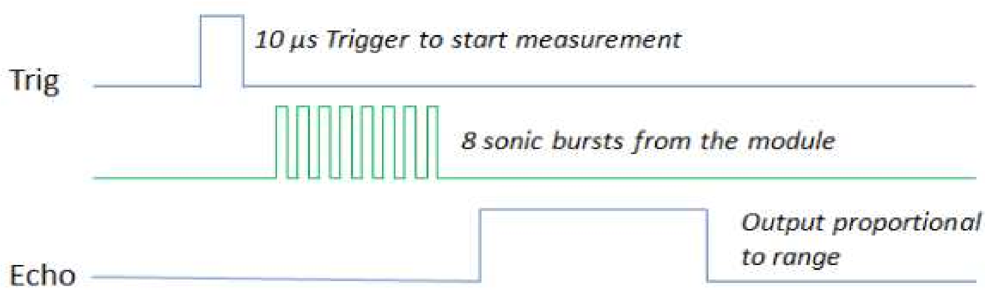


Figure 4.1.1: Timing diagram for PING

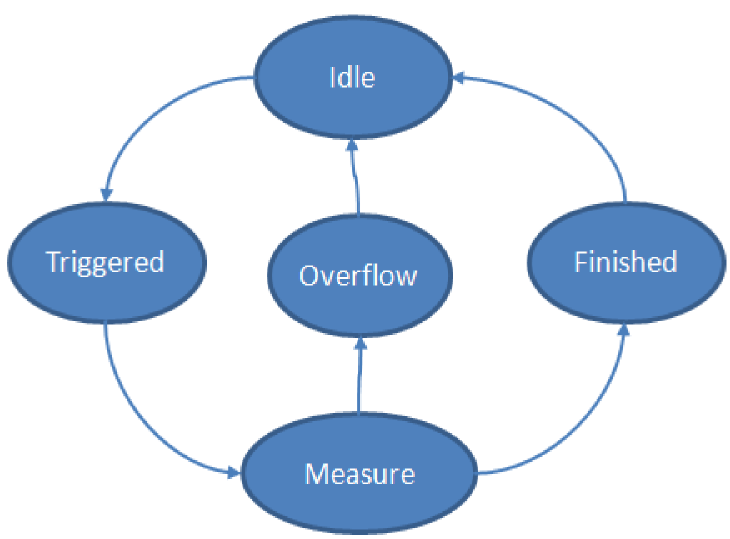


Figure 4.1.2: Process of PING sensor

1. Idle: Sensor is idle
2. Triggered: we sent the trigger signal to the sensor
3. Measure: we received raising edge of echo signal and are measuring
4. Overflow: Counter overflow happened (see above)
5. Finished: received falling echo signal edge and we have captured the echo signal time

Another way is to show the different states on the timing diagram (without the Overflow case):

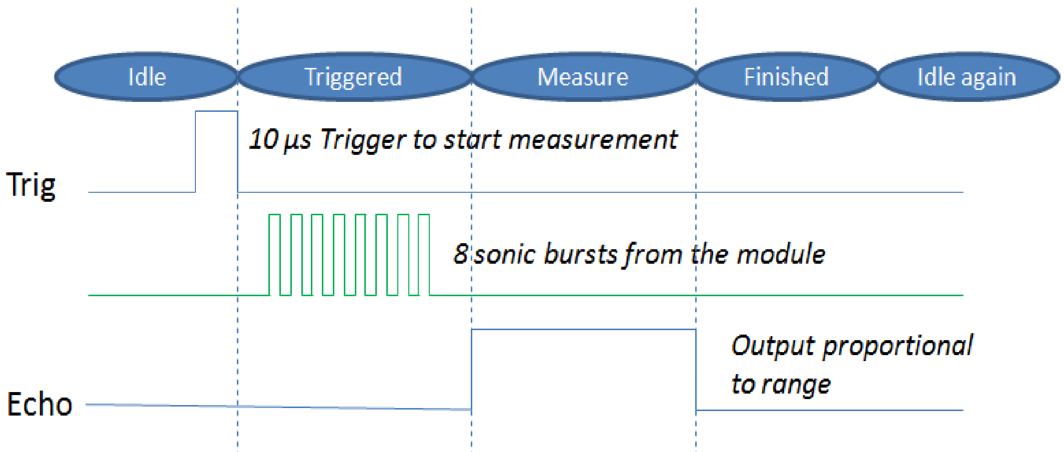


Figure 4.1.3: Timing diagram and process of PING

The PING sensor detects objects by emitting a short ultrasonic burst and then "listening" for the echo. Under control of a host microcontroller (trigger pulse), the sensor emits a short 40 kHz (ultrasonic) burst. This burst travels through the air, hits an object and then bounces back to the sensor. The PING sensor provides an output pulse to the host that will terminate when the echo is detected, hence the width of this pulse corresponds to the distance to the target.

	Host Device	Input Trigger Pulse	t_{OUT}	2 µs (min), 5 µs typical
	PING))) Sensor	Echo Holdoff	$t_{HOLDOFF}$	750 µs
		Burst Frequency	t_{BURST}	200 µs @ 40 kHz
		Echo Return Pulse Minimum	t_{IN-MIN}	115 µs
		Echo Return Pulse Maximum	t_{IN-MAX}	18.5 ms
		Delay before next measurement		200 µs

Table 4.1.1: Timing diagram for PING

Object positioning for The PING sensor cannot accurately measure the distance to an object that:

a) Is more than 3 meters away,
b) That has its reflective surface at a shallow angle so that sound will not be reflected back towards the sensor,
c) Is too small to reflect enough sound back to the sensor. In addition, if your PING sensor is mounted low on your device, you may detect sound reflecting off of the floor.
d) Object is too soft, mean the trigger output did not receive the actual echo.

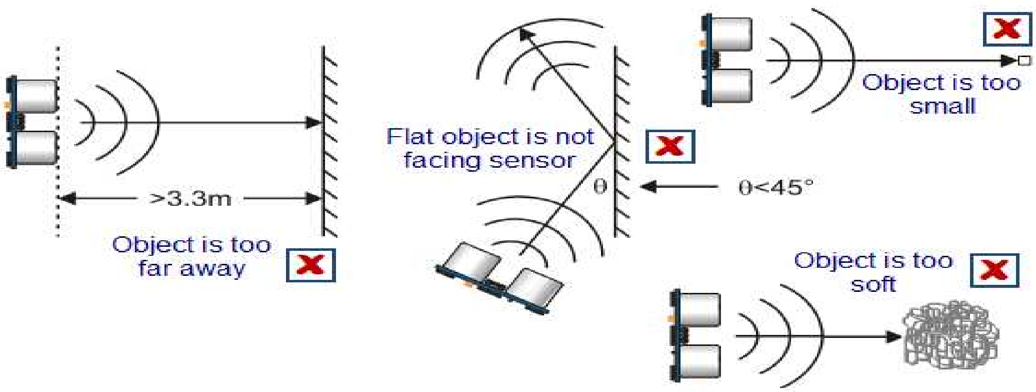


Figure 4.1.4: Angle of detection object

Target object material that absorb sound or have a soft or irregular surface, such as a stuffed animal, may not reflect enough sound to be detected accurately. The PING sensor will detect the surface of water, however it is not rated for outdoor use or continual use in a wet environment. Condensation on its transducers may affect performance and lifespan of the device. Air temperature has an effect on the speed of sound in air that is measurable by the PING sensor. If the temperature (°C) is known, the formula is:

$$C_{air} = 331.5 + (0.6 \times T_C)\ m/s$$

The percent error over the sensor’s operating range of 0 to 70 ° C is significant, in the magnitude of 11 to 12 percent. The use of conversion constants to account for air temperature may be incorporated into the program. Percent error and conversion constant calculations are in Chapter IV.

4.2 Discussion

From the results in the table, there are a few obvious changes to the value method of the motion detection. Estimated values that are usually calculated using statistical analysis are different from the value using the ultrasonic theory on the prototype. The value gained from the ultrasonic theory is the combination from the experiment value that is more accurate because most of the data that exist like the resistance and capacitance value also plays a role in determining the frequency ranges. It is taken from the experiment done in the chapter IV.

The experimental voltage is lesser that the theory value because the model is calculated based on the actual voltage. This value is considered as a success because the percentage of difference is low. Once the voltage value is calculated with the oscilloscope, the voltage value such as coverage area and material is also need to be calculate which is are effected in detection factor.

Finally I can conclude that after the analysis is done on the prototype, I have succeeded in producing a value voltage for the coverage area that is suitable for the needs of the project.

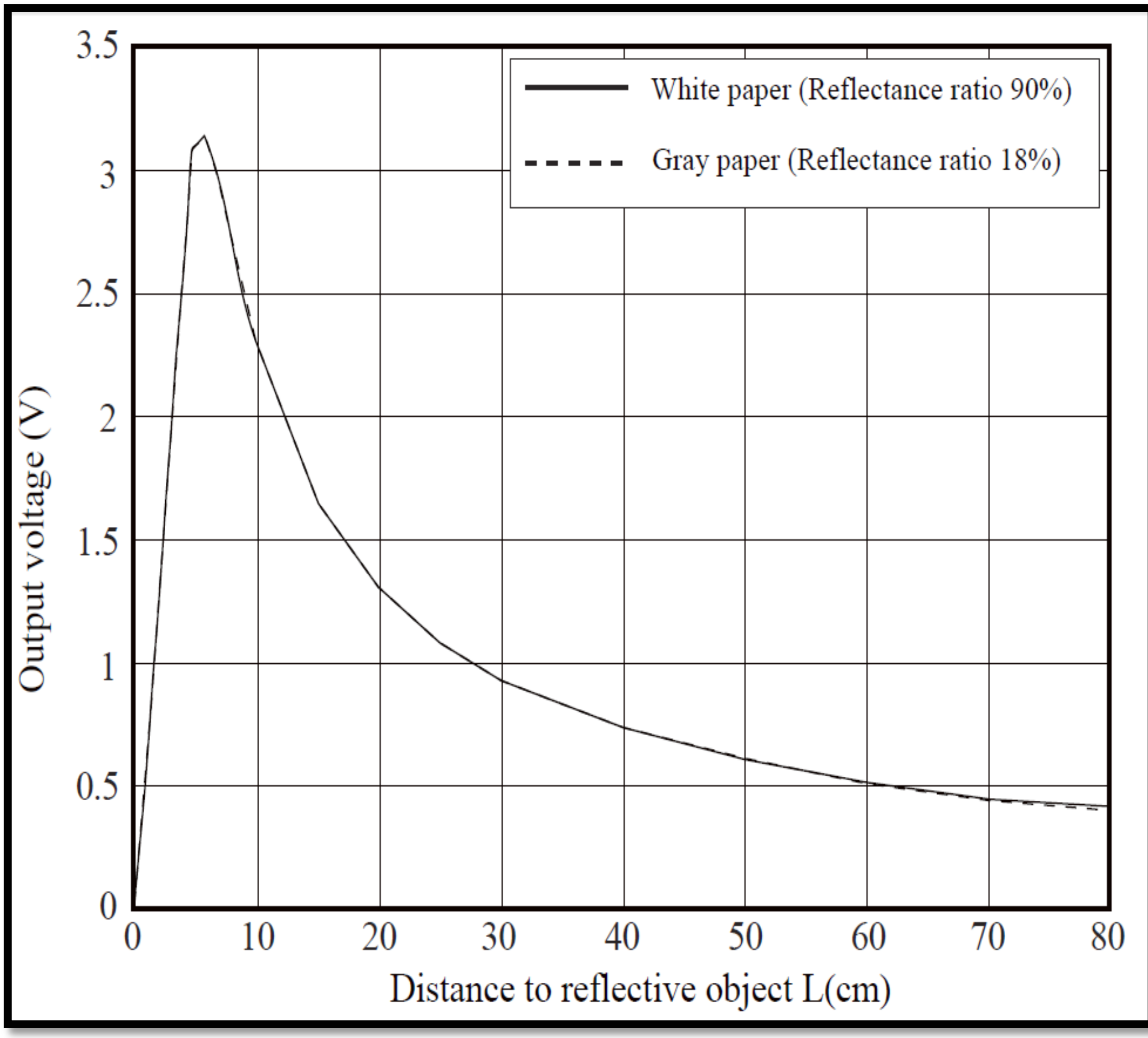


Figure 4.2.1: voltage vs. distance

The test data on the following pages is based on the PING sensor, tested in the Parallax lab, while connected to a BASIC Stamp microcontroller module. The test surface was a linoleum floor, so the sensor was elevated to minimize floor reflections in the data. All tests were conducted at room temperature, indoors, in a protected environment. The target was always centered at the same elevation as the PING sensor.

Test 1

Sensor Elevation: 40 in. (101.6 cm)
Target: 3.5 in. (8.9 cm) diameter cylinder, 4 ft. (121.9 cm) tall – vertical orientation

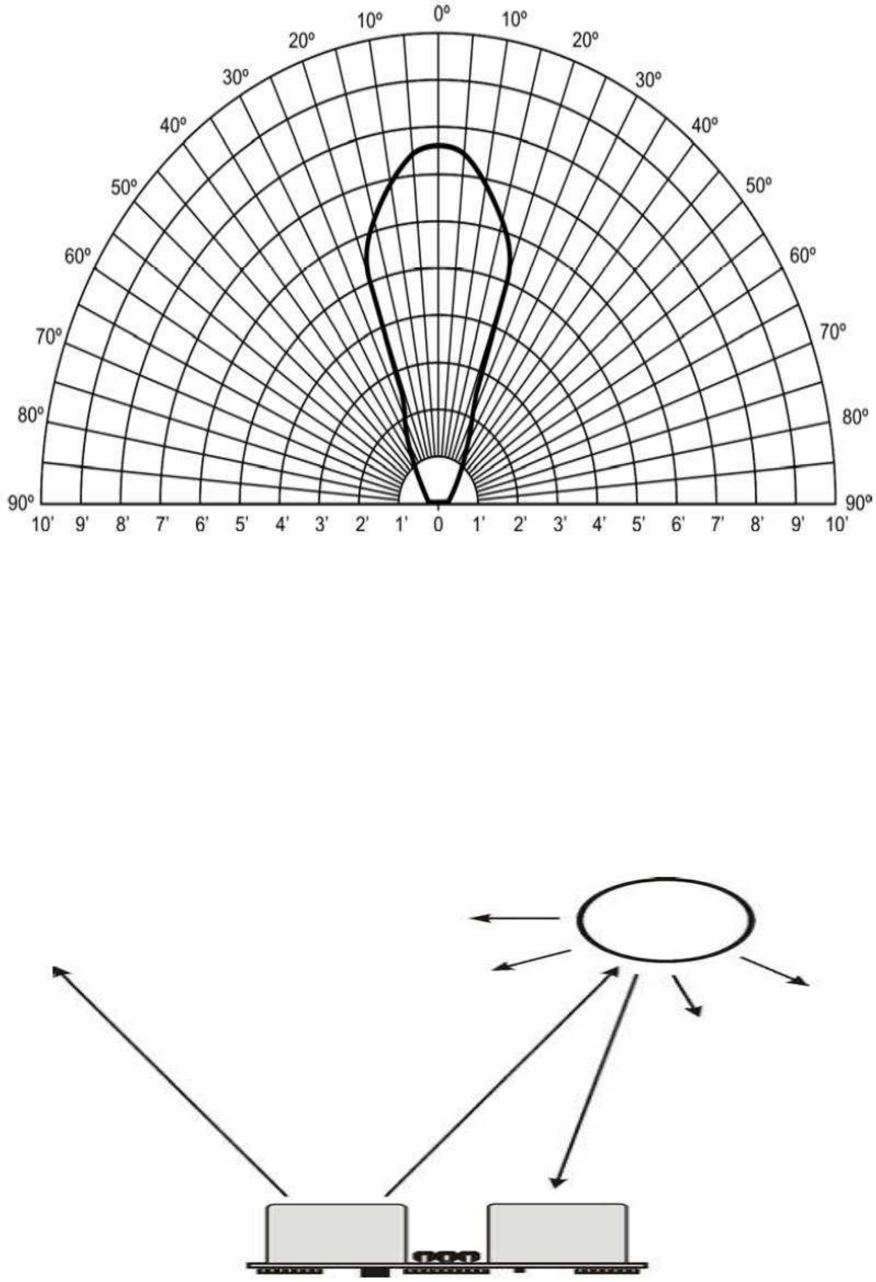
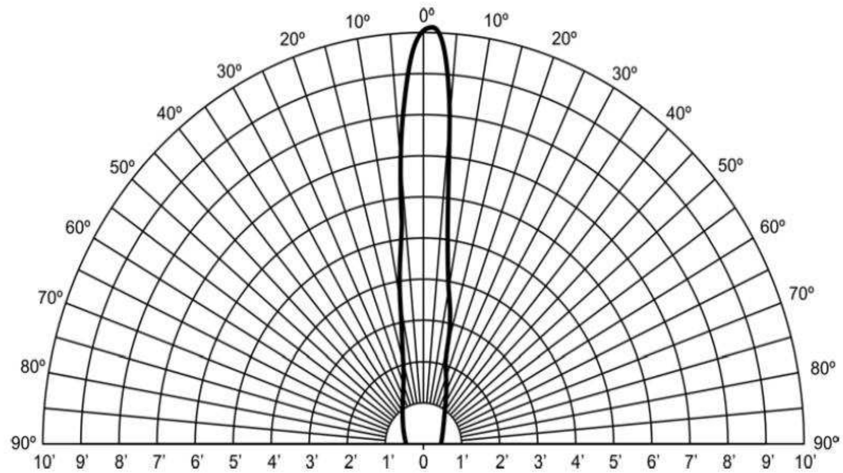


Figure 4.2.2: Test 1 result

Test 2

Sensor Elevation: 40 in. (101.6 cm)
Target: 12 in. x 12 in. (30.5 cm x 30.5 cm) cardboard, mounted on 1 in. (2.5 cm) pole
Target positioned parallel to backplane of sensor



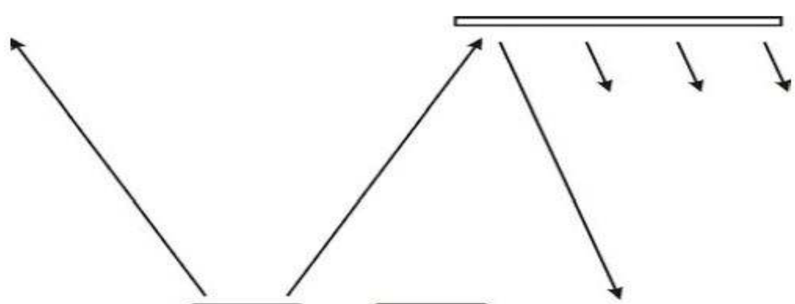


Figure 4.2.3: Test 2 result

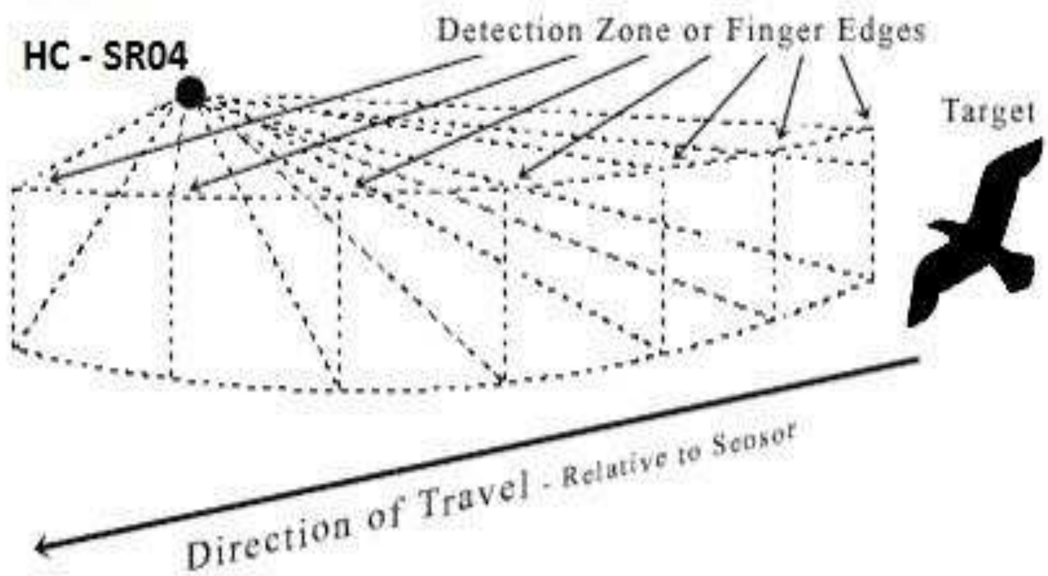


Figure 4.2.4: Direction of Travel - relative to sensor

4.3 Passive Infra Red (PIR) VS Ultrasonic Ranging Module (PING)

As long any robots have been made ,and as long as obstacle detection has been used, there has existed a dilemna for which sensor to use for ranging and noncontact obstacle avoidance. In this brief tutorial I will explain to you the pros and cons of each sensor.

4.3.1 Passive Infra Red (PIR)

The two types of IR sensors. There are IR sensors with built in circuits which provide a binary output , and there are those which provide an analog output or a multiple bit output. The sensors with a binary output are only good for detecting the proximity of an obstacle , and not the range. By that I mean that the sensor can only tell you when an obstacle is within a certain distance (we will call it the threshold distance) . This is fine for most robots which only need to know when an obstacle is right in front of it . This is the cheapest sensor which I will be explaining here.

The other IR sensors, which are ranging sensors , output the actual distance of an obstacle from the sensor. This output can either be analog or a digital byte. Building an IR sensor , whether ranging or binary , is incredibly simple . Admin talks about how to build your own IR sensor here . Those sensors can be made cheaply but they are not so accurate . If you want accuracy get these Sharp IR sensors. They are the kings of infrared ranging , they are the most accurate IR sensors, and they provide an easy to use analog output. They usually cost between RM30-RM50 . However, be aware that there are many different types of Sharp IR sensor which have different minimum and maximum ranges , so search around for the one that suits you.

Now that I have explained the different types of IR sensors , I will tell you why IR is NOT the best out there. Infrared sensors , emit infrared light ,and therefore the sensors cannot work accurately outside or even inside , if there is direct or indirect sunlight(but this is not entirely true for Sharp IR sensors , since they will work pretty accurately in ambient light.) So no infrared ranging sensors on your outdoor robot. Also, the way the infrared sensor works is as follows "The Sharp IR Range Finder works by the process of triangulation. A pulse of light (wavelength range of 850nm +/-70nm) is emitted and then reflected back (or not reflected at all). When the light returns it comes back at an angle that is dependent on the distance of the reflecting object. Triangulation works by detecting this reflected beam angle - by knowing the angle, distance can then be determined. "

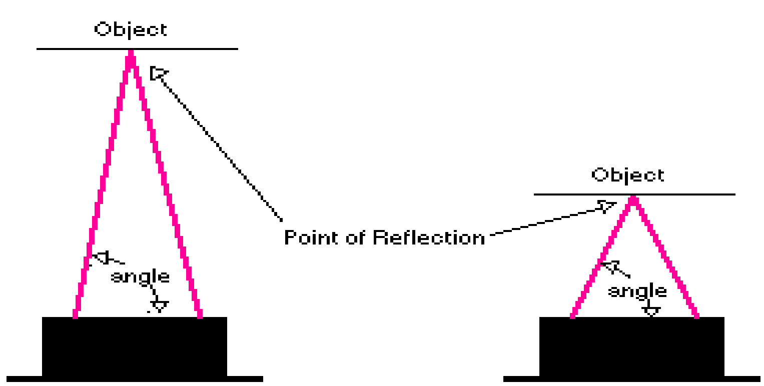


Figure 4.3.1: Angle and Distance the Sensor

Now since light does not reflect the same way off every surface, the infrared sensor reading will be different for different surfaces , different colors, and different shades EVEN if the range is the same. Most of the time this reading is not too off, so the robot can still function.

CONCLUSION FOR PIR SENSORS: Use infrared ranging sensors if:

a) You do not care about incredibly accurate ranging
b) The sensor will not be used outside in the sun
c) You need a narrow beam width
d) You want to spend less than RM 30 per ranging sensor

4.3.2 Ultrasonic Ranging Module (PING)

Ultrasonic sensors use sound instead of light for ranging , so ultrasonic sensors (some people call it sonar) can be used outside in bright sunlight. These sensors are amazingly accurate ,though they may be thrown off by a sound absorbing obstacle , like a sponge. The only real issue that arises is the "ghost echo" issue. As you can see below , the walls bounce off in a strange pattern causing a ghost effect.

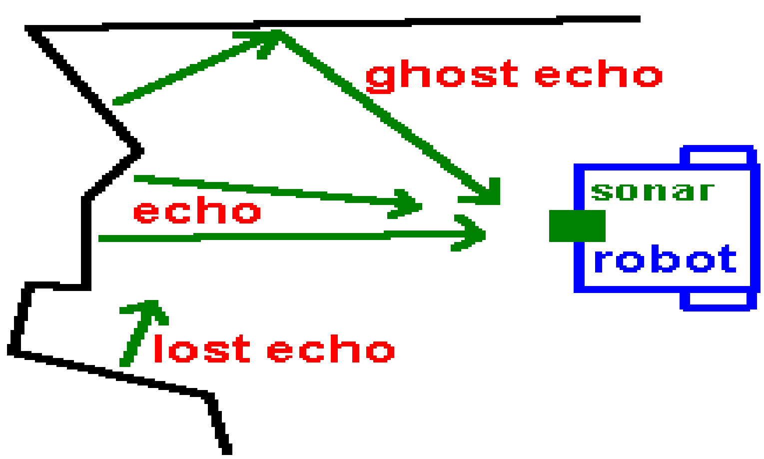


Figure 4.3.2: Echo effect of the Sensor

CONCLUSION FOR PING SENSORS: Use ultrasonic sensors if:

a) You need accurate distances of obstacles, no matter what color they are
b) The robot will not encounter sound absorbing materials as obstacles
c) You will be using the ultrasonic sensor inside or outside
d) You are willing to pay over RM 50 for each ranging sensor

4.3.3 Recommendations For Sensors

After reading this tutorial and assesing whether to get IR sensors of ultrasonic sensors , you are faced with a lot of choices for each type of sensor. For ultrasonic ranging(the best type of ranging) , I prefer the Parallax PING ultrasonic sensor , since it can detect obstacles that are 2cm away and obstacles that are up to 1 m away. Also, it uses only one I/O pin on the microcontroller since you can trigger the sonar and take a reading on the same pin . It usually costs between RM 30 - RM 50, so look around for good prices.

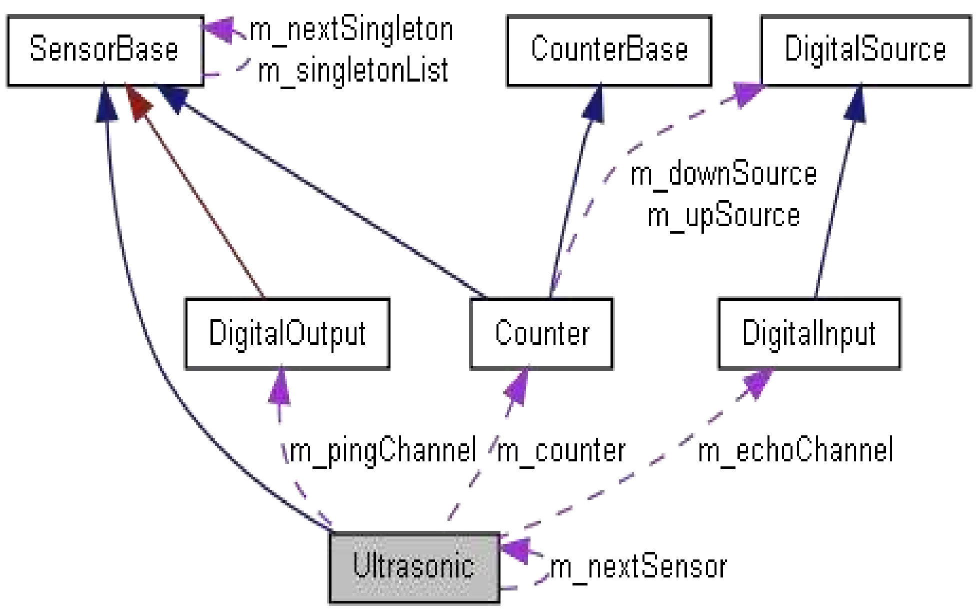


Figure 4.3.3: Diagram detection system of the PING Sensor

FINAL STATEMENT :

a) PIR is cheap RM 30 small beam, not good measuring distance to dark objects.
b) PING is expensive RM 50and more accurate , not good with absorbent objects (like sponges) , and wide beam.

4.4 Conclusion Experiment

From this experiment, to calculate the frequency value the prototype of **Motion Bird Detection System** should be measure because detection range of bird is different. We can see in figure during experiment the voltage value must be measure with oscilloscope because bird does not same distance, if the voltage did not reach the covering area range. So the thrust calculation must include with distance range of bird.

In this experiment, there were differences between the Voltage value experiment and theory because:

- When the research was done, the voltage was quite hard to be controlled in the static position in the oscilloscope display.
- Error during measurement and oscilloscope reading those not precisely.

CHAPTER

V

CONCLUSION AND SUGGESTION

5.0 Conclusion

From chapter I until chapter V, the Motion Bird Detection System is a good choice to design and build the prototype of the bird deterrents to applied in commercial airport like for detect the bird. From other characteristics, Motion Bird Detection System has a good maintains and avails to human safety by prevent disturbed compared with others bird deterrents. In this bird deterrents have theory can be used is Ultrasonic Theory.

To get a good design, we choose a concept that is statistical analysis, Ultrasonic Theory. The elementary data that is needed is the voltage value to produce the motion for detect the bird. The data is then compared with the Principles Ultrasonic Theory. The difference in the value is used as a reference to get a better detection method and data to analysis.

The data is been used to analysis the tested the prototype. The voltage value calculations is then calculated based on the data from statistical design for sample detection and using electronic device to determine the design point calculations. After prototype was complete, we make testing and modification sensing tests to get the true data and compared with theory. This is important part because we can justify the true voltage value for **Motion Bird Detection System**.

Throughout the design process it was success to corporate the true voltage value for affected the **Motion Bird Detection System**. During testing, there were many aspects of the prototype design which made voltage analysis difficult. For example, testing in a enclosed room caused wave lost. Also, the oscilloscope effect would have affected results due to the proximity of the prototype to the voltage values testing. It was difficult to analysis these effects on the prototype and may have caused uncelebrated prototype because we don't have a actual area coverage.

5.1 Suggestion

For the future work, the coding for microcontroller of the prototype must be evaluated and this work becomes easy in order to get accurate motion detection. Other than that, a full analysis on voltage value should be tested to get actual area coverage. Actual test and using proper instruments are suggested to define the coverage for the prototype.

REFERENCES

1. Clark, Larry & Shah, Pankaj S, 1993 'Chemical bird repellents: Possible use in cyanide ponds', *Journal of Wildlife Management*, Jul93, Vol. 57 Issue 3, p657
2. Coghlan, Andy, 1990 'Pigeons, pests and people' *New Scientist*, 12/1/90, Vol. 128 Issue 1745, p48
3. Nakamura, Kazuo, 1997 'Estimation of effective area of bird scarers', J*ournal of Wildlife Management*, Jul97, Vol. 61 Issue 3, p925
4. Marks, James W. 2001 'BIRDS AWAY' *Organic Gardening* ,Mar85, Vol. 32 Issue 3, p22
5. Bishop J., McKay H, Parrott D. & Allan J, 2003 'Review of international research literature regarding the effectiveness of auditory bird scaring techniques and potential alternatives.'
6. Coleman, J & Spurr, E, 2001 'FARMER PERCEPTIONS OF BIRD DAMAGE AND CONTROL IN ARABLE CROPS' *The New Zealand Plant Protection Society Incorporated*

7. Blackwell, B, Simmons, G, Salmon, T, Dolbeer, R, Gorenzel, W, 2002 ' Evaluation of lasers to disperse American crows, from urban night roosts' *Journal of Pest Management*, Issue 48, p327 – 331

8. Dolbeer, R, Bernhardt, G, Blackwell, B, 2002 ' Lasers as Nonlethal Avian Repellents' *Journal of Wildlife Management*, Issue 66, p250-258

9. Fisher, R, Perkins, S, Walker, A, Wolfart, E, 2003 *'Motion Detector PIR Sensor'* www.hipr2.com, [cited Mac 2013]

10. Eximcorp, *'Properties of Moisture Resistant or Exterior grade MDF Panels'*, www.eximcorp.com, [cited Mac 2013]

11. Arduino, 1999; '*How to connect the arduino'*. http://www.arduino.cc/. [cited February 2013]

12. Cytron, 2000; '*New Robotic Project'* http://www.cytron.com.my/. [cited February 2013]

13. Scaring Birds, 1997; '*Device in Scaring Bird'* http://www.scaringbirds.com/. [cited Mac 2013]

14. Bird x, 1999; ' *Bird Control'* http://www.bird-x.com/. [cited Mac 2013]

15. Hobby King; ‘*Microservo and Tilt and Pan Bracket’* http://www.hobbyking.com/. [cited April 2013]

16. Bird Busters, ‘*Total Environment Bird Control’* http://www.birdbusters.com/. [cited Mac 2013]

17. Bird Strike, ‘Aircraft Bird Strike’ http://www.birdstrike.org/. [cited Mac 2013]