DESIGN AND CONSTRUCTION OF AUTOMATIC DOORBELL ALARM SYSTEM

BY

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EEE/11/0382

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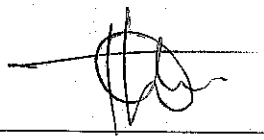
BACHELOR OF ENGINEERING DEGREE (BEng. ELECTRICAL ENGINEEERING)

SEPTEMBER 2016.

DECLARATION

I AkintoyeAyobami Emmanuel hereby declare that this project work carried out is the result of my personal effort and has not been submitted elsewhere for this purpose. All sources of information are duly acknowledged by means of references.



30/08/2017

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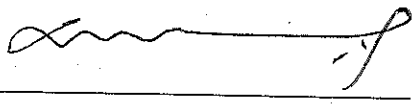
DATE

CERTIFICATION

This is to certify that this study was carried out by AKINTOYE AYOBAMI EMMANUEL OF THE DEPARTMENT OF ELECTRICAL ELECTRONICS ENGINEERING, FEDERAL UNIVERSITY OYE EKITI, (FUOYE) NIGERIA.



30/3/17

ENGR. K.O. OLUSUYI
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DATE

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(Head of Department)

DATE

DEDICATION

This project is dedicated to God the source and guide of my life.

ACKNOWLEDGEMENT

During the course of my education some were of great help to me and to this people I am heavily indebted. My thanks go to my supervisor, Engr. Olusuyi who was of great help during the execution.

I will all my life be indebted to my parents Mr. and Mrs. Akintoye L.T, if not for them, I would not have achieved anything in this world. They were always behind me in prayers, morally and financially.

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There are other numerous friends and well-wishers who should share in this moment of job. They include my siblings and friends like; Mr. and Mrs. OyewumiAbolaji, Mr. Dammy, and Awelewa Sunday Arinbola.

I should also thank those whose books and journals I used in compiling this project.

My prayer is that the Lord God Almighty will increase and multiply you in all dealings of life in Jesus name. Thank you all.

ABSTRACT

This project is based on an automatic doorbell alarm system which utilizes a passive infrared resistor (PIR) for detection with a microcontroller as well as a light emitting diode as light signal. This activates a buzzer as soon as the signal is detected. The project sequence of operation begins when the PIR sensor receives the analog input signal which is transferred to the Microcontroller (ATmega328). The analog signal is thereafter processed into a digital signal before beingconverted back to analog signal which is sent to the output (Buzzer).Test results shows that the project works with slight deviations and inconsistent range, the distance is not fixed. The doorbell automatically turns on with alarm triggered once there is an intruder within the detecting area through infrared radiation (IR).This project could find application in security systems both in domestic and commercial areas.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

Motion detection is the action of sensing physical movement in a given area. An automatic doorbell is a circuit which operates using sensor modules, which can be used to detect the presence of a person, and then if the person is detected, the doorbell is automatically tuned ON and rings when the person is in front of the door. This is one of the very interesting and much useful circuits in our real life "Automatic Doorbell Alarm System". If we use automatic doorbell using object detection circuit, the circuit will automatically sense the presence of the person and it rings the doorbell [1]. Motion can be detected by measuring change in speed or vector of an object in the field of view. This can be achieved either by mechanical devices that physically interact with the field or by electronic devices that quantifies and measures changes in the given environment [1].

1.2 STATEMENT OF THE PROBLEM

It is assumed that we all have doorbell at our homes or have been seen one somewhere. When a visitor comes to our house, he searches for the doorbell switch and then rings to let us know his presence. The doorbell recognizes the presence of anyone who comes near it, either short or tall. Isn't it intriguing when at an individual's presence, the doorbell rings automatically? There are no more hassles, stress and difficulties of any sort. The person who comes to our house need not search for the doorbell and press it anymore. If we install this automatic doorbell using object detection circuit (ultrasonic transmitter/Passive Infrared Resistor), the circuit will automatically sense the presence of the person and it rings the doorbell [2].

1.3 SIGNIFICANCE OF THE STUDY

The significance of this study is to enhance proper security and alarm system, detect the presence of a visitor in homes, corporate organizations, bank halls, industries, libraries, government institutions (offices).

1.4 SCOPE OF THE STUDY

This project concentrates on a development of an active infrared motion detector for house automatic security system. To develop the whole project, it consists of three methods which are the concept of security system (automatic doorbell), the electrical structure, and the software programming. The concept of security system is on the detection of movement using active sensor to trigger alarm controlled by the microcontroller Arduino UNO. The electrical structure consist of two systems which are the passive infrared circuit that used to detect or sense motion and the microcontroller Arduino UNO circuit, used to control the whole operation of the security system. While the software programming is based on the microcontroller Arduino UNO instruction sets. It contains a program designed for a security system as an interaction to operate the electrical structure.

1.5 AIM AND OBJECTIVES

This project is aimed at design and implementation of an automatic doorbell that can detect object using a passive infrared resistor. The objectives are:

a. To design the sensor circuit
b. To design the alarm circuit
c. To design the power circuit

1.6 PROJECT OUTLINE

This project is broken into five (5) chapters thus: Chapter one entails the introduction as touching the purpose, significance, aim of the project; chapter two gives a literature review about different techniques of going about the project. Chapter three gives an analysis of

hardware and software design of the automatic doorbell. Chapter four comprises the construction and testing of the system. Chapter five draws conclusion, gives limitation and recommendation of the project.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

A motion detector is a device that contains a motion sensor that detects moving objects and transforms the detection of motion into an electric signal. The detector is often integrated as a component of a system that automatically performs a task or alerts a user of motion in an area. Motion detectors form a vital component of security, automated lighting control, home control, energy efficiency, and other useful systems [9]. Motion detectors are mainly used in security systems. It is typically positioned near exterior doorways or windows of a building to monitor the area around it. Since motion detectors are so flexible and have so many uses, it offers feelings of protection and security for the average homeowner as well as commercial organizations.

2.2 ULTRASONIC TRANSMITTER SENSOR

This sensor operates using a pair of ultrasonic transmitter and receiver modules which are used to detect and if a person is detected, the doorbell is automatically tuned ON when the person is in front of the door. The ultrasonic transmitter operates at a frequency of about 40 kilo Hertz. That means it continuously transmits the ultrasonic waves of about 40 kHz. The power supply should be moderate such that the range of the transmitter is only about one or two meter. If the transmitting power is less than one meter, then there is a chance that the person who is one meter away is not detected. Also, if the range is set to be very large, this may lead to false triggering, meaning that, the objects far away from the door are considered as the visitors and the alarm rings. This can be a nuisance for us if the alarm rings for every object or person far away. So, to avoid both the problems, the transmitting power is kept to an optimum level [2]. This is shown in figure 2.1.

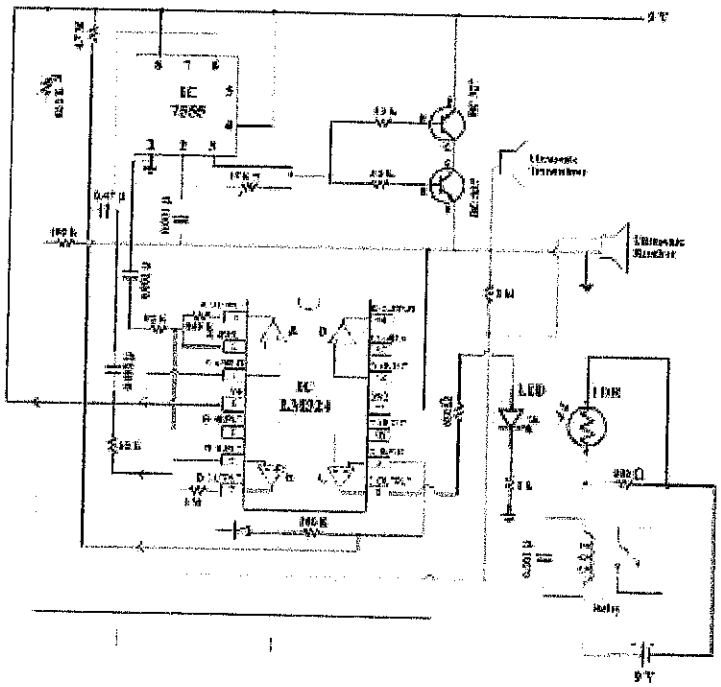

Figure 2.1: Typical Circuit Diagram of Automatic Doorbell Using Object Detection with ultrasonic transmitter

2.2.1 HOW IT WORKS

The ultrasonic receiver module receives the power at the frequency same as that of the transmitter's so that noise will be eliminated and we get less false triggering. The sensitivity of the receiver can be tuned by using the 500KΩ variable resistor arranged as a pot in the circuit. By running this properly, we can achieve the desired results. The output of our circuit is given to busser circuit which acts as a doorbell in our case [3]. The receiver in the circuit uses LM324 which internally has four op-amps. Out of the op-amps, we are using only four of them and leaving the other one unused as it is not much required in our case. The tree op-amps are used in cascaded arrangement to provide high gain as well as noise free output. An opto-coupler is used at the output to avoid any interaction between the circuit and the doorbell.

2.2.3 THEORY OF OPERATION (ULTRASONIC SENSOR)

Ultrasonic sensors work in ways that are similar to radar and sonar utilizing the Doppler principle. A piezoelectric transducer converts electrical energy into an ultrasonic wave typically between 40-50 kHz. This high frequency sound wave, which is beyond the capability of human hearing, hits an object and is reflected back toward another transducer which converts the sound wave back into electrical energy. The distance of an object can be evaluated once this echo is received back using the following equation where d is the distance, c is the speed of sound, and t is the elapsed time of the signal. This is shown in figure 2.2.

$$d = \frac{t \times c}{2}$$

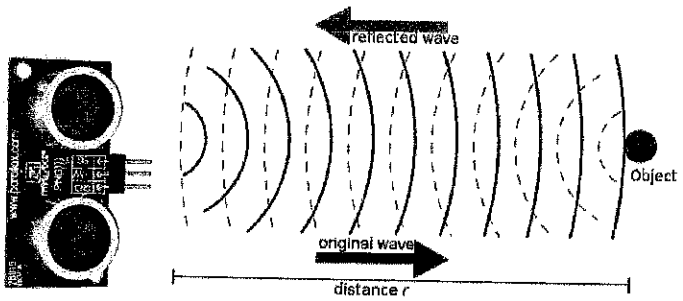

Figure 2.2: Ultrasonic transmitter with Doppler Effect

When the medium of propagation is air c is equal to 340.29 m/s. The control circuitry on the ultrasonic sensor can determine between stationary objects and objects in motion by interpreting change in frequency as motion in the space. Figure 2.3 shows the operation and sensitivity for an ultrasonic sensor.

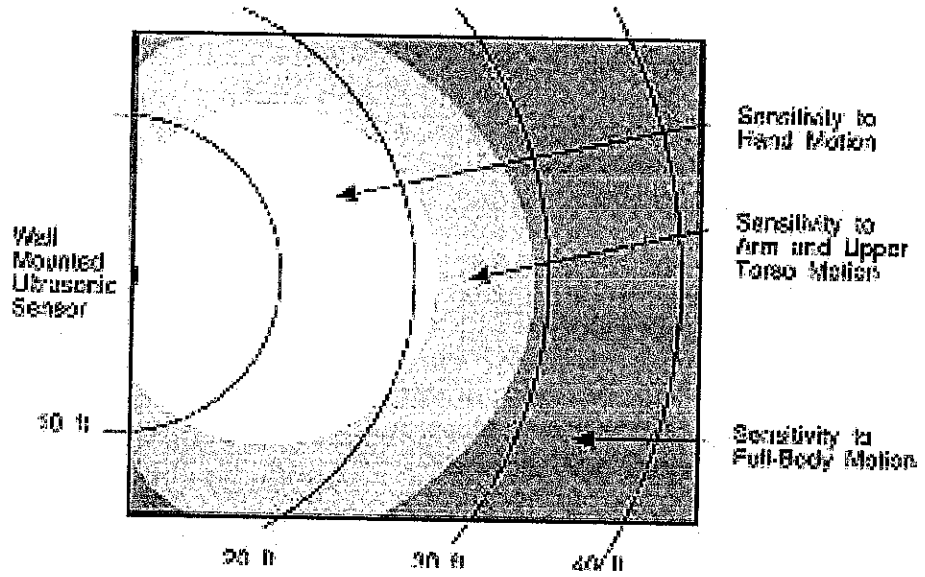

Figure 2.3 Operation and Sensitivity for an ultrasonic sensor

2.2.4 MERITS AND DE-MERITS OF ULTRASONIC TRANSMITTER

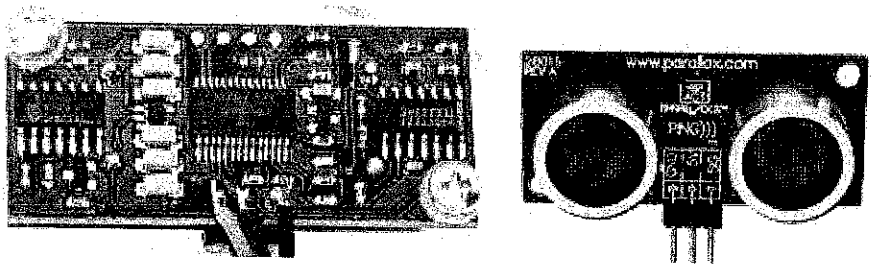

Figure 2.4: Parallax Ultrasonic Sensor

- **MERITS**

1. An ultrasonic sensor's response is not dependent upon the surface color or optical reflectivity of the object. For example, the sensing of a clear glass plate, a brown pottery plate, a white plastic plate, and a shiny aluminum plate is the same.

2. Ultrasonic sensors with digital (ON/OFF) outputs have excellent repeat sensing accuracy. It is possible to ignore immediate background objects, even at long sensing distances because switching hysteresis is relatively low.

3. The response of analog ultrasonic sensors is linear with distance. By interfacing the sensor to an LED display, it is possible to have a visual indication of target distance. This makes ultrasonic sensors ideal for level monitoring or linear motion monitoring applications.

- **DEMERITS**

1. Ultrasonic sensors must view a surface (especially a hard, flat surface) squarely (perpendicularly) to receive ample sound echo. Also, reliable sensing requires a minimum target surface area, which is specified for each sensor type.

2. While ultrasonic exhibit good immunity to background noise, these sensors are still likely to falsely respond to some loud noises, like the "hissing" sound produced by air hoses and relief valves.

3. Proximity style ultrasonic sensors require time for the transducer to stop ringing after each transmission burst before they are ready to receive returned echoes. As a result, sensor response times are typically slower than other technologies at about 0.1 second. This is generally not a disadvantage in most level sensing and distance measurement applications. Extended response times are even advantageous in some applications. Transmitted beam style ultrasonic sensors are much faster with response times on the order of 0.002 or 0.003 seconds.

4. Ultrasonic sensors have a minimum sensing distance.

5. Changes in the environment, such as temperature, pressure, humidity, air turbulence, and airborne particles affect ultrasonic response.

6. Targets of low density, like foam and cloth, tend to absorb sound energy; these materials may

be difficult to sense at long range.

7. Smooth surfaces reflect sound energy more efficiently than rough surfaces; however, the sensing angle to a smooth surface is generally more critical than to a rough surface.

8. One of the main advantages of the ultrasonic sensor is often one of the main disadvantages as well. Oftentimes the high sensitivity to ultrasonic sensors leads to false triggering. For example, excessive air motion from a fan or an HVAC (Heating, Ventilation and air conditioning system) system can cause the sensor to trigger.

2.3 PASSIVE INFRARED RESISTOR (PIR)

The PIR (Passive Infra-Red) Sensor is a pyro electric device that detects motion by measuring changes in the infrared levels emitted by surrounding objects. This motion can be detected by checking for a high signal on a single I/O pin. Passive infrared (PIR) sensors are widely used in daily life. They are a key component in motion detection and can be used for security systems, automatic doorbells, or automatic light control [8]. They are commonly used to detect humans. For example, when someone is detected in a specified area an alarm may be triggered or a specific room may be lit. Another common use is with regard to pets, for example, cat flaps. Everything on earth has infrared (IR) energy. The IR energy of an object depends on different parameters such as its temperature, color, and texture. This energy is not visible with the human eye, but PIR sensors can detect it.

Passive IR sensors are the opposite of active IR sensors that emit energy, such as ultrasound, light, or microwaves. Active sensors are able to detect a change in the environment [8] when the reflected emitted signal is disturbed. Active sensors consume more energy than passive sensors. A basic drawing of a PIR is shown in figure 2.5.

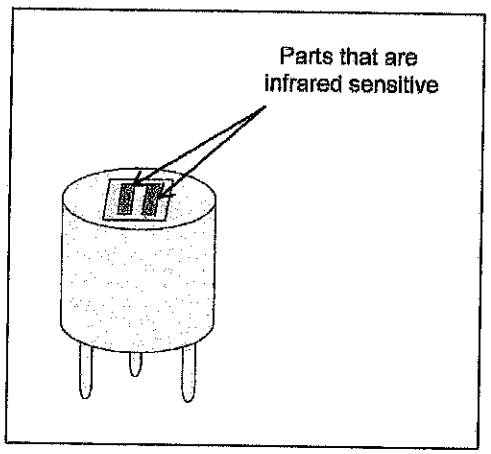

Figure 2.5: A Passive Infrared Resistor (PIR) sensor

2.3.1 HOW DOES THE PIR SENSOR WORK

The aim of the PIR sensor is to detect motion in a specific area. As seen in figure 2.6, these sensors contain two parts that are sensitive to IR. Since it is motion that is important, the signal delivered by the sensor reflects different amounts of IR detected by each part. If both parts "see" the same amount of IR, the sensor detects nothing. But, if one of the two parts "sees" more or less IR than the other part, the sensor detects something and the output voltage of the sensor varies.

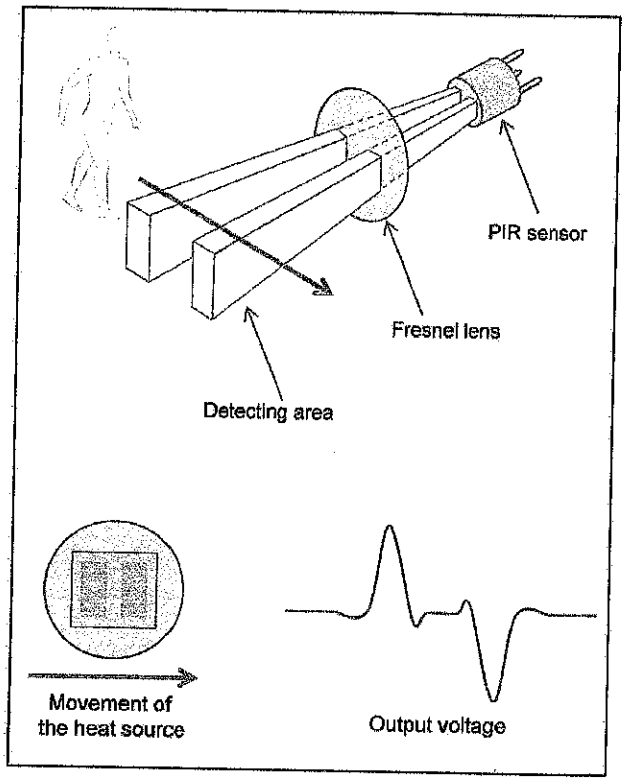

Figure 2.6: Principle of the PIR sensor

1. **The sensor signal**

When a body, with a temperature different to ambient, moves into the detection field of a PIR sensor, the sensor provides a small AC signal. This signal is in the range of 1mVpp. This small voltage is around a DC signal that may significantly vary from one sensor to another. For this reason, it is mandatory to cancel the DC part of the signal and to amplify the AC part. As the signal is disturbed by the environment, a noise filter is useful. . The sensor is designed to adjust to slowly changing conditions that would happen normally as the day progresses and the environmental conditions change, but responds by making its output high when sudden changes occur, such as when there is motion.

2. **Three-stage architecture for detecting motion**

To detect motion, a three-stage architecture based on op-amps is used to condition the signal of a PIR sensor. This architecture is shown below in figure 2.7.

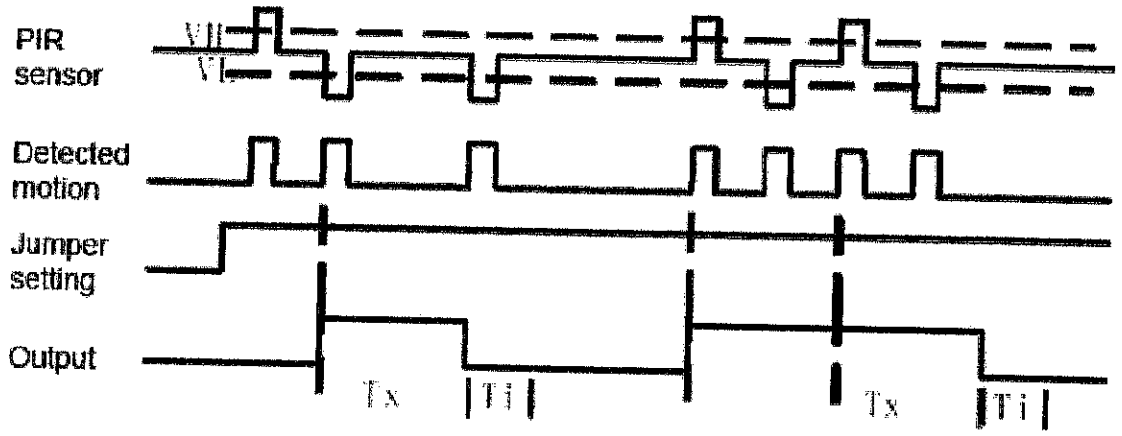

Figure 2.7: A three-stage architecture based on op-amps

2.3.2 MERITS AND DDEMERITS OF PASSIVE INFRARED SENSOR (PIR)

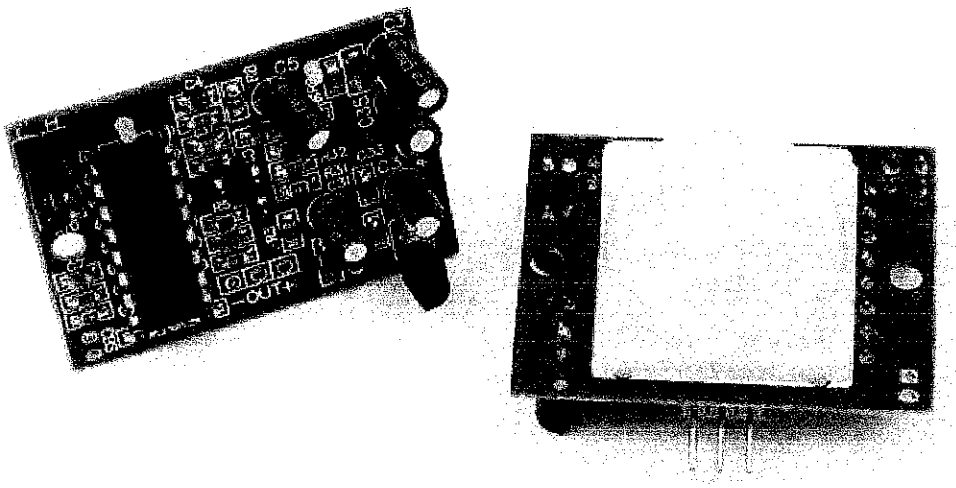

Figure 2.8: Parallax PIR Sensor

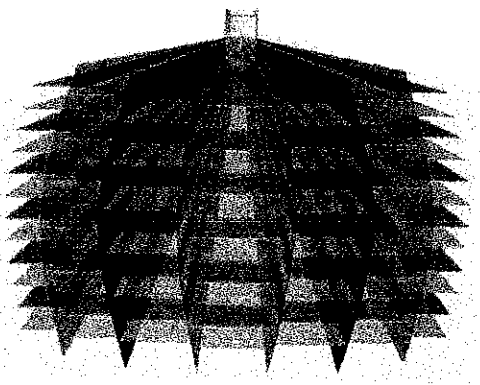

Figure 2.9: Fresnel lens

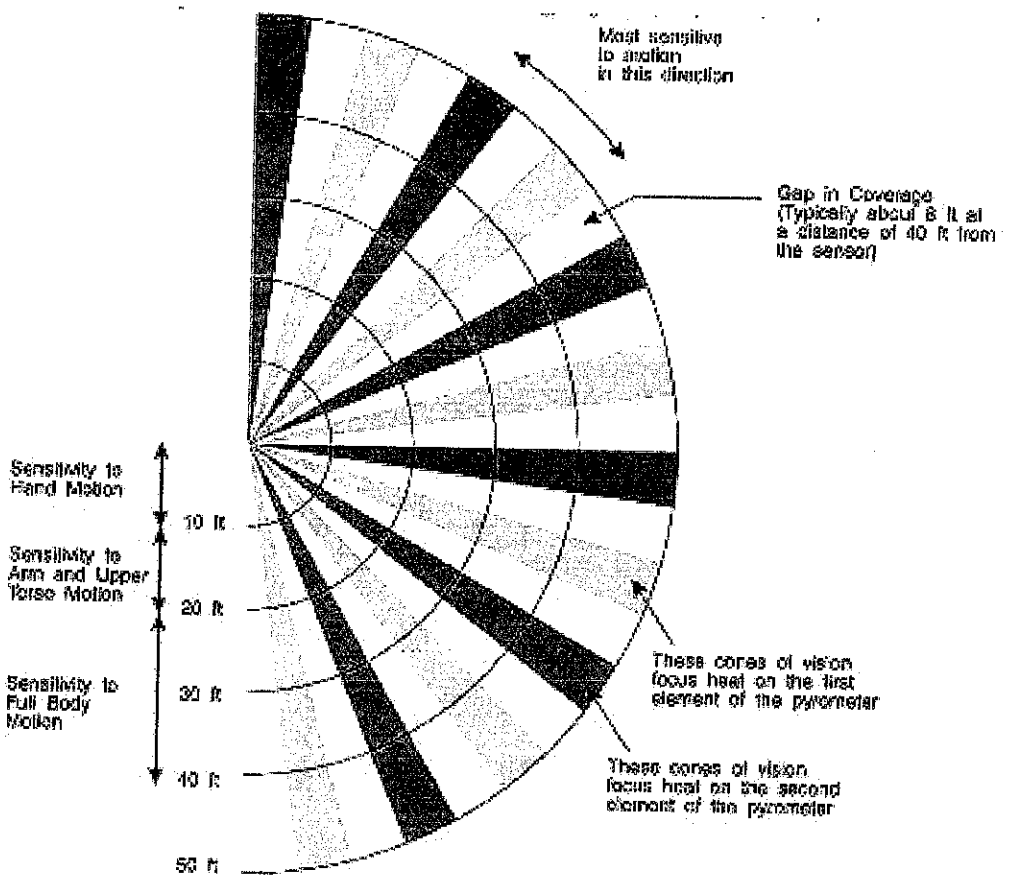

Figure 2.10: Operation and Sensitivity of PIR Sensors

- **MERITS**

PIR have been used for many years as motion detectors due to their high reliability and resilience to false triggering. They are not adversely affected by airflow like some sensors can be. Also, due to their passive nature, PIR sensors are very low on power consumption and thus suitable for battery powered applications [11].

- **DEMERITS**

While there are many advantages to a PIR sensor that make them an ideal choice for user detection applications, there are a few disadvantages to consider. PIR sensors require an unobstructed view of the occurrence of motion and cannot easily discern between humans and small animals. They are susceptible to "dead spots," which are

areas where motion cannot be detected within the field of view. The farther one gets from the sensor the less sensitive it becomes. Also, PIR sensors cannot determine the distance of the user from the sensing device [11].

2.3.3 EFFECTS OF TEMPERATURE CHANGES ON PIR SENSORS

All PIR operate by detecting the temperature difference between the ambient air temperature and a moving heat source (person). Outside air temperature changes have the greatest effect on the operating performance of PIRs, the sensitivity of the sensor increases on cold nights and decreases on hot nights. On cold nights, the difference in temperature between a person (normal body temperature is 37 ^{O}C) and the outside air temperature is relatively large, giving an apparent increase in performance of the sensor. On hot nights, this difference in temperature is relatively small and a decrease in performance of the sensor can be expected. At 15–20 ^{O}C the sensor should perform according to the stated specifications. If the ambient temperature increases to 30 ^{O}C or more, the following changes will occur:-

1. The maximum distance and field of view significantly decrease (up to as much as 50%).
2. The distance from a heat source has to move across the zones to activate the sensor increases. This can be seen in Figure 2.11.
3. The size of the heat source required to activate the sensor increases, and,

At an ambient temperature of 10 ^{O}C or less, the opposite occurs: -

1. The maximum distance and field of view increases.
2. The distance from a heat source has to move across the zones to activate the sensor decreases.
3. The size of the heat source required to activate the sensor decreases.

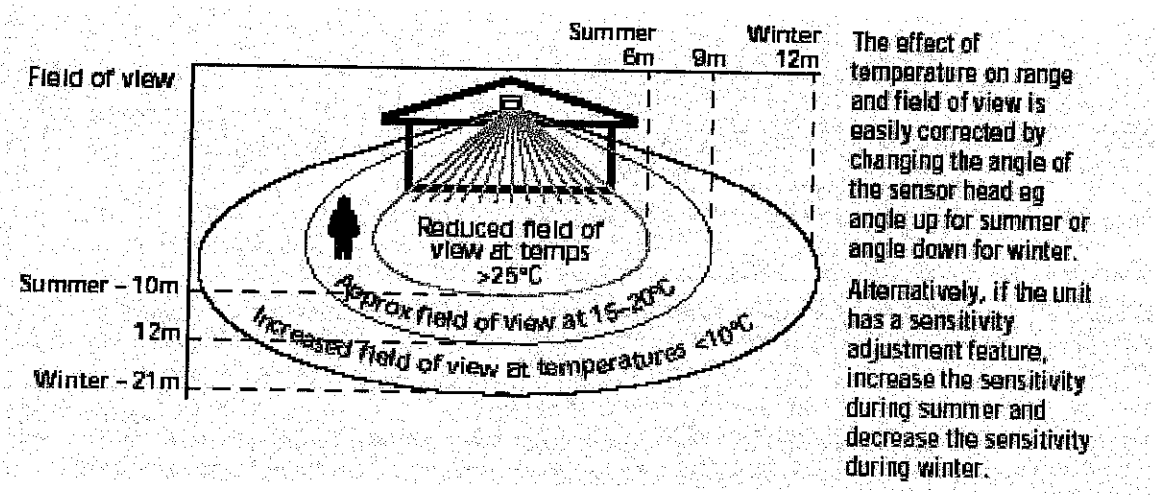

Figure 2.11: PIR Field View Dimensions

2.4 MOTION DETECTORS

A motion detector is a device that contains a motion sensor and is either integrated with or connected to other devices that alert the user of the presence of motion. An electronic motion detector contains a motion sensor that transforms the detection of motion into an electric signal. The electric signal can be connected to a burglar alarm (buzzer) system which is used to alert the home owner after it detects motion. An example of sensor that used in security system is a passive sensor. Passive sensors in motion detectors system are commonly in homes for a security system (automatic doorbell) [5]. An active motion detector emits optics or sound waves and measures feedback to detect motion. The simplest type of passive motion detector is commonly used in commercial doorways to trigger a doorbell. A device is fixed to one side of the doorway, an optical sensor to the other. A beam of light will passes from the device through the sensor. When someone enters the establishment, the beam is broken, triggering the doorbell thus warn user for the intrusion. For that reason, passive motion detectors can be purchased for home improvement security system. It is inexpensive devices that can add for more security to a home and provide peace of mind for home owners. Motion sensors detect intruder's Presence [6]. In the home environment, the sensors deployed will pick the signals, send them to the Arduino board, which does the interpretation, and send

commands for specific actuations to be performed. All the sensors in this environment communicate directly with the Arduino board. The sensors and actuators are directly interfaced to the main Arduino controller. [7]

The occupancy sensors detect the presence of people (and sometimes animals) in a monitored area. Motion detectors respond only to moving objects. A distinction between the two is that the occupancy sensors produce signals whenever an object is stationary or not, while the motion detectors are selectively sensitive to moving objects. The applications of these sensors include security, surveillance, energy management (electric lights control), personal safety, friendly home appliances, point-of-sale advertisements, interactive toys, novelty products, etc. Depending on the applications, presence of humans may be detected through any means that is associated with some kind of a human body's property or body's actions [10]. For instance, a detector may be sensitive to body weight, heat, sounds, dielectric constant, etc.

An electronic motion detector is a device used to detect any physical movement in a given area and transforms motion into an electric signal. It consist of sensor that electrically connected to other devices such as security system, lighting, audio alarms, and other applications. Motion sensors are used in a wide variety of applications and as a result, many different types of motion sensors are available including the infrared sensor.

Infrared sensors are widely known in the arts of intrusion detection and in fire or smoke detection. It is a device that often used in automatic light switches and security systems to turn on a light or to activate some other form of alarm or warning indicator when a person enters a monitored area [5]. The infrared sensors have basically two forms: active and passive. [5]

A passive infrared detector includes a radiation source and an infrared sensor which is sensitive to interruptions in the radiation sensed from the source. [5] These detectors are used

as intrusion detectors by providing a path of radiation from the source to the sensor in a place where the path is likely to be interrupted by an intruder.

Passive infrared motion detection detects heat energy radiated or emitted by an object, such as a body of a person, moving across a field of view of a heat sensor of the motion detection system. It is generally use an optical collection system and multiple sensing elements of alternating polarity to create a detection pattern in the volume of interest.

PIR detectors employ a group of radiation sensors coupled through amplifiers to a logic circuit. The radiation sensors detect changes in ambient infrared radiation. The detection system has an electrical circuit operatively coupled to the heat sensor for producing a detection signal in response to the heat sensor detecting a change of temperature caused by the body heat of a person entering the detection pattern.

PIR motion detectors are perhaps the most frequently used home security device. [5] Passive IR motion detectors are usually designed to provide an indication to an alarm panel in response to detecting IR that is indicative of motion of the object. The alarm panel is responsive to receipt of the breach indication to cause an alarm condition to occur.

The other motion detector used in security system is an ultrasonic motion detector. It is commonly used for automatic door openers and security alarms [5]. It is inexpensive and can operate with narrow beam-widths. The ultrasonic transducers are the sensor that used in ultrasonic motion detector. It can be used to detect motion in an area where there are not supposed to be any moving objects. This type of motion detector is most commonly used in burglar alarm systems since they are very effective in this application [5].

In an ultrasonic motion detector, there are two transducers; one emits an ultrasonic wave and the other picks up reflections from the different objects in the area. The reflected waves arrive at the receiver in constant phase if none of the objects in the area are moving. If

something moves, the received signal is shifted in phase. A phase comparator detects the shifted phase and sends a triggering pulse to the alarm.

Ultrasonic motion detectors have certain advantages and disadvantages when compared with other types of motion detectors. The main advantage is that they are very sensitive and extremely fast acting. However, the largest problem with this type of motion detector is that it sometimes responds to normal environmental vibration that can be caused by a passing car or a plane overhead. Besides, the installation options on this type of motion detector are limited because ultrasonic beams are easily blocked by thin materials, including paper. False triggering is easily caused by reflections from blowing curtains, pets, and flying insects.

While the passive infrared motion detectors offers solution which prevents false triggering where it can be falsely triggered by warm air movement or other disturbances that can alter the infrared radiation levels in an area.

For that reason, the purpose of using the passive infrared as a sensor to detect motion for this project is surely on the advantage offered by the sensor. Its capability on detecting motion with a simple design at lowest cost is needed to build an effective house security system based on motion detection.

2.5 TYPES OF DETECTORS

The following types of detectors are presently used for the occupancy and motion sensing of people:

1. **Air pressure sensors**: detect changes in air pressure resulted from opening doors and windows
2. **Capacitive**: detectors of human body capacitance
3. **Acoustic**: detectors of sound produced by people

4. **Photoelectric**: interruption of light beams by moving objects
5. **Optoelectric**: detection of variations in illumination or optical contrast in the protected area.
6. **Pressure mat switches**: pressure sensitive long strips used on floors beneath the carpets to detect weight of an intruder
7. **Stress detectors**: strain gauges imbedded into floor beams, staircases, and other structural components.
8. **Switch sensors**: electrical contacts connected to doors and windows.
9. **Magnetic switches**: a noncontact version of switch sensors.
10. **Vibration detectors**: react to the vibration of walls or other building structures. Also, may be attached to doors or windows to detect movements.
11. **Glass breakage detectors**: sensors reacting to specific vibrations produced by shattered glass
12. **Infrared motion detectors**: devices sensitive to heat waves emanated from warm or cold moving objects
13. **Microwave detectors**: active sensors responsive to microwave electromagnetic signals reflected from objects.
14. **Ultrasonic detectors**: devices similar to microwave detectors except that instead of electromagnetic radiation, ultrasonic waves are used.
15. **Video motion detectors**: video equipment that compares a stationary image stored in memory with the current image from a protected area.
16. **Video face recognition system**: image analyzers that compare facial features with database.
17. **Laser system detectors**: similar to photoelectric detectors, except that they use narrow light beams and combinations of reflectors.

18. **Triboelectric detectors**: sensors capable of detecting static electric charges carried by moving objects.

- **CAPACITOR**

A **capacitor** (originally known as a condenser) is a passive two-terminal electrical component used to store electrical energy temporarily in an electric field. Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass. This is illustrated in figure 2.12.

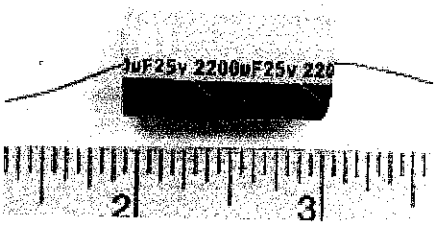

Figure 2.12: A capacitor

- **VOLTAGE REGULATOR**

A voltage regulator is designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. This is illustrated in figure 2.13.

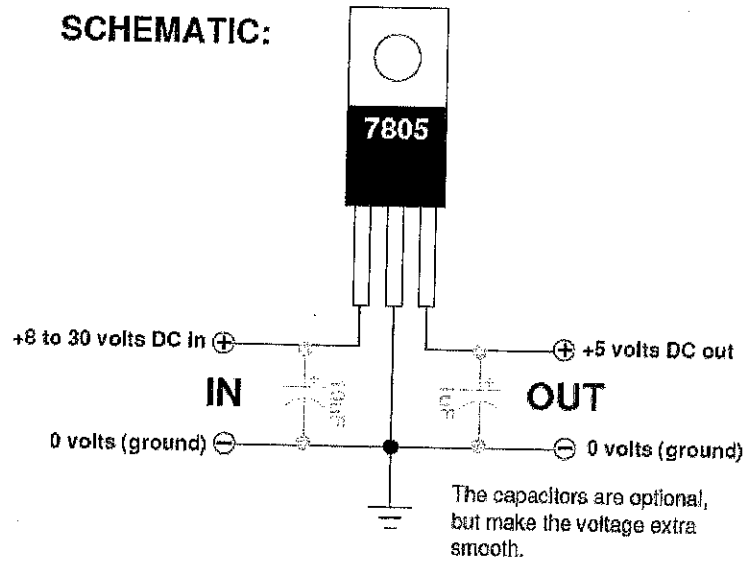

Figure 2.13: A Voltage Regulator

- **TRANSFORMER**

A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. Electromagnetic induction produces an electromotive force within a conductor which is exposed to time varying magnetic fields. Transformers are used to increase or decrease the alternating voltages in electric power applications. This is illustrated in figure 2.14.

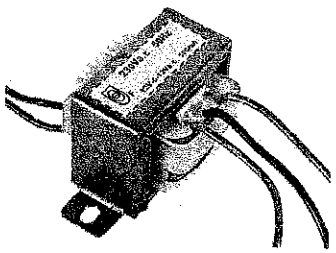

Figure 2.14: A 12V Transformer

- **RELAY**

A relay is an electrical switch that uses an electromagnet to move the switch from the off to on position instead of a person moving the switch. It takes a relatively small amount of power to turn on a relay but the relay can control something that draws much more power. This is shown in figure 2.15.

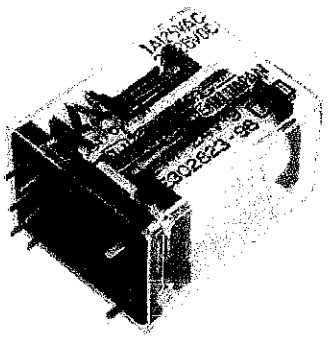

Figure 2.15: A Relay

- **RESISTOR**

A resistor is a passive two terminal electrical component that implements electrical resistance as a circuit element. Resistors may be used to reduce current flow, and, at the same time, may act to lower voltage levels within circuits. This is shown in figure 2.16

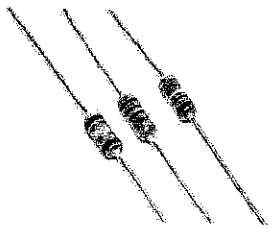

Figure 2.16: A Resistor

- **DIODE**

In electronics, a diode is a two-terminal electronic component that conducts primarily in one direction (asymmetric conductance); it has low (ideally zero) resistance to the flow of current in one direction, and high (ideally infinite) resistance in the other. This is shown in figure 2.17.

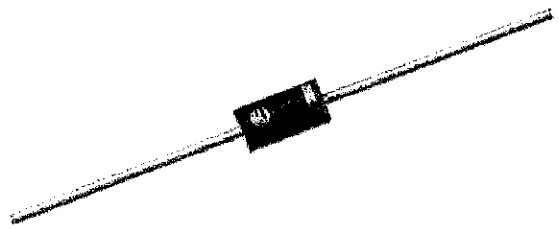

Figure 2.17: A Diode

- **BUZZER**

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. This is seen in figure 2.18.

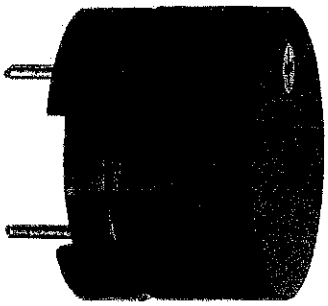

Figure 2.18: A Buzzer

- **SWITCH**

A switch is an electronic device to turn an electric current on and off or direct its flow. This is shown in figure 2.19.

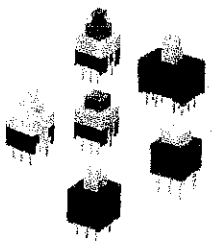

Figure 2.19: Electronic Switch

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

In this chapter, we shall be looking at the principles of operation, hardware structure of the entire project and we would be explaining the function of the devices used. This would entail block diagram and we would also be taking a look at the software design and how it was implemented. There are several steps to be applied in designing a passive infrared motion detector for an automatic doorbell alarm system. The relevant information is gathered through literature review from previous chapter.

3.2 PRINCIPLES OF OPERATION

All PIR sensors detect changes in infra-red radiation, in the form of heat emitted by a number of bodies including people, or other small animals. In the bigger body, more infra-red radiation is emitted and it is easier for a PIR sensor to detect. The field of view is the area in which changes in infra-red radiation can be detected. This is shown in figure 3.1. The field of view can alter with changes in temperature and the size of the heat source [13]. The construction of PIR and the Fresnel lens as shown in figure 3.2 divide the field of view into a number of zones both vertically and horizontally, as shown in the diagram overleaf. Each zone is constantly monitored by the sensor. When a person or other heat source enters any zone, the level of infra-red radiation in that zone increases. This change is detected and processed by the sensor, switching on the connected lighting and starting the in-built 'Time' process.[13] Providing the heat source (person) continues to move in the field of view, PIR sensor will keep processing the changes in infra-red radiation and the lighting will stay on. If a person stands still in the field of view or moves out of the detection area, the sensor will not detect any changes in infra-red radiation between the zones and the lights will go out after the 'Time' period is complete [13].

In order to the sensor detect effectively the changes in heat between its zones; it is advisable to walk across the covered zones of it and not up or along detection zones. PIR sensors are passive devices; they do not emit or radiate any energy or beams.

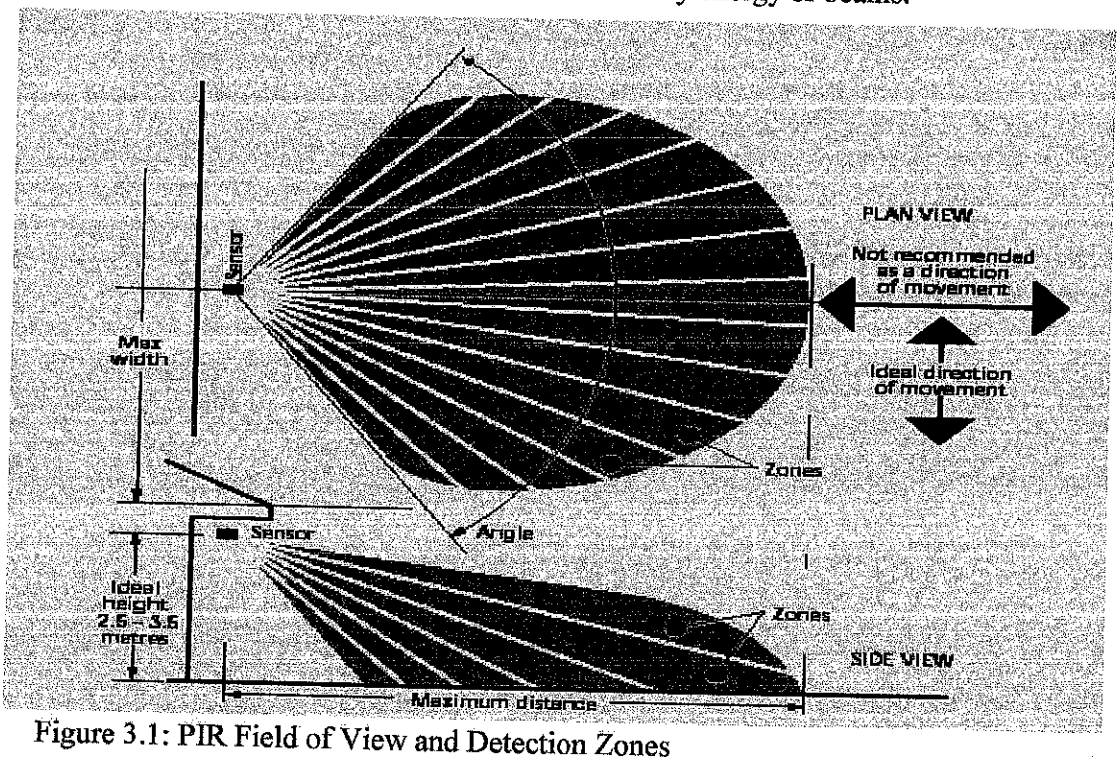

Figure 3.1: PIR Field of View and Detection Zones

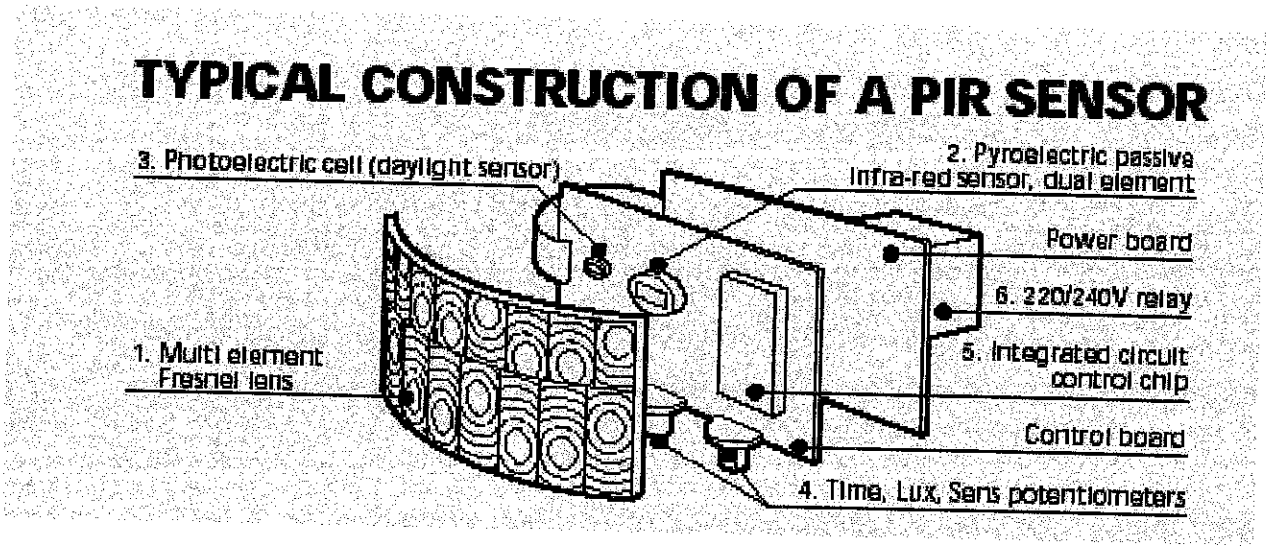

Figure 3.2: PIR Construction.

3.2.1 MULTI ELEMENT FRESNEL LENS

The lens focuses the infra-red radiation given out by a heat source (person) on to the pyroelectric sensor. The different elements or facets of the lens divide the incoming infrared radiation into vertical and horizontal zones.

3.2.2 PYROELECTRIC PASSIVE INFRA-RED SENSOR

The dual element pyroelectric sensor receives the incoming infra-red radiation from the various zones. The two elements of the sensor receive varying amounts of infra-red radiation and this difference is amplified, turning into a signal via the integrated circuit.

3.2.3 INTEGRATED CIRCUIT CONTROL CHIP (IC)

This is a customized chip which controls the various modes of operation, timing functions and the processing of the signal from the sensor to drive the output relay.

3.3 DESIGN PROCESS AND OPERATION

It is an important step in ensuring effectiveness and implementation of the project going forward. The description of the project design process is clearly explained in the block diagram as shown in figure 3.3 which entails the hardware design and the software design. The different stages are analyzed with their objectives, expected results and activities.

3.3.1 HARDWARE DEVELOPMENT

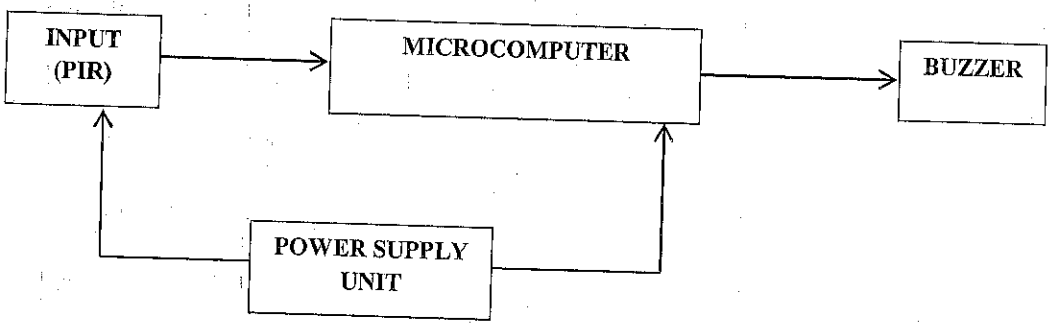

Figure 3.3: Block Diagram of the motion detector circuit system

The hardware is divided into four stages as shown in the block diagram above. The input stage of the system is the PIR (Passive infrared resistor). The second stage is the controller unit which is the Arduino Microcontroller UNO. The purpose of using microcontroller is to control the whole system operation by sending data to the output stage which is the LED indicator, and buzzer. The third stage is the microprocessor and as the name implies processes the signal to give the output required. The fourth stage is the power supply unit which enables access to signals (current/voltage) by a 5v power source.

3.3.2 INPUT PASSIVE INFRARED RESISTOR

The Passive Infrared Resistor receives the input signal as heat and converts to electrical signal for further processing. Passive Infrared Sensor (PIR) is very useful module, used to build many kinds of Security Alarm Systems and Motion Detectors. It is called passive because it receives infrared, not emits. Basically PIR sensor detects any change in heat, and whenever it detects any change, its output PIN becomes HIGH. They are also referred as Pyroelectric or IR motion sensors.

Here we should note that every object emits some amount of infrared when heated. Human also emits infrared because of body heat. PIR sensors can detect small amount of variation in infrared. Whenever an object passes through the sensor range, it produces infrared of the friction between the air and object, and gets caught by PIR.

The main component of PIR sensor is Pyroelectric sensor shown in figure below (rectangular crystal behind the plastic cap). Along with this, BISS0001 (Micro Power PIR Motion Detector IC), some resistors, capacitors, and other components are used to build PIR sensor. BISS0001 takes the input from sensor and does processing to make the output pin HIGH or LOW accordingly.

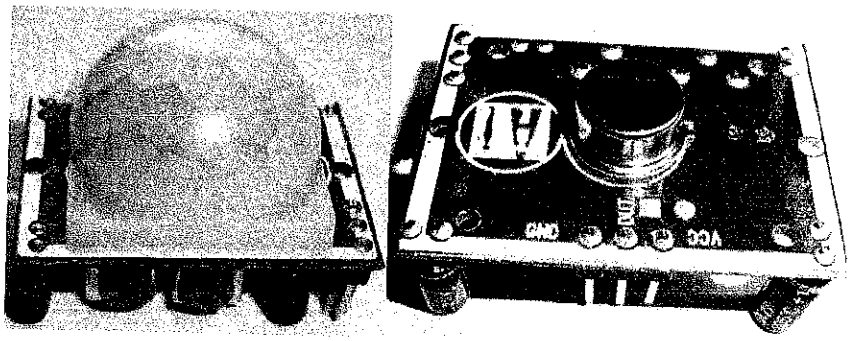

Figure 3.4: Passive Infrared Resistor

Pyroelectric sensor divide in two halves, when there is no motion, both halves remain in same state, means both senses the same level of infrared. As soon as somebody enters in first half, the infrared level of one half becomes greater than other, and this causes PIR to react and make the output pin high.

Pyroelectric sensor is covered by a plastic cap, which has array of many Fresnel lens inside. These lenses are curved in such a manner so that sensor can cover a wide range.

3.3.3 MICROCONTROLLER UNIT AND CALIBRATION

A microcontroller (μC) is a solitary chip microcomputer fabricated from VLSI fabrication. A micro controller is also known as embedded controller. A microcontroller comprises of components like- memory, peripherals and most importantly a processor. Microcontrollers are basically employed in devices that need a degree of control to be applied by the user of the device.

In this project Microcontroller Arduino UNO is used. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. This is shown in figure 3.5.

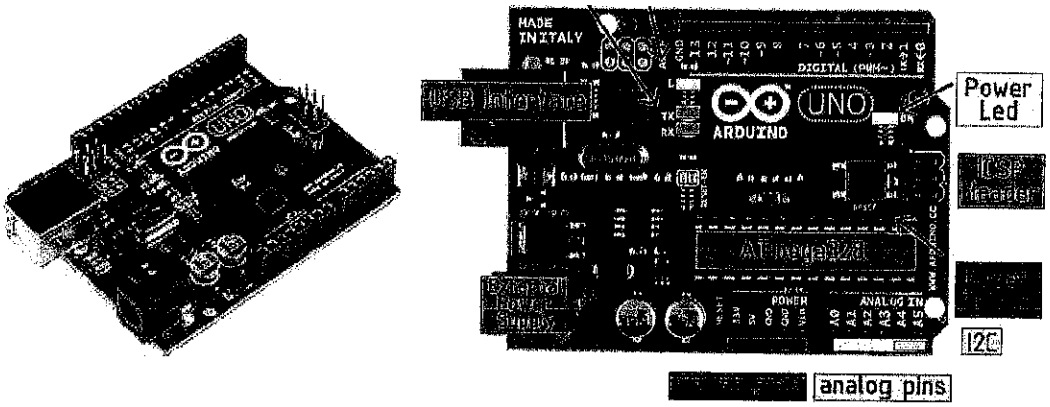

Figure 3.5: Microcontroller UNO ATmega328

The basic features of microcontroller UNO ATmega 328 include:

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

3.3.4 BUZZER

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm

devices, timers and confirmation of user input such as a mouse click or keystroke [13]. The buzzer receives signal from the PIR through the Microcontroller to give the output signal.

3.4 SOFTWARE DEVELOPMENT

The software structure is using the C language where a set of program based on security system is assembled using Arduino assembler. The code is very simple, and it basically keeps track of whether the input to pin 2 is high or low. It also keep tracks the state of the pins, so that it prints out a message when motion has started and stopped.

```
/*
* PIR sensor tester
*/
int ledPin = 13; // choose the pin for the LED
int inputPin = 2; // choose the input pin (for PIR sensor)
int pirState = LOW; // we start, assuming no motion detected
int val = 0; // variable for reading the pin status
void setup() {
pinMode(ledPin, OUTPUT); // declare LED as output
pinMode(inputPin, INPUT); // declare sensor as input
Serial.begin(9600);]
}
void loop(){
val = digitalRead(inputPin); // read input value
if (val == HIGH) { // check if the input is HIGH
digitalWrite(ledPin, HIGH); // turn LED ON
if (pirState == LOW) {
// we have just turned on
Serial.println("Motion detected!");
// We only want to print on the output change, not state
pirState = HIGH;
}
} else {
digitalWrite(ledPin, LOW); // turn LED OFF
if (pirState == HIGH){
// we have just turned of
Serial.println("Motion ended!");
// We only want to print on the output change, not state
```

```
pirState = HIGH;
}
} else {
digitalWrite(ledPin, LOW); // turn LED OFF
if (pirState == HIGH){
// we have just turned of
Serial.println("Motion ended!");
// We only want to print on the output change, not state
pirState = LOW;
}
}
}
```

3.5 POWER SUPPLY

A power supply is an electronic device that supplies electric energy to an electrical load. The primary function of a power supply is to convert one form of electrical energy to another and, as a result, power supplies are sometimes referred to as electric power converters.

This circuit is assembled on a Vero board as compactly as possible and then attaches it to a main door. Power supply using a 9V adapter with regulated output. If the 9V adapter with regulated output is not available, then 12V unregulated DC adapter with 709voltage regulator can be used. This is explained using the block diagram in figure 3.6 and circuit diagram in figure 3.7.

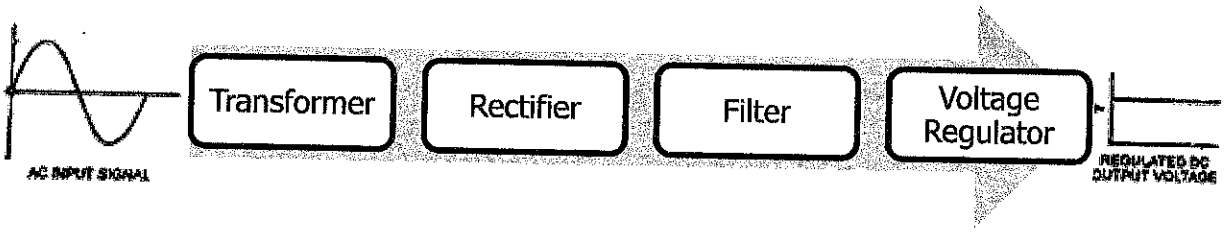

Figure 3.6: Block Diagram of a DC Power supply

CIRCUIT DIAGRAM

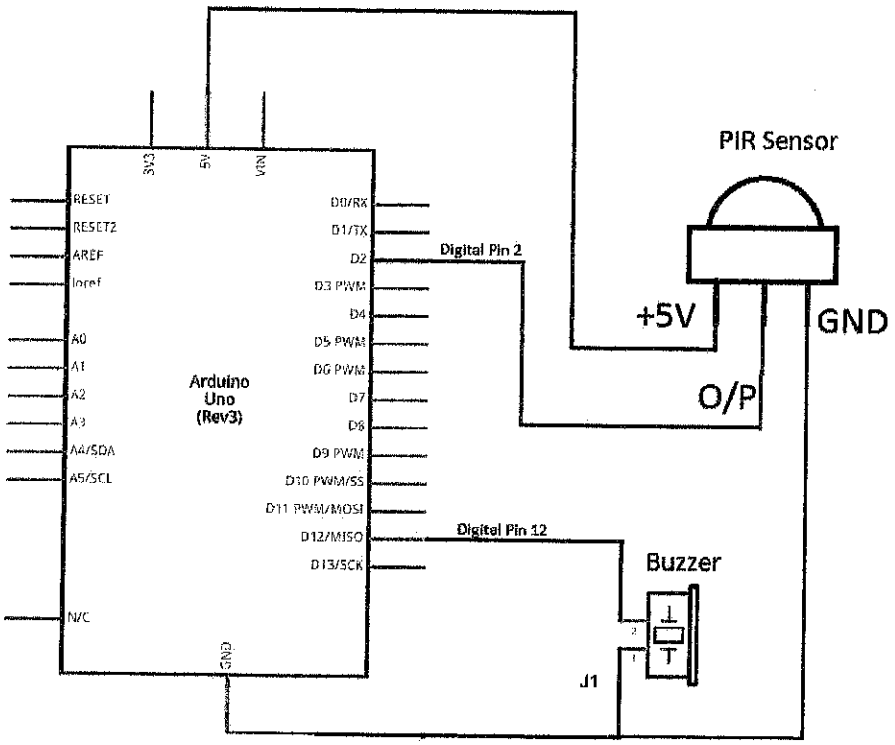

Figure 3.7: Circuit diagram

3.6 DESIGN CALCULATION

To determine the required value of C1

Q = It

Q = CV

CV = It

$C = \frac{It}{V} = i\frac{dt}{dv}$

$t = \frac{1}{f} = \frac{1}{50} = 0.02\ secs$

$dt = \frac{0.02}{2} = 0.01 = 10ms$

Peak voltage = $12\sqrt{2} = 16.6v$

For the ripple select 20%

$$dv = 0.02\ x\ 16.6 = 3.3v$$

$$c = i\frac{dt}{dv} = 500mA\ x\ \frac{0.01}{3.3} = 1515\mu F\ \approx 2000\mu F$$

CHAPTER FOUR

DESIGN, TESTING AND IMPLEMENTATION

4.1 INTRODUCTION

The analysis of this work is based on the input and output of the circuit with the use of a Passive Infrared Resistor (PIR). To implement electronics circuit, a circuit diagram is first obtained after which all components and materials needed in the circuit project are made available. The components are then connected on a breadboard which provides a temporary platform to construct a circuit and make sure that the circuit is operational /as desired before it is transferred and soldered on a Vero board which is a permanent platform for the construction. The system layout is shown in figure 4.1 and figure 4.2.

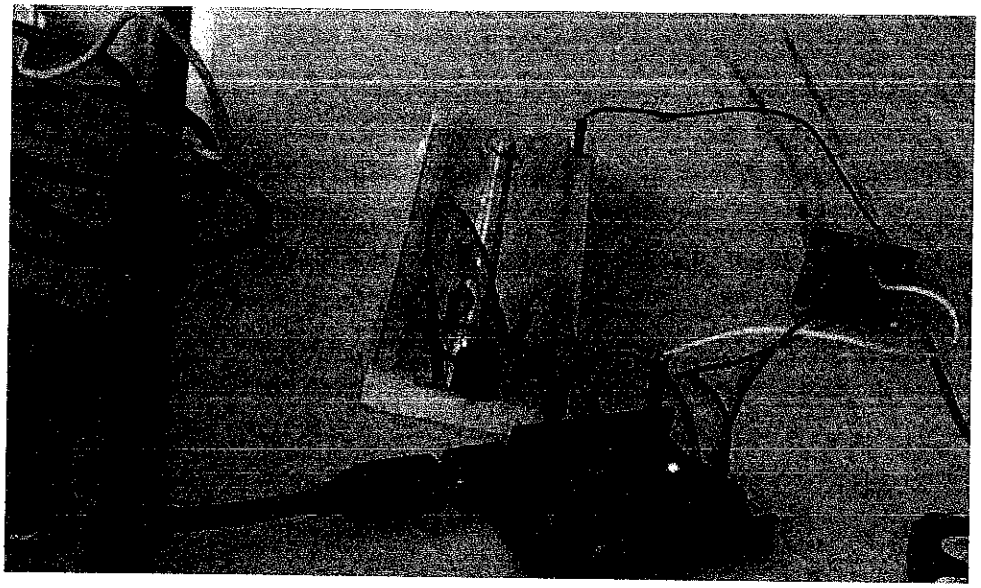

Figure 4.1: System layout (circuit) on breadboard

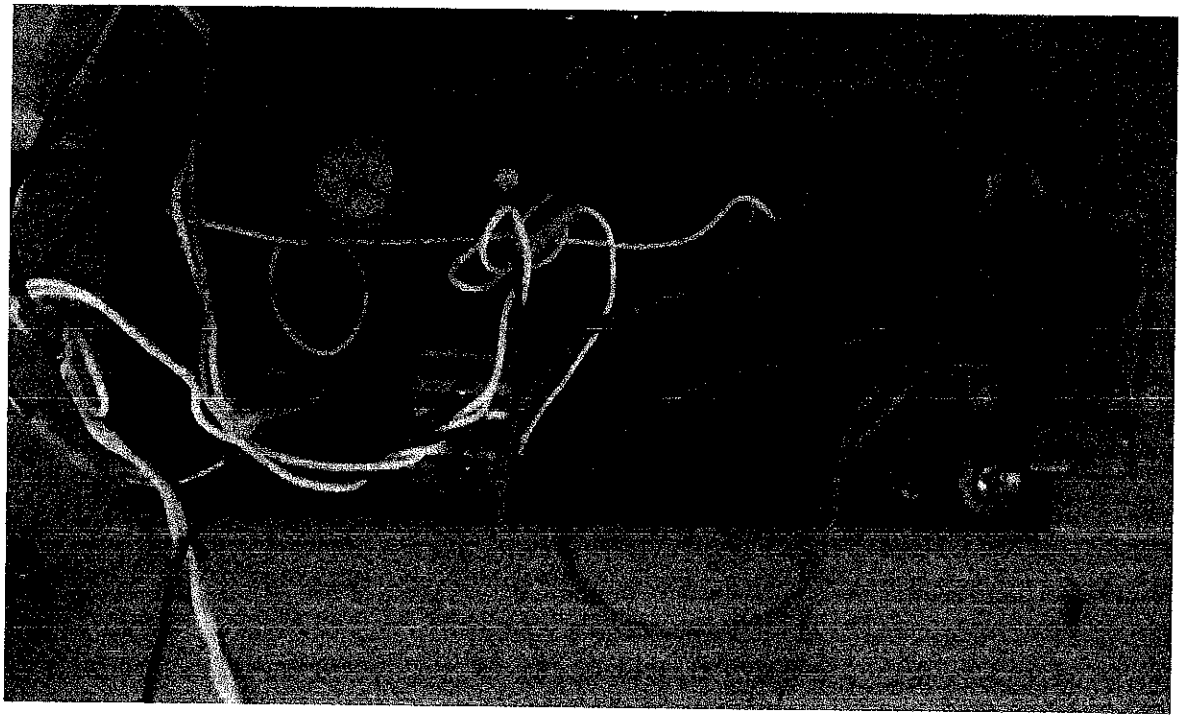

Figure 4.2: System layout (circuit) on Vero board

4.2 TESTING

As stated earlier (Fig 4.1), the testing was first done on breadboard whereby all components used were affixed on the breadboard. This first test is done to ascertain the reliability of the circuit with its functionality.

Also, another testing is done when the components have all been soldered on the Vero board before the final work is cased. At this point, the working principle of the project is tested to make sure it is working perfectly. To achieve this project, it is essential some procedure are taken into cognizance which are in different stages, from circuit design, to bread-board connection, to placement on Vero-board, then to soldering, constructing the model and then to testing and results. In summary, this chapter deals with the following stages:

- Breadboard connection.
- Soldering of circuit on Vero-board.

• Testing and Result.

• Coupling of the entire project to the casing and to a model.

Used Type =PIR Motion Sensor, 10 meters detection

Worked ambient temperature, from -20 Co to 60 Co

Power supply voltage =12 VDC

Detection Current =15 m A

Non-detection currents, from 0 to 2.5 m A

View Field =5×5 meters

Vertical angle, from, -11 to 11

Horizontal angle, from -19 to 19

4.3 APPLICATION

The automatic doorbell alarm system is best used in homes giving visitors a way of announcing their presence; it can also find its application in security systems to detect intruders at a given area automatically.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

In this chapter of the project, the conclusion, limitations of the project and recommendation for further work is clearly stated.

5.2 CONCLUSION

This project has based on designing and implementation of automatic doorbell alarm system. Doorbells are a common convenience in homes; giving visitors a way of announcing their presence and preventing residents from missing deliveries or guests. Doorbells are simple pieces of home equipment that let you know a visitor has arrived. They're useful if you are too far from the front door to hear someone knocking.

5.3 LIMITATIONS

During and after the completion of this project, some limitations were noted as thus:

- It cannot easily discern between humans and small animals.
- Its performance is dependent on temperature difference. On cold nights, the difference in temperature between a person (normal body temperature is 37 ^{O}C) and the outside air temperature is relatively large, giving an apparent increase in performance of the sensor. On hot nights, this difference in temperature is relatively small and a decrease in performance of the sensor can be expected.

5.4 RECOMMENDATIONS

The objective of the project is been achieved but it is still subject to further improvement

- An image sensor that can differentiate between human, non-humans, inanimate things can be employed to solve one of the limitations above.

- Also if possible, the distance can be varied as desired to virtually prevent false triggering to occur.

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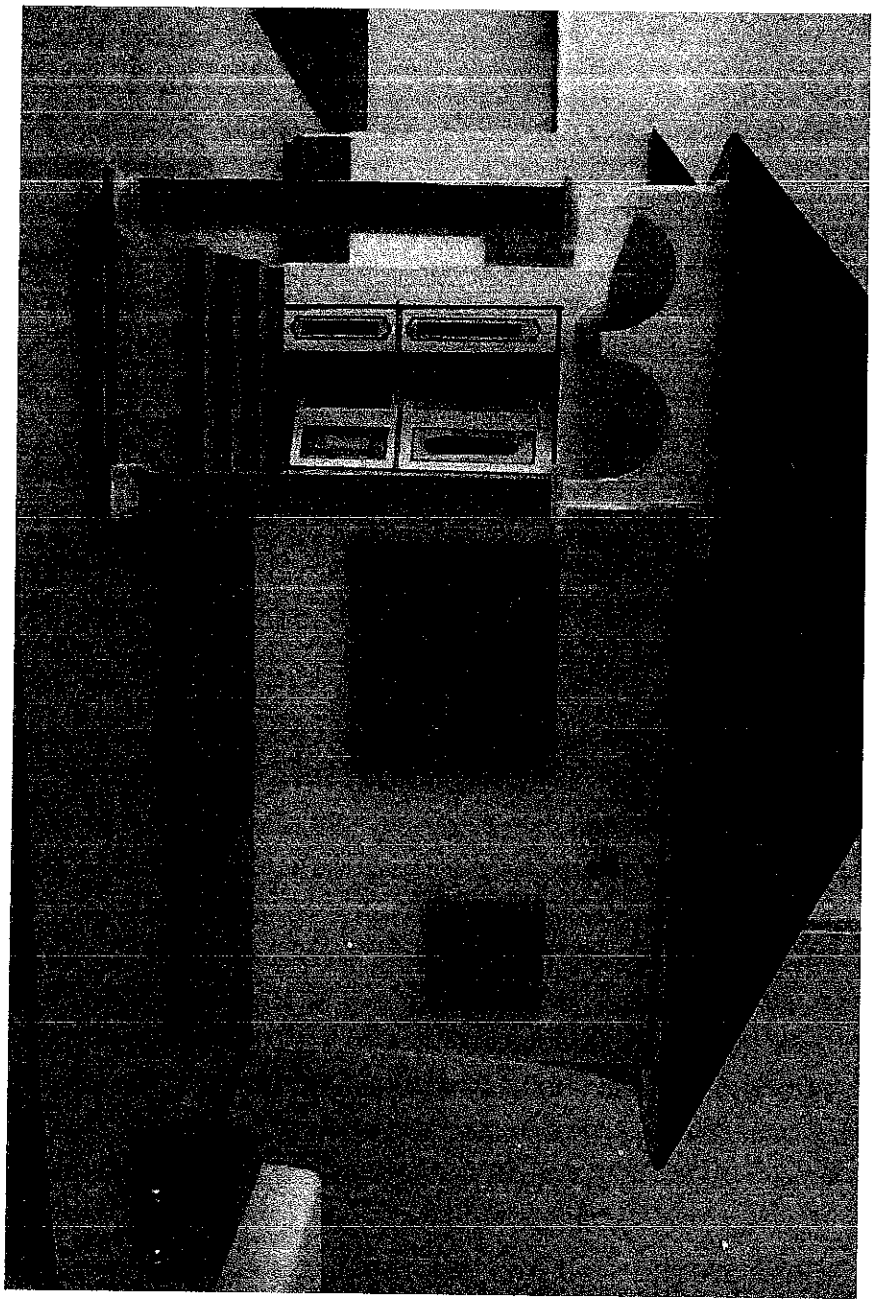
APPENDIX I

COST ESTIMATION OF THE WHOLE PROJECT

COMPONENTS	QUANTITY	UNIT AMOUNT(#)	TOTAL AMOUNT(#)
Arduino Kit (PIR Sensor, Buzzer, Microcontroller, connecting wires, Light Emitting Diode etc)	1	6,900	6,900
Fero Board	1	200	200
4 Diodes (1N4001)	4	50	200
Voltage regulator (7805, 7812)	2	100	200
Jumper Cables	5	20	100
Resistors (330, 470) ohms	1	20	20
12V Transformer	1	300	300
Capacitor (2200μF)	2	50	100
DC Relay	1	250	250
Packaging			7,000
Switch	1	100	**100**
TOTAL			**15, 370**

APPENDIX II

IMAGE OF THE WHOLE PROJECT AS IMPLEMENTED



Completion of the project