

**The Application of the Infra-Red Sensors in a Mouse Trap Design**

by

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Dissertation submitted in partial fulfilment of  
The requirements for the Degree of  
Bachelor of Engineering (Hons)  
(Electrical and Electronics Engineering)

MAY 2004

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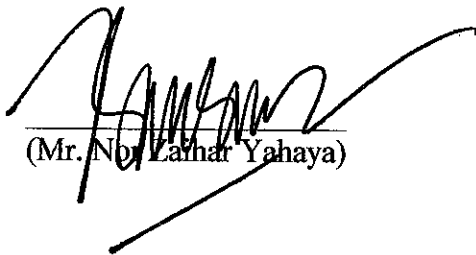
# **The Application of the Infra-Red Sensors in a Mouse Trap Design**

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A project dissertation submitted to the  
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Universiti Teknologi PETRONAS  
In partial fulfilment of the requirement for the  
BACHELOR OF ENGINEERING (Hons)  
(ELECTRICAL AND ELECTRONICS ENGINEERING)

Approved by,



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UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

May 2004

## CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



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SITI NUR LAILA BINTI MUKHTAR

## **ACKNOWLEDGEMENT**

In the name of Allah, the most compassionate, the merciful. First and foremost, I would like to thank Allah the Almighty for His blessing and guidance in allowing me to complete this project as required.

It would obviously have been impossible to complete this project without contributions and assistance from other people. The greatest appreciation goes to my parents, for their love, support and understanding while I spend most of holidays in the campus.

My deepest gratitude goes towards my supervisor, Mr. Nor Zaihar Yahaya. His guidance, support, and trust in me, has allowed me to learn and complete my project successfully.

A special acknowledge to Muhammad Imran Lee Abdullah from PETRONAS Fertilizer Kedah, for his contribution and sharing of ideas on electronics side towards my project. I wish to thank my sister, Miss Aniza Isahak for her support and help for the final report writing. I would like to thank Electrical and Electronics Engineering lecturers for making this 'Final Year Project' a success.

I would like to thank also to those whose names I have not mentioned. My sincere thanks goes to all those who had helped me whether directly or indirectly. My heart goes to UTP for giving me this opportunity to thrive in my journey of pursuing knowledge. May Allah bless all those who have touched my heart in so many ways.

Thank you.

Siti Nur Laila Binti Mukhtar [00001539]

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## **ABSTRACT**

Infrared technologies involve in many ways in our life today including industrial, electrical and electronics systems, health and many more. The use of infrared sensor, which is beneficial to detect the movement of an object, is implemented in this project.

The main objective of this project is intended to develop the application of Infra-Red Sensors in a mouse trap design. This electronic project is proposed to introduce a new method to catch the mouse. "Smart Mouse Trap" consists of infrared sensor, weight sensor, motor speed controller and flat belt conveyor into a system. The system is capable to perform a smooth integration between all these sub-systems. Two main stages were involved in accomplishing the project. The first stage was identification and designation of the components of Smart Mouse Trap system. Research, several discussion and literature review were performed in order to progress with the project. The most common used tools were Microsoft Eval 7.1 and Microsoft Visio. The second stage of the project was to establish the real model of Smart Mouse Trap, which consists of troubleshooting, evaluating, result testing and refining areas of weaknesses. In this stage, most of hardware tools had been used. Focus also given to the preparation of the project report itself. At the end, the prototype construction of a Smart Mouse Trap by implementation of infrared as its interfaces has accomplished within the allocated time. The features, advantages and benefit of the design were identified and the recommendation for the future expansion also suggested.

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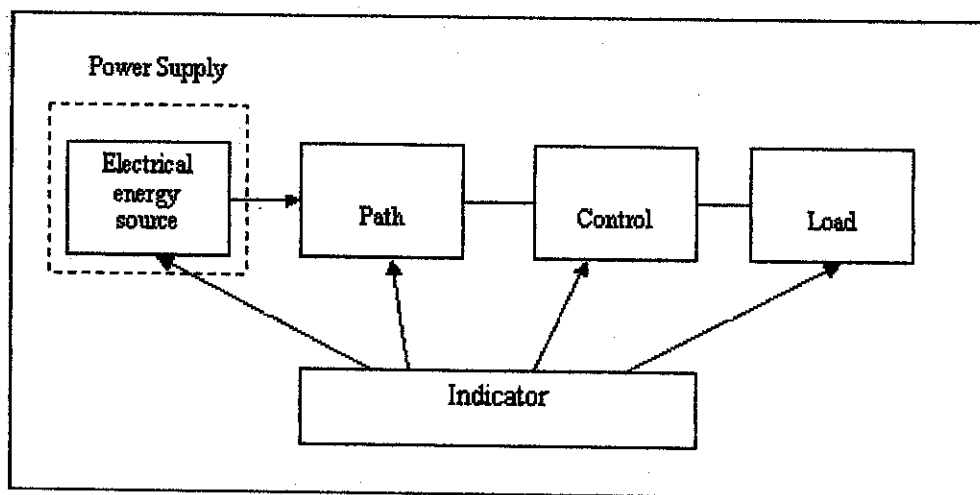
# CHAPTER 1: INTRODUCTION

## 1.1 Background of Study

The use of Infrared sensors is beneficial to detect the movement of an object. The application of this sensor is used in this Smart Mouse Trap design. The detection will generate the conveyor motor and by automatic adjustable speed control, the more forward movement of a mouse out of the trap will generate the high motor speed, hence preventing the mouse from escaping. The conveyor is just then responding to the motor speed that controlled by the controller. This Smart Mouse Trap consists of five main part which are power supply circuit, weight sensor circuit, infrared sensor circuit and controllable motor circuit to run the conveyor and conveyor system.

### 1.1.1 Power Supply

This project, which is considered as an electronic project, requires 9V and 12V direct-current voltage and current values for operation. The energy source of the system is primarily responsible for this function. As general rule, the source is more commonly called power supply. The block diagram in Figure 1.1 illustrates Electrical system parts. It consists of electrical energy source, path, control, load and indicator. The path can be wires, printed circuit foil, conductors, etc. Control components can be electronic devices, resistors, capacitor, etc. The load is all system components that require electrical energy for operation. In this project, load can be motor, conveyor and infrared sensor. The indicator can be LED, lamps or meter.



**Figure 1.1** Electrical Sub-System

### 1.1.2 Weight sensor

The weight sensor acts as a switching button to activate the infrared sensor circuit. The food will be placed on the weight sensor at the end of the mouse trap. The weight sensor will trigger a signal to the infrared sensor as it detects the lighter load on it. This weight sensor is used as mechanical contact mechanism.

### 1.1.3 Infrared sensor

Basically, this infrared sensor is to detect the movement of the mouse. There are three pairs of infrared sensor are built as a controller for the motor. Each sensor will run the motor at different speed when their infrared signals are blocked. The first pair of infrared will run the motor at the slowest speed as a start-up speed. The second pair of infrared will further run the motor at medium speed and the fastest motor speed will be activated by the third infrared circuit. Each one of infrared circuit consists of transmitter and receiver circuit.

#### 1.1.4 Adjustable speed motor

The primary function of any adjustable speed drive is to control the speed, torque, acceleration, deceleration and direction of rotation of a machine. Unlike constant speed systems, the adjustable speed drive permits the selection of an infinite number of speeds within its operating range. There are many ways to control the speed of motor. It can be application of potential meter that varies the resistor which will result the different supply to the load. Hence, the motor will run at different speed for the different resistances. Multispeed motor may contain many windings that can be connected in different ways. This allows the each sensor to set the motor to run at any of the three preset speeds. Another way is to use voltage regulator. Voltage regulator circuit function to control the power supply to the motor. In this application, it will set different speed for different signal from the infrared sensor. The motor then will be used to run the conveyor belt.

#### 1.1.5 Conveyor system

Now a days, many conveyor types presents in industries. In many industrial factories, conveyor lines are used to make products. The most application involves flat belt conveyors, roller conveyors, elevators and hoppers. The conveyor needs to transfer items for one place to another. In this project, the conveyor is just then responding to the motor speed controlled by the controller. This project implements small belt conveyor system.

## 1.2 Problem Statement

The use of glue traps dates back to at least 1832, when a sticky device was developed to capture birds. Since then, glue or adhesive traps have been used to trap a variety of animals, and they are now common methods of mouse and rat control [1]. Sticky glue traps cause the animals they catch an enormous amount of suffering and a traumatic death.

A glue trap consists of a piece of cardboard, fibreboard, or plastic that is coated with a sticky adhesive. Sticky traps are designed for indoor use, since outside they can become clogged with leaves and other loose material. Glue trap makers generally state that trapped animals should be thrown away along with the trap. Thus, animals suffer alive in the trap for days.

With believe that if people understood the degree of cruelty associated with the use of glue traps, they would want no part of them. Thus, the purpose of the project was to design a Smart Mouse Trap, which implementing of sensor interfacing, electrical circuit application and mechanical system. All the sub-system should be smoothly integrated each other to accomplish this project. The circuits were structured and built one by one. The flexibility of the circuits was tested in developing of the Smart Mouse Trap model.

### **1.3 Objective and Scope of Study**

The focal objectives are:

- ❖ To understand the working principle of Infrared sensor and its application.
- ❖ To understand the working principle of the electrical and electronic devices.
- ❖ To develop a prototype of Smart Mouse Trap by implementation of infrared as its interfaces.
- ❖ To integrate all the sub-system (power supply, motor controller, infrared sensor, conveyor system, etc) into one system.

In order to run the project accordingly throughout a year, a Gantt chart was developed as attached as Appendix I. The purpose of having the Gantt chart is to determine all the required tasks and then be able to trace all the completed tasks. The chart also alerts any lag in the project development.

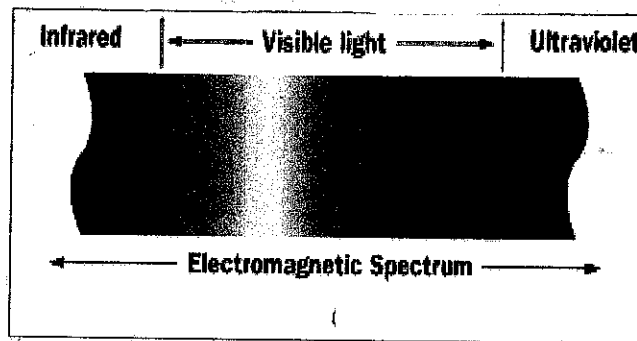
## CHAPTER 2 : LITERATURE REVIEW AND THEORY

### 2.1 Motion Sensors

There are many different ways to create a motion sensor. For example, it is common for stores to have a beam of light crossing the room near the door, and a photosensor on the other side of the room. When a customer breaks the beam, the photosensor detects the change in the amount of light and rings a bell. Many grocery stores have automatic door openers that use a very simple form of radar to detect when someone passes near the door. The box above the door sends out a burst of microwave radio energy and waits for the reflected energy to bounce back. When a person moves into the field of microwave energy, it changes the amount of reflected energy or the time it takes for the reflection to arrive, and the box opens the door. Since these devices use radar, they often set off radar detectors. The same thing can be done with ultrasonic sound waves, bouncing them off a target and waiting for the echo.

All of these are active sensors. They inject energy (light, microwaves or sound) into the environment in order to detect a change of some sort. The "motion sensing" feature on most lights (and security systems) is a passive system that detects infrared energy. These sensors are therefore known as PIR (passive infrared) detectors or pyroelectric sensors. In order to make a sensor that can detect a human being, it needs to make the sensor sensitive to the temperature of a human body. Humans, having a skin temperature of about 93°F, radiate infrared energy with a wavelength between 9 and 10  $\mu\text{m}$ . Therefore, the sensors are typically sensitive in the range of 8 to 12 $\mu\text{m}$ .

The amount of energy in a light wave is related to its wavelength. Shorter wavelengths have higher energy. Of visible light, violet has the most energy, and red has the least. Just next to the visible light spectrum is the infrared spectrum.



**Figure 2. 1** Infrared light is a small part of the light spectrum.

Infrared light can be split into three categories:

- ❖ Near-infrared (near-IR) - Closest to visible light, near-IR has wavelengths that range from 0.7 to 1.3 microns, or 700 billionths to 1,300 billionths of a meter.
- ❖ Mid-infrared (mid-IR) - Mid-IR has wavelengths ranging from 1.3 to 3 microns. Both near-IR and mid-IR are used by a variety of electronic devices, including remote controls.
- ❖ Thermal-infrared (thermal-IR) - Occupying the largest part of the infrared spectrum, thermal-IR has wavelengths ranging from 3 microns to over 30 microns [2].

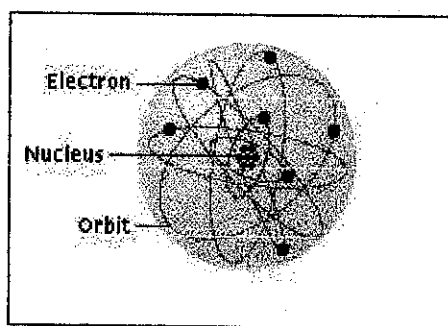
The key difference between thermal-IR and the other two is that thermal-IR is emitted by an object instead of reflected off it. Infrared light is emitted by an object because of what is happening at the atomic level.

Atoms are constantly in motion. They continuously vibrate, move and rotate. Even the atoms that make up the chairs that we sit in are moving around. Solids are actually in motion. Atoms can be in different states of excitation. In other words, they can have different energies. If a lot of energy apply to an atom, it can leave what is called the



ground-state energy level and move to an excited level. The level of excitation depends on the amount of energy applied to the atom via heat, light or electricity.

An atom consists of a nucleus that containing the protons and neutrons and an electron cloud. The electrons in this cloud are circling the nucleus in many different orbits. Although more modern views of the atom do not depict discrete orbits for the electrons, it can be useful to think of these orbits as the different energy levels of the atom. In other words, if some heat is apply to an atom, it might expect that some of the electrons in the lower energy orbitals would transition to higher energy orbitals, moving farther from the nucleus.



**Figure 2. 2** An atom has a nucleus and an electron cloud.

Once an electron moves to a higher-energy orbit, it eventually wants to return to the ground state. When it does, it releases its energy as a photon, a particle of light. It can be seen that atoms releasing energy as photons all the time. For example, when the heating element in a toaster turns bright red, the red color is caused by atoms excited by heat, releasing red photons. An excited electron has more energy than a relaxed electron, and just as the electron absorbed some amount of energy to reach this excited level, it can release this energy to return to the ground state. This emitted energy is in the form of photons (light energy). The photon emitted has a very specific wavelength (color) that depends on the state of the electron's energy when the photon is released.

Anything that is alive uses energy, and so do many inanimate items such as engines and rockets. Energy consumption generates heat. In turn, heat causes the atoms in an object to fire off photons in the thermal-infrared spectrum. The hotter the object, the shorter the wavelength of the infrared photon it releases. An object that is very hot will even begin to emit photons in the visible spectrum, glowing red and then moving up through orange, yellow, blue and eventually white.

## 2.2 Glue Traps

A 1983 test that evaluated the effectiveness of glue traps found that trapped mice struggling to free themselves would pull out their own hair, exposing bare, raw areas of skin. The mice broke or even bit off their own legs, and the glue caused their eyes to become badly irritated and scarred. After three to five hours in the glue traps, the mice defecated and urinated heavily because of their severe stress and fear, and quickly became covered with their own excrement. Animals whose faces become stuck in the glue slowly suffocate, and all trapped animals are subject to starvation and dehydration.

Because of the cruelty of glue traps, many veterinarians have issued affidavits opposing their use. In one such document [3], Dr. Robert M. Lynn stated, "In my estimation, there is much suffering by the entrapped animals. It is not a sudden or merciful death, but one brought on by starvation and thirst." In the same article, Dr. Dianne Ferris added, "Because all mammals have similar nervous systems, they are capable of experiencing the same type of pain and suffering. Thus, rodents suffer as much as any other mammal and are capable of being traumatized and abused."

## 2.3 DC Power Supply

Most electronic circuits require a DC power supply. Direct current (DC) is the continuous flow of electricity through a conductor such as a wire from high to low potential. In direct current, the electric charges flow always in the same direction, which distinguishes it from alternating current (AC).

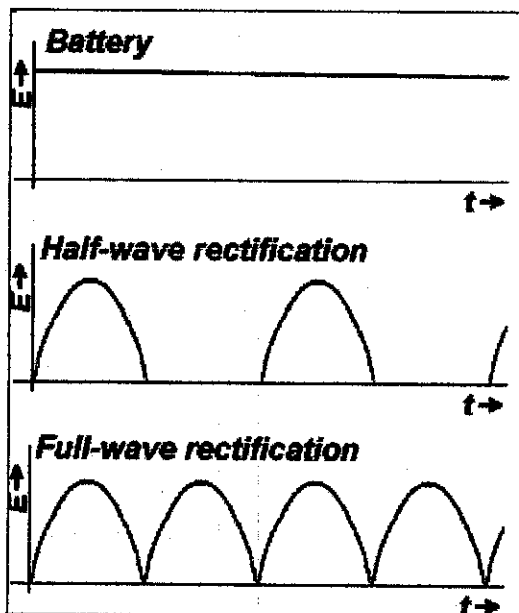


Figure 2.3 Types of direct current

Direct current was used originally for electric power transmission after the discovery by Thomas Edison of the generation of electricity in the late nineteenth century. It has mostly been abandoned for this purpose in favor of alternating current, which is much more suited to transmission over long distances. DC power transmission is still used to link AC power networks with different frequencies [4].

DC is commonly found in many low-voltage applications, especially where these are powered by batteries, which can only produce DC. Most automotive applications use DC although the generator is an AC device which uses a rectifier to produce DC.

Although DC stands for 'Direct Current', DC is generically used to refer to constant polarity voltages. Some forms of DC vary wildly in voltage, such as the raw output of a rectifier. Running them through an RC low-pass filter will produce more stable voltage. Direct current installations usually have different types of sockets, switches, and fixtures, mostly due to the very low voltages used, from those suitable for alternating current. It is usually extremely important with a direct current appliance to not reverse polarity unless the device has a bridge to correct for this. But then, most battery-powered devices don't.

## 2.4 DC Drives

### 2.4.1 Adjustable speed drives

Most multi-purpose production machines benefit from adjustable speed control, since frequently their speeds must change to optimize the machine process or adapt it to various tasks for improved product quality, production speed or safety. Electrical adjustable speed drives typically consist of three principle elements, as outlined below and as shown by the system block diagram in Figure 2.4.

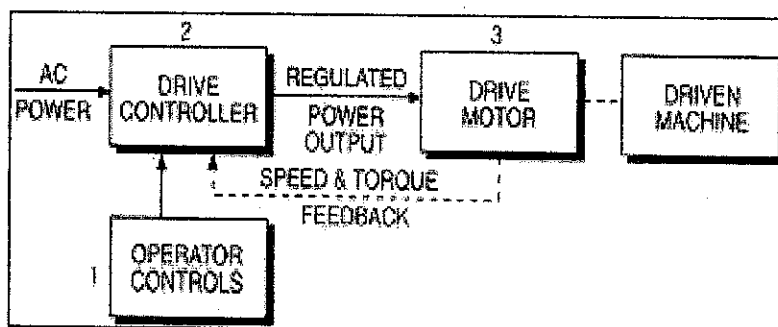
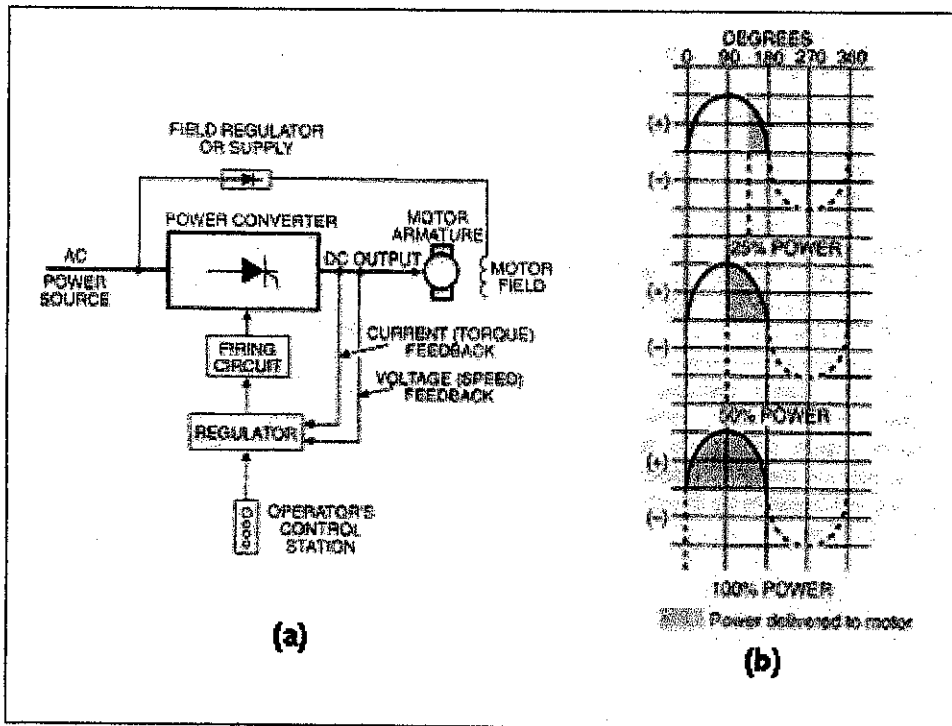


Figure 2.4 Functional Block Diagram

## 2.4.2 Principles of Operation

DC drives, because of their simplicity, ease of application, reliability and favorable cost have long been a backbone of industrial applications. A typical adjustable speed drive using a silicon controller rectifier (SCR) power conversion section, common for this type unit, is shown in Figure 2.5 (a). The SCR, also termed a thyristor converts the fixed voltage alternating current (AC) of the power source to an adjustable voltage, controlled direct current (DC) output which is applied to the armature of a DC motor [5].



**Figure 2.5** (a) Typical DC Drive (b) Triggering Point for Various Power Output

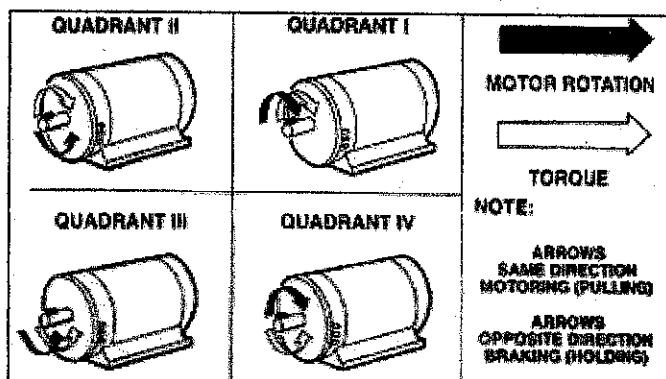
SCR's provide a controllable power output by "phase angle control", so called because the firing angle, which is a point in time where the SCR is triggered into conduction is synchronized with the phase rotation of the AC power source. If the device is triggered early in half cycle, maximum power is delivered to the motor; late triggering in the half cycle provides minimum power, as illustrated by Figure 2.5 (b). The effect is similar to a very high speed switch, capable of being turned on and "conducted" off at an infinite number of points within each half cycle. This occurs at a rate of 60 times a second on a

60 Hz line, to deliver a precise amount of power to the motor. The efficiency of this form of power control is extremely high since a very small amount of triggering energy can enable the SCR to control a great deal of output power.

### 2.4.3 Dc Drive Types

Nonregenerative DC drives are the most conventional type in common usage. In their most basic form they are able to control motor speed and torque in one direction only as shown by Quadrant I in Figure 2.6. The addition of an electromechanical (magnetic) armature reversing contactor or manual switch (units rated 2 HP or less) permits reversing the controller output polarity and therefore the direction of rotation of the motor armature as illustrated in Quadrant III. In both cases torque and rotational direction are the same [6].

Regenerative adjustable speed drives, also known as four-quadrant drives, are capable of controlling not only the speed and direction of motor rotation, but also the direction of motor torque. This is illustrated by Figure 2.6. The term regenerative describes the ability of the drive under braking conditions to convert the mechanical energy of the motor and connected load into electrical energy which is returned (or regenerated) to the AC power source.



**Figure 2. 6** Motor Rotation and Torque Direction for DC Motor

When the drive is operating in Quadrants I and III, both motor rotation and torque are in the same direction and it functions as a conventional nonregenerative unit. The unique characteristics of a regenerative drive are apparent only in Quadrants II and IV. In these quadrants, the motor torque opposes the direction of motor rotation which provides a controlled braking or retarding force. A high performance regenerative drive, is able to switch rapidly from motoring to braking modes while simultaneously controlling the direction of motor rotation.

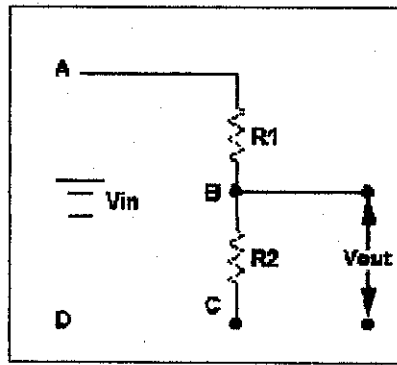
A regenerative DC drive is essentially two coordinated DC drives integrated within a common package. One drive operates in Quadrants I and IV, the other operates in Quadrants II and III. Sophisticated electronic control circuits provide interlocking between the two opposing drive sections for reliable control of the direction of motor torque and/or direction of rotation. In this project, Quadrants I or III will be used since the conveyor system doesn't need to reverse or stop (brake) its movement.

Speed control of DC motor also can be done by:

- i. Adding the resistance
- ii. Adjusting armature voltage
- iii. Adjusting Field voltage

## **2.5 Voltage Divider Network**

The voltage-divider circuit shown in Figure 2.7 contains two resistors,  $R_1$  and  $R_2$ , and a power source having a constant voltage that refers as the input voltage. The output voltage,  $V_{out}$  is taken to be between the two points labelled B and C in Figure 2.7, across the resistor  $R_2$  [7].



**Figure 2.7** Voltage-divider Circuit

Resistors  $R_1$  and  $R_2$  are in a series connection. The series combination of these two resistors results in the single equivalent resistance  $R_{12} = R_1 + R_2$ . Since  $R_{12}$  comes from the series combination of  $R_1$  and  $R_2$ , it follows that the current  $I$  flowing out of the voltage source must also flow through each of the resistors  $R_1$  and  $R_2$ . From Ohm's law, it then immediately follows that the output voltage, taken to be the voltage across resistor  $R_2$  in Figure 2.7 will be

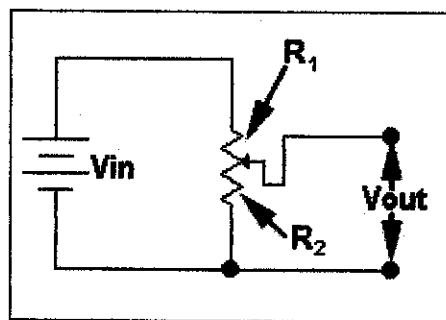
$$\Delta V_{\text{out}} = IR_2 = \left( \frac{\Delta V_{\text{in}}}{R_1 + R_2} \right) R_2 \quad \text{or} \quad \Delta V_{\text{out}} = \left( \frac{R_2}{R_1 + R_2} \right) \Delta V_{\text{in}}$$

The input voltage for the circuit,  $V_{\text{in}}$ , is divided into two parts, one part across resistor  $R_1$  and the other part across resistor  $R_2$ . With the output taken to be across resistor  $R_2$ , the output voltage is just a fraction of the input voltage, that fraction being completely determined by the values of the resistances  $R_1$  and  $R_2$ .

A potentiometer is a single resistor  $R$  that is split into two parts,  $R_1$  and  $R_2$ , such that  $R_1 + R_2$  is always equal to the total resistance  $R$ :  $R_1 + R_2 = R$ . The potentiometer usually has a knob that can be turned. As this knob is turned the resistance  $R_1$  gets smaller and the resistance  $R_2 = R - R_1$  gets larger. The way this works is that, as the knob is turned, a contact point inside the potentiometer that defines the breaking-off point between  $R_1$  and  $R_2$  is moved along a resistive wire or strip that defines the total resistance  $R$ . This



can be seen in the way the circuit symbol for a potentiometer is drawn. As shown in Figure 2.8 below, the circuit element for the potentiometer is just the circuit symbol for a resistor with a contact point with an arrow drawn in towards the middle of the resistor. The portion of the resistor above the contact point is labeled as resistor  $R_1$  in the Figure, and that below the contact point is labelled as  $R_2$ . If the resistances  $R_1$  and  $R_2$  from a potentiometer are used in the voltage-divider circuit as shown in Figure 2.8, then the output voltage can be continuously varied from zero to some maximum value as the potentiometer knob is turned and the values of  $R_1$  and  $R_2$  are changed.



**Figure 2. 8** Voltage-divider using Potentiometer

## CHAPTER 3 : METHODOLOGY

### 3.1 Procedure Identification

The project was planned to follow the Problem Cycle Solving as illustrated on Figure 3.1. It began with identifying the problems, went through step-by-step and ended with prototype construction. If any problems occurred, the cycle went to the beginning and all steps were evaluated.

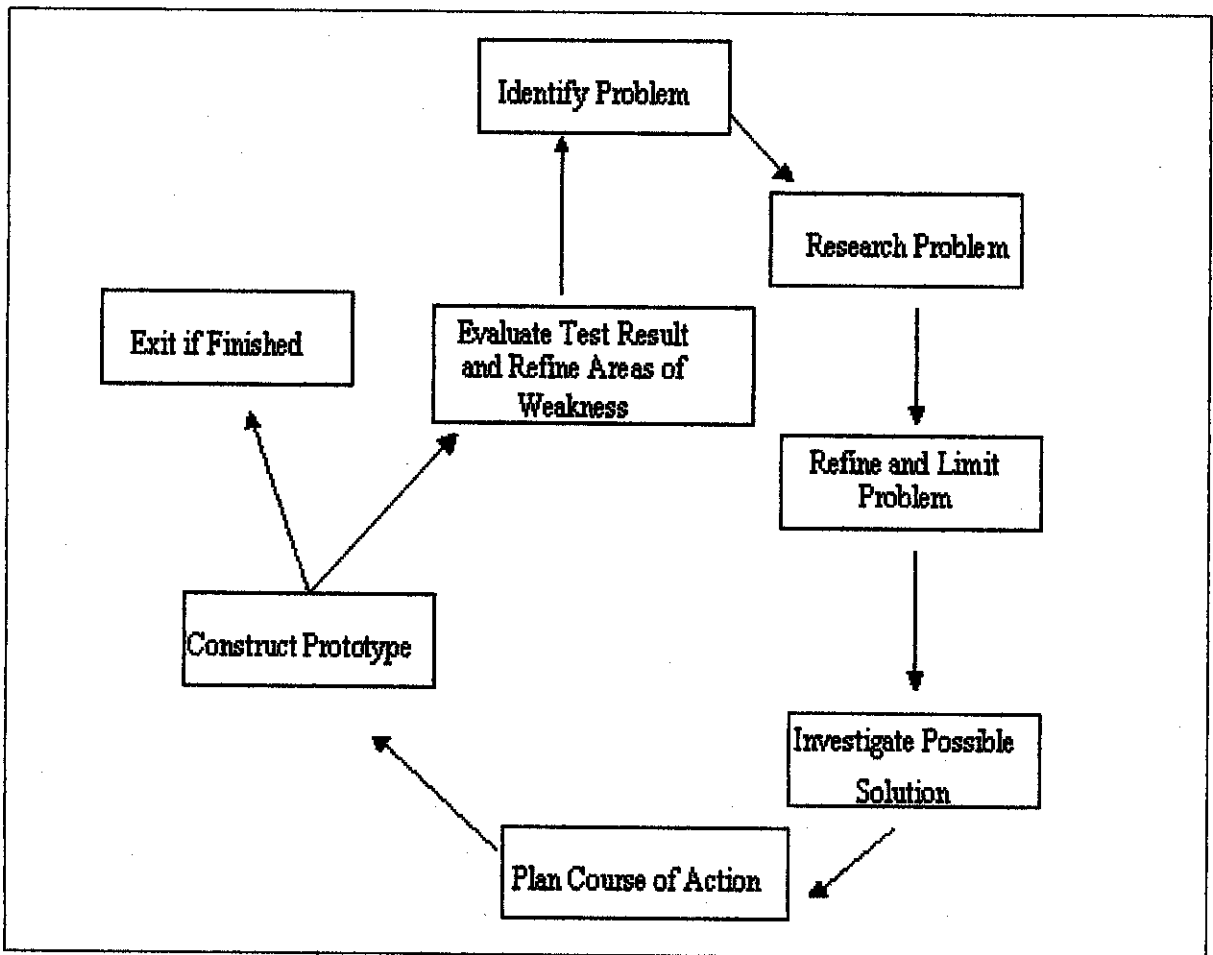


Figure 3.1 Problem-cycle Solving

Since the first semester of the Final Year Project only need all the set up of the circuit, the project mainly consist on building up the requirement circuit and testing session. This required a lot of effort as all the connection set up needed to be done properly and the circuit design must all be understood.

In order to progress with the project, research, several discussion and literature review were performed. By performing this method, the ability to grasp the understanding and the same time developing with the project progressed successfully. The effort in learning new knowledge in order to help in completing the project successfully was the most important. Discussion with supervisor was very essential in order to keep track of the progress and also help to understand the scenario of the project better.

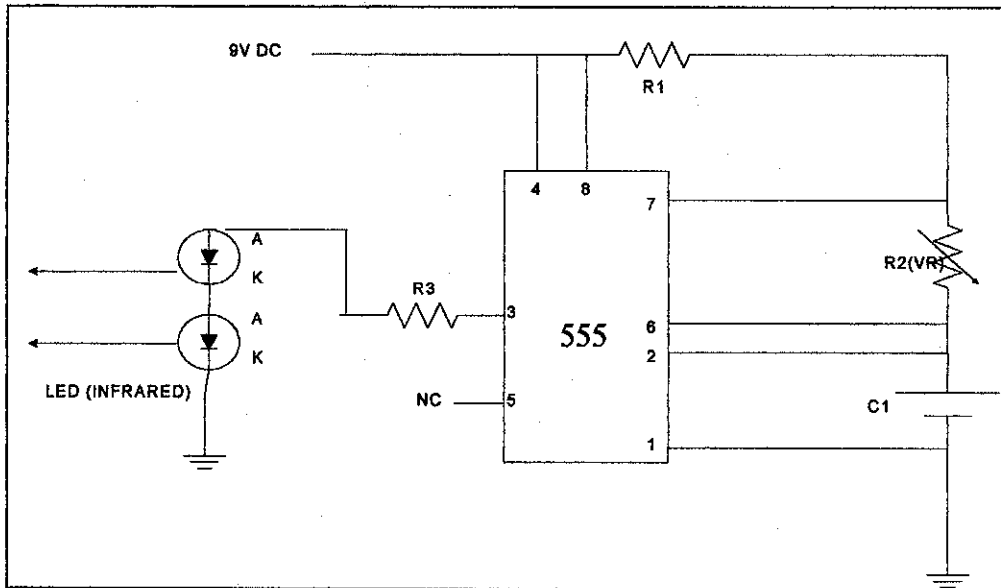
For the second semester of Final Year Project, the main focus was on the construction of prototype, which consists of troubleshooting, evaluating, result testing and refining areas of weaknesses. The second focus was given to the preparation of the project report itself.

### 3.1.1 Sensor's circuit construction

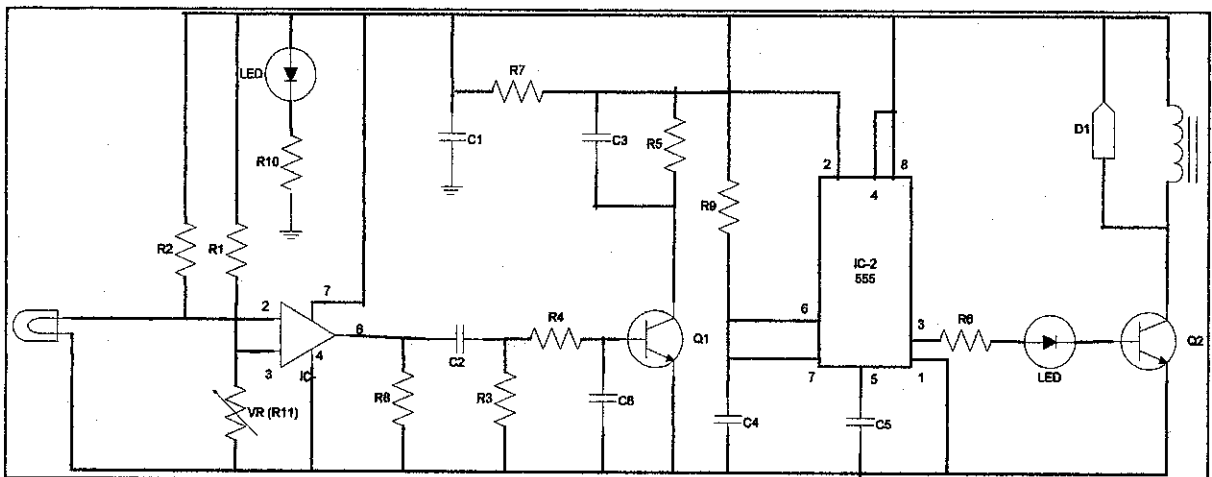
This project needs three pairs of infrared sensor in order to run the motor at three different speeds. The infrared circuit was constructed to be a movement detector of the mouse. They will be activated only when the limit switch is triggered. Generally, there are three pairs of infrared sensor that need to run the conveyor motor at difference speed, which consist of:

- i. Three Infrared Transmitter
- ii. Three Infrared Receiver

The circuit of infrared transmitter and receiver are shown as Figure 3.2 and Figure 3.3 respectively.



**Figure 3.2** Infrared Transmitter



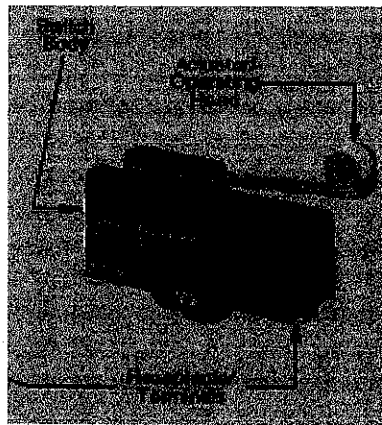
**Figure 3.3** Infrared Receiver

At the beginning, the entire sensor was run using the electrical software. The second step began by constructing the circuit on the breadboard. After some simulation and experimentation, the circuit then are built on the electronic board.

For the beginning of assembling the circuit on the electronic board, all the three circuit of Infrared receivers and transmitter were constructed on different electronic board.

After some modification, the entire circuit were decided to be assembled on an electronic board in order to minimize the space used for the project and make the circuit simple. The component list for infrared sensor is attached as appendix II.

These infrared circuits only will be activated by activating the limit switch. Thus, it was connected as “Normally Closed” switch. The condition of the contact when the circuit is not energized, contacts are closed. A limit switch is a mechanical device that requires the physical contact of an object with the switch’s actuator to make the contacts change state . The term limit switch is derived from this operation of the switch. Figure 3.4 shows the limit switch that has been used in the project.



**Figure 3. 4** Limit Switch

A limit switch consists of three main components:-

- i. The actuator is the part of the limit switch that physically comes in contact with the target. In some limit switches, the actuator is attached to an operating head . The operating head translates a rotary, linear or perpendicular “triggering” motion into the motion type needed to open or close the electrical contacts of the switch.
- ii. The switch body is the component that contains the electrical contact mechanism.

- iii. The terminal screw or screw/clamp assembly necessary for wiring is referred to as the receptacle .

### 3.1.2 Motor System Construction

The project using a general-purpose heavy duty motor, DC 12V, 60 r.p.m. The data of the motor are as below :-

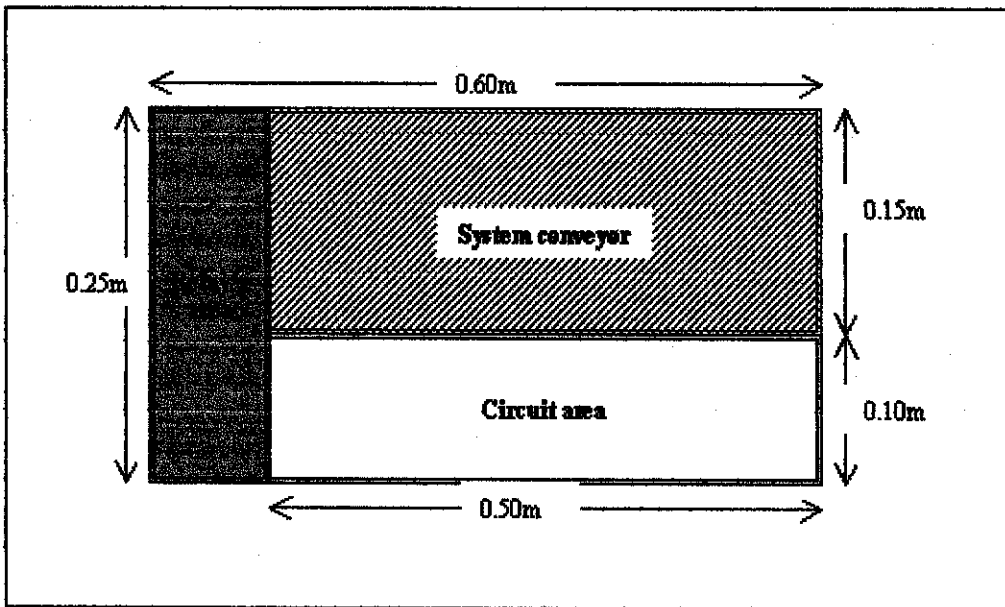
Technical specification:

Rated load speed	60 r.p.m
Rated load torque	300mNm
Rated load current	310mA
Nominal Voltage	12V
Starting torque	900mNm
No load speed	70r.p.m

For the first step, study on voltage divider was conducted in order to understand how to vary the speed of motor accordingly with the action of infrared sensors. After doing some experiments, potentiometers have been used to regulate the voltage supply to the motor. Potentiometers are variable voltage dividers with a shaft or slide control for setting the division ratio. The potentiometers were placed on the path where speed 1 and speed 2 are applied. A 100k $\Omega$  potentiometer is used at speed 1 while 80k $\Omega$  potentiometer is used at speed 2. The largest resistance is allocated to speed 1 as the least voltage is assigned to this speed compared to speed 2 and speed 3. There is no resistance assigned in the path for speed 3 since the full voltage needs to be supplied towards the motor to run the highest speed.

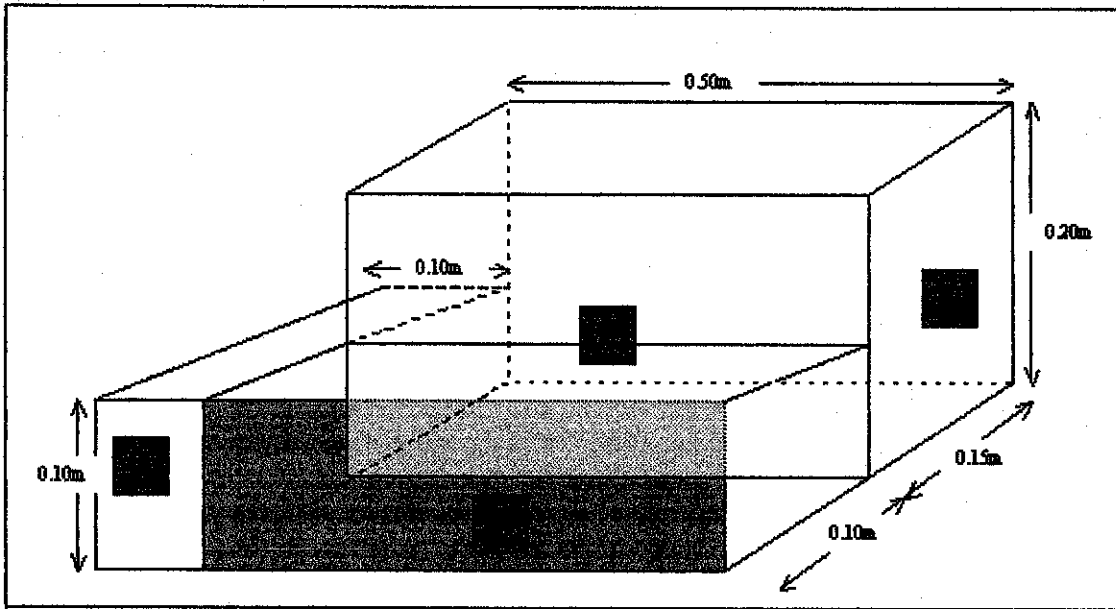
### 3.1.3 Mouse Cage Construction

The base of the cage is wooden made in order to be robust to have all the project components on it (conveyor system, IR circuit, motor circuit, etc). As illustrated as Figure 3.5 and Figure 3.6, the length and width of the cage are 0.60 metres and 0.25 metres respectively.



**Figure 3.5** Cage Dimensions (Top View)

Figure 3.6 illustrates the mouse cage for the side view. This mouse cage is divided to three compartments, which are A, B, and D. Compartment A is for the conveyor system area, B for the circuit area and D is for the relays' area. C is referring to the transparent wall that separates the between A and B areas. The walls where the system conveyor area is made by the transparent plastic in order to see through the system while it is running. The wall of the circuit area's and the relays' area are made by wood since to cover all the circuit and component's wiring inside it.



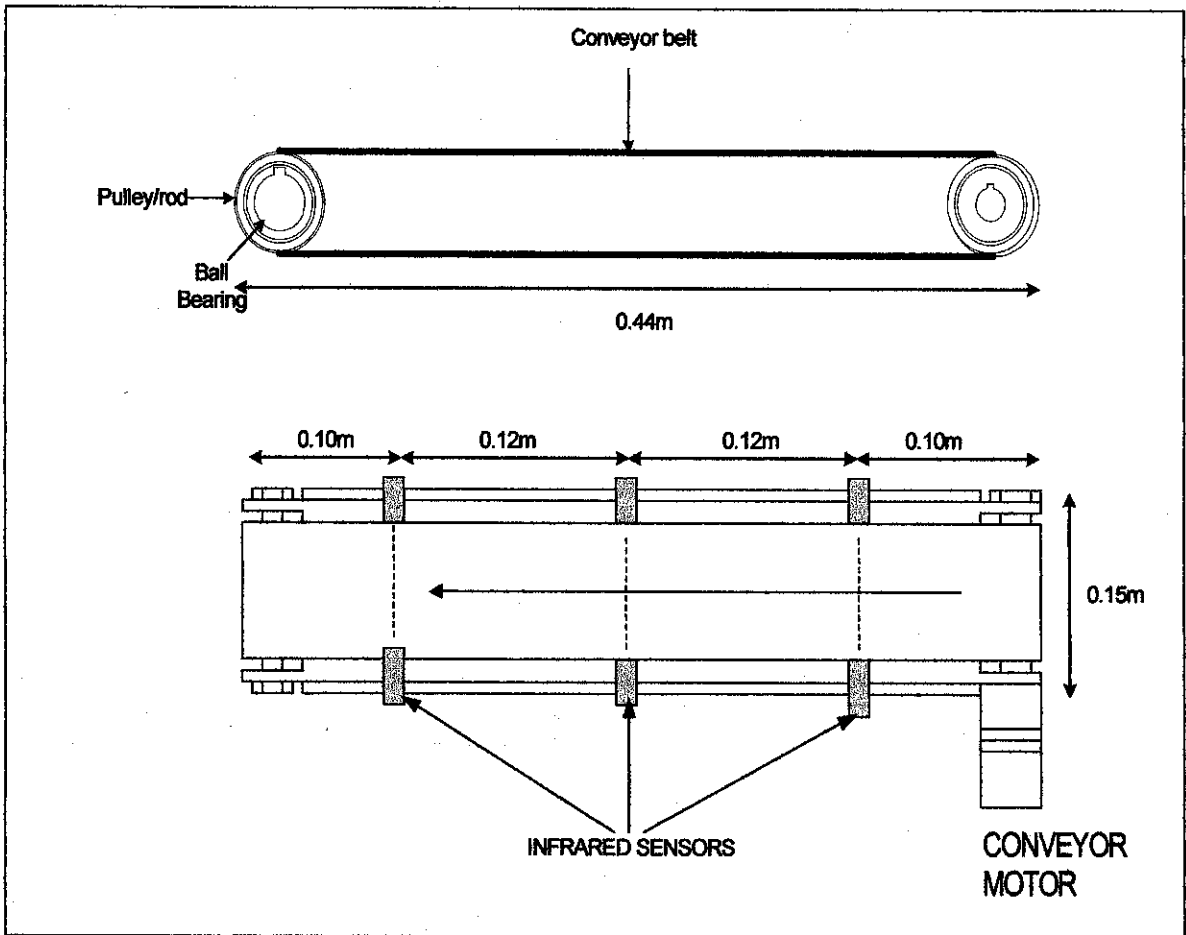
**Figure 3. 6** Mouse cage (side view)

The width of the circuit area, conveyor system area and relays' area are 0.10m, 0.15m and 0.25m respectively. Most of the components of this mouse cage are recycle stuff.

#### 3.1.4 Conveyor system construction

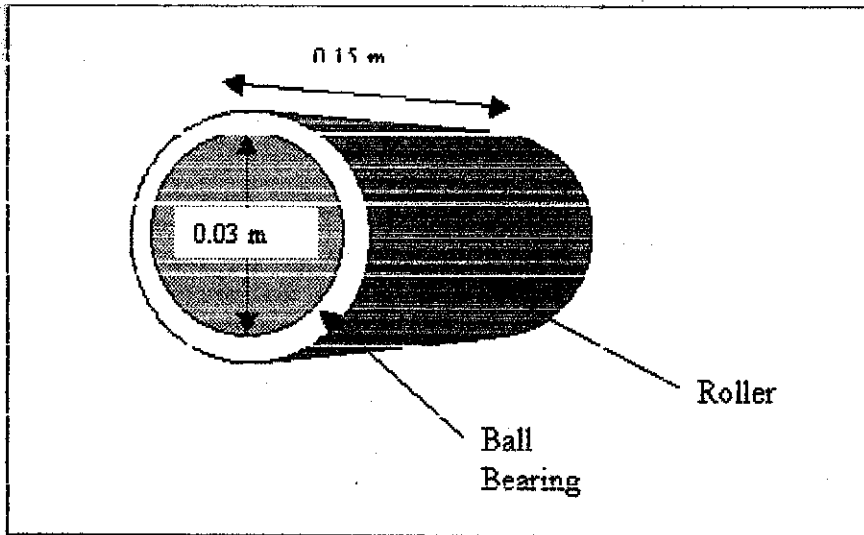
The project application involves small flat belt conveyors. The system conveyor is constructed as shown as Figure 3.7. The length and width of conveyor will be 0.44m and 0.15m respectively. The distance between infrared sensors is 0.12m. This is because to provide a proper distance for the running mouse and the time for motor action to be taken. The main criterion for the material is the material must has smooth surfaces to prevent the mouse from climbing the wall. The material used for the conveyor belt is from rubber.





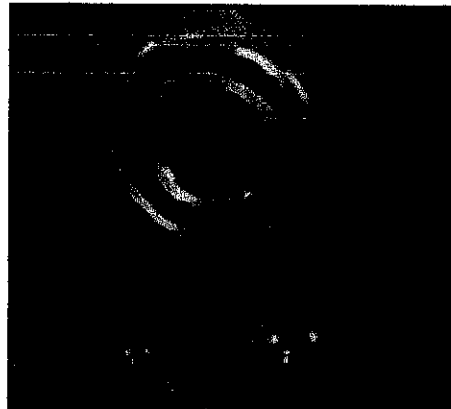
**Figure 3.7** Conveyor System (side and top view)

There are two 0.15 metres Polyvinyl chloride (PVC) pipe are used for the conveyor's rollers and two pair of metal bearing that fitted to each roller which are required to move the conveyor system. Figure 3.8 illustrates roller and bearing dimension. The diameter of the ball bearing is 0.03m (1 inch).



**Figure 3. 8** Roller and Bearing Dimension

Anti-friction bearings are typically chosen for most conveyor-drive application. Figure 3.9 shows the ball bearing type that used for the project.



**Figure 3. 9** Ball Bearing

### 3.1.5 Wiring work

Wiring work was the most vital and complex part. Detail wiring connection is attached as appendix III. Different colours of wires are used for different connection to make the troubleshooting easy if any. From this wiring, user could see clearly which parts are connected to other parts.

## 3.2 Tool

These are the lists of software that have been used to complete the project:

### ❖ MICROSOFT PROJECT

This software has been used to set up the Gantt chart of the project. Gantt chart was the very important tool to ensure that all the project tasks were well tracked and avoid any delays.

### ❖ MIRCOSIM EVAL 7.1

Construction and circuit simulation was started by using this electrical software. This software also offered designing a circuit layout on the PCB.

### ❖ Microsoft Visio

This software has been used to draw most electrical circuits, flow charts and figures in this report.

### ❖ Hardware

Circuit construction was started on the breadboard. Then followed by evaluating, testing the result and refining areas of weakness. For the prototype assemble, the basic tools needed to complete the circuit including wire cutter, bread board, solder, solder iron, hammer, saw, nails etc.

## CHAPTER 4 : RESULT AND DISCUSSION

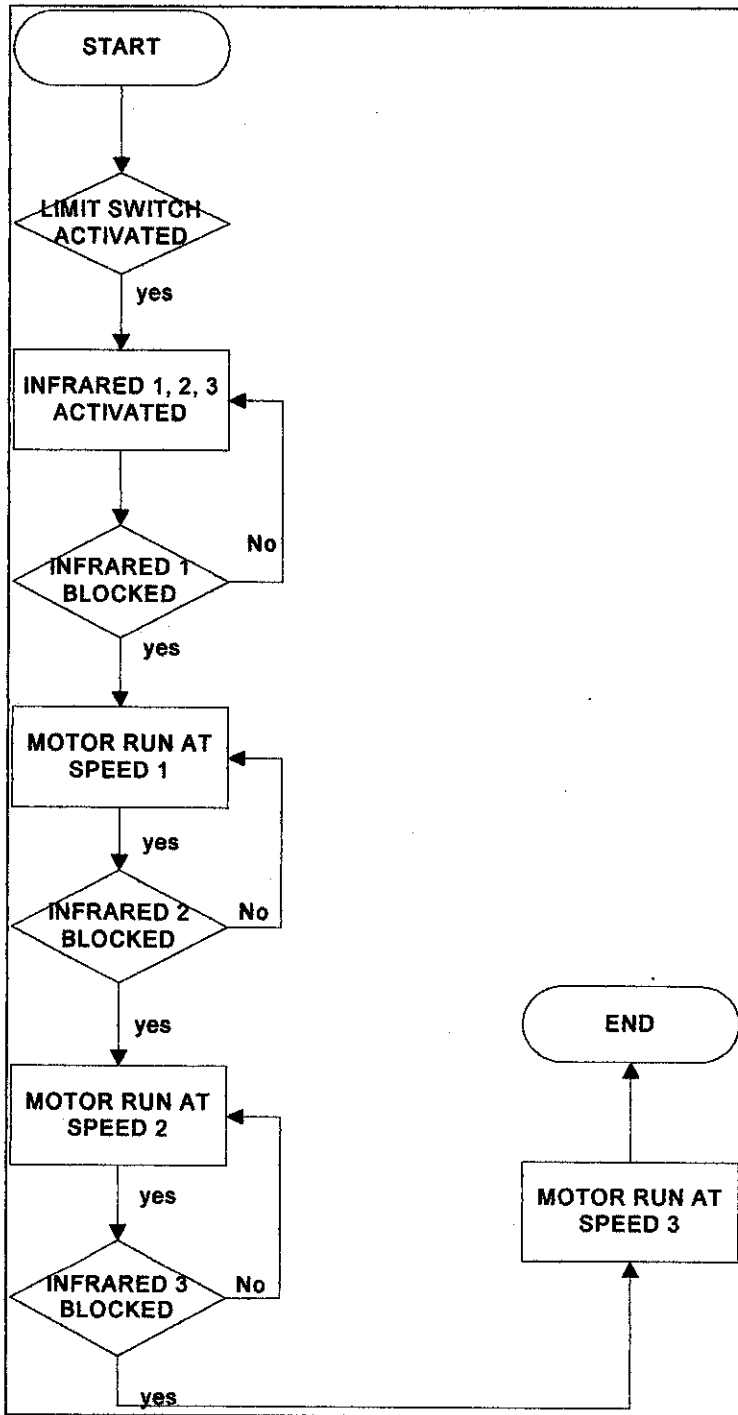
### 4.1 General System

Flow chart of Figure 4.1 illustrates the flow of overall system. The system begins with the activation on the limit switch, which is placed at the end of the mouse cage. This limit switch acts as weigh sensor where the food will be placed on it. When the mouse enter the cage and eats the food on it, this weight sensor will detect lighter load on it. Thus, send a signal that will activate all three pairs of infrared sensors.

Let assume the three pairs of infrared are ready. When the mouse moves to get out from the cage, it will block the first infrared sensor. Due to infrared receiver does not receive the signal from the infrared transmitter, it will trigger a signal to the motor to be run at the first speed as starting motor motion. The conveyor will operate and that prevent the mouse from escaping. The same situations occur when the mouse block the second and the third pair of infrared sensor, but different speed of motor will be run. The "speed 2" will be faster than "speed 1" while "speed 3" is the fastest speed assigned in this system.

According to the ladder diagram on Figure 4.2, there are two power supply provided in this system. The first power supply is  $9V_{DC}$  and the second power supply is  $12V_{DC}$ . The first one is used for weight sensor and infrared sensor. The second power supply is used to run the conveyor belt by activating the DC motor. This circuit applied relay system. There are five relays involved that named as R, R1, R2, and R3. It also has weight sensor, three pairs of infrared sensors, on/off switches and motor system.

There is a pair of green-red LED provided for the purpose of display for each infrared receiver. This bulb will switch on and off as the infrared receiver, receive the signal from infrared transmitter. When the receiver receive no infrared light, the LED of infrared receiver will alternately switch on the red LED instead of green one.



**Figure 4. 1** System Flowchart

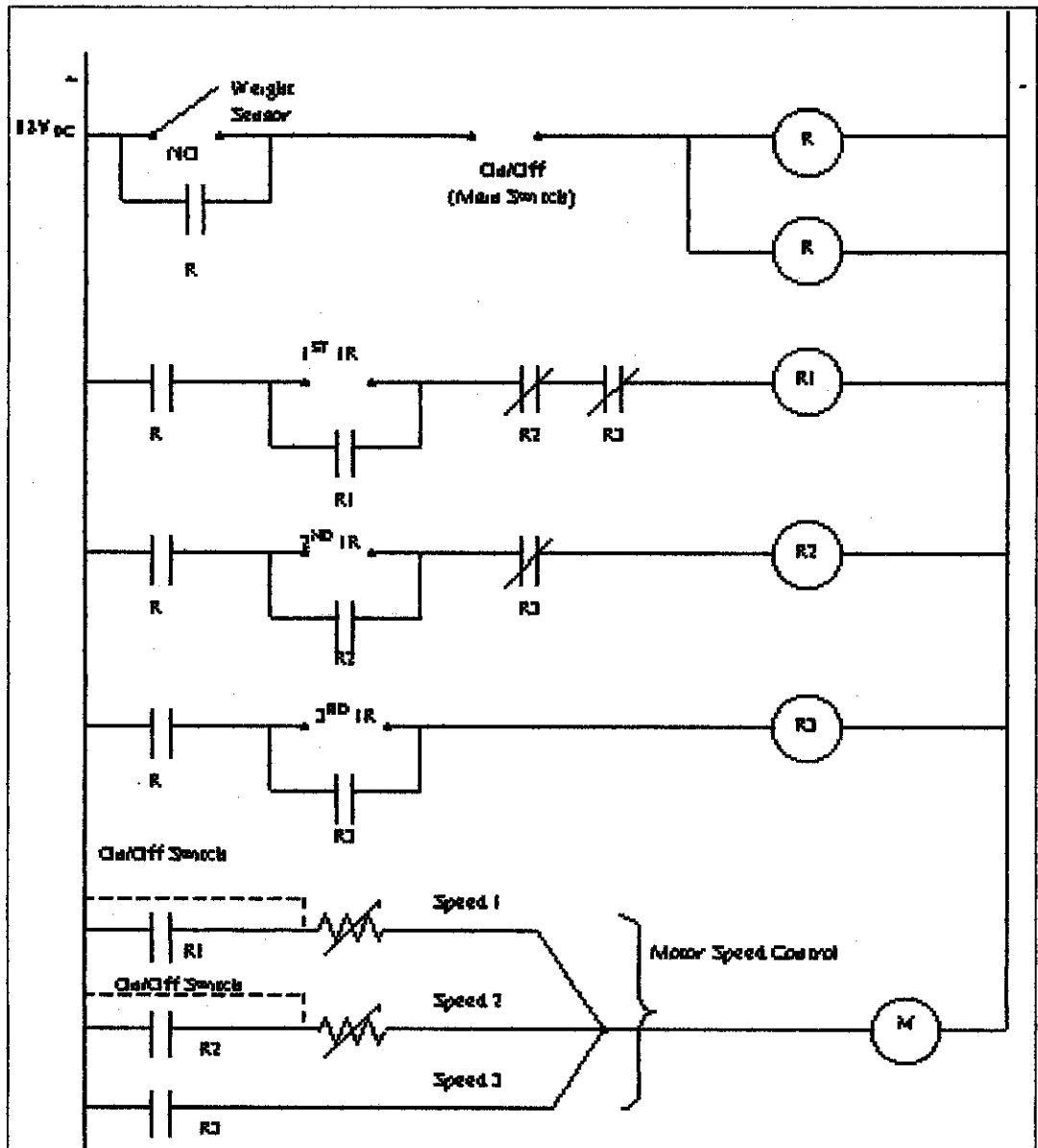
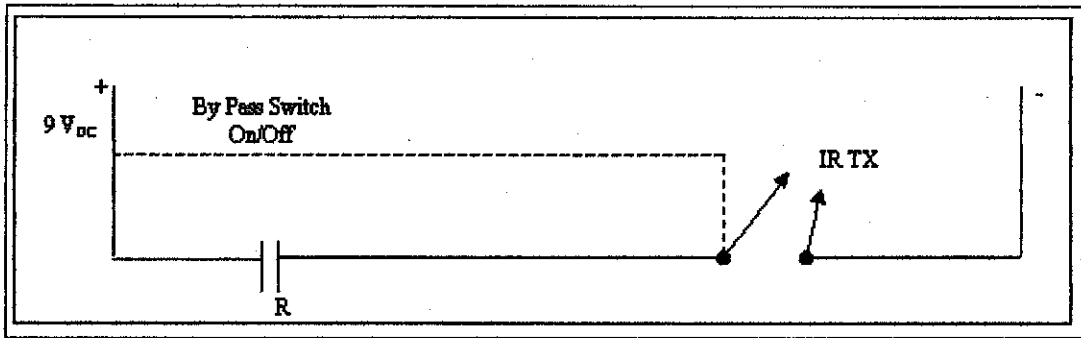


Figure 4.2 System Ladder Diagram

These infrareds need  $9V_{DC}$  power supply. This circuit has provided with 9V relays which will activate another higher voltage relay (12V) and then will trigger the motor. The higher voltage relay here needed since the motor utilize higher power to be run. It is also needed since the motor needs to be operated directly without stop (the action of LED-red-green, the LED will alternately switch on and off when the infrared light is interrupted). In this case, when the mouse block the light, the motor will be run. When the mouse moves forward, the motor will be stopped. Thus it is need to use a relay to prevent that situation to be happened.

The “on/off switches” are used as bypass switches. They will be used when the user wants to test the system or make any new setting for the system. “On/off switch 1” is used when to test either the power is supplied through out the system. The red LED will lights on when the power is supplied to the system. If the LED doesn’t lights up, that’s mean the power is not supplied or the power supplied is not enough to run overall system.

Both “on/off switch 2” and “on/off switch 3” are used when the user want to set the resistance to the motor circuit for speed 1 and speed 2 respectively. Thus, user can vary the motor speed 1 and speed 2. There is no on/off switch provided to control motor at speed 3 since the full  $12V_{DC}$  need to be supplied to the motor at that speed. The advantages of using these “on/off switches” is for the safety purposes and the user can setup the system of this mousetrap accordingly to their preferences.

For infrared transmitter, variable resistance  $R_2$  has can be varies in order to change the speed of the infrared light. For infrared receiver, resistor  $R_9$  and capacitor  $C_4$  will determine the delay time of the receiver circuit. Resistor  $R_{11}$  can be adjustable to receive the light from the transmitter, which control the sensitivity. These infrared sensors only can operate less than 17.5cm range.

## 4.2 Conveyor System

For the conveyor system, there are many conveyor types presents in industries. The most application involves flat belt conveyors, roller conveyors, elevators and hoppers. The conveyor needs to transfer items for one place to another. In this project, the conveyor is just then responding to the motor speed controlled by the controller. The detection infrared sensor will generate the conveyor motor and by automatic adjustable speed control, the more forward movement of a mouse out of the trap will generate the high motor speed, hence preventing the mouse from escaping.

In industries, belt materials are available such as tough polyurethane, pvc, high friction silicone rubber, etc. Most belts are anti-static and some can be conductive to suit the electronics industries. There is a belt material and type to suit every application, these include numerous types of textured belts, belts with locations, profiled and perforated belts. This project uses recycle motorcycle tyre tube since it was hard to find the suitable conveyor belt.

## 4.3 The Smart Mouse Trap

This smart design present with own features, advantages and benefit. Table 4.1 summarized the features, advantages and benefit of this Smart Mousetrap design. A few pictures related to the real Smart Mouse Trap design are attached as appendix IV.

**Table 4. 1** Features, Advantages and Benefit of The Smart Mousetrap Design

FEATURES	ADVANTAGES	BENEFIT
Unique design	Quality construction	Quicker response time. Easy to set.
Electronic trap	No poisons or dangerous chemicals	Safe to use around children and pets. Safe for user and environment.
Protected working parts	Can be used in home, business and factory.	Reliable, trustworthy and dependable
Plastic and wood construction	Durability.	Stronger, longer lasting



## **CHAPTER 5 : CONCLUSION AND RECOMMENDATION**

### **5.1 Conclusion**

As a conclusion, this project is successfully achieved all the objectives outlined. The prototype construction of a Smart Mouse Trap by implementation of infrared as its interfaces has accomplished within the allocated time. This project integrates all the sub-system which are power supply, weight sensor, infrared sensors, motor controller, and conveyor system into one smart system.

This Smart Mouse Trap design considered as electronic project requires 12Volt and 9Volt direct current to be operated smoothly. The 12V<sub>DC</sub> is supplied for the motor that can be operated at 60r.p.m as the fastest speed. The 9V<sub>DC</sub> is supplied to the three pairs of infrared sensors circuits. The main focus was on the infrared sensors circuit which only will be activated by triggering the weight sensor circuit which is placed at the end of the cage. Each pair of infrared sensors will run the motor with three different speeds accordingly, the first infrared will run the slowest speed while the third one will run the motor at the fastest speed. The conveyor just responds to the motor movement which will move into the mouse cage.

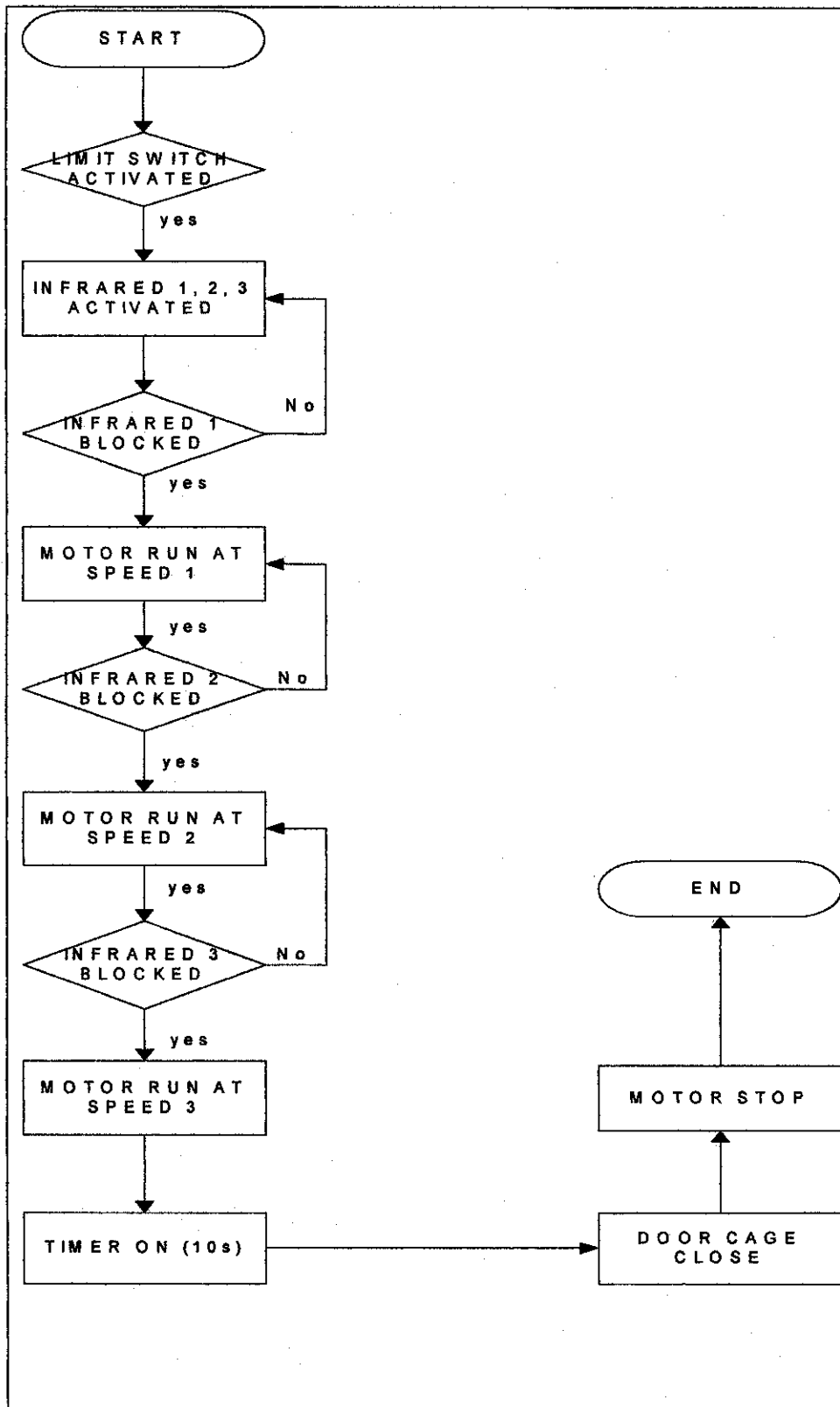
The functionality of the circuit is fully revised and understood in order to progress with the Smart Mouse Trap design. This helped in the project development and also project compilation but most importance part is to enhance the knowledge that can be gained in the project. Furthermore, the project also helps to shape up to be well prepared in project management. The entire problem faced during the project provided a challenge as well as helping to eliminate the failure probability for the Smart Mouse Trap design.

## **5.2 Recommendation**

Nowadays, the application of infrared sensor in industries and other area become very popular and demanding. Thus, it is recommended that the implementation of this infrared design working principles also can be widen to other area such as in production lines, factories, education field etc. For this project, there are few recommendations that are suggested for the future work expansion and continuation purposes if any.

### **5.2.1 System Functionality**

In this recommended flow, some extra item need to be put in consideration. Figure 5.1 shows the flow of the system that recommended if any expansion to be done. The starting condition of the system stills the same as present system. The addition items suggested could begin after the blockages of infrared sensor pair number three, which activated the motor to be run at speed 3. At this speed, the motor also will trigger a timer. After 10 seconds, the door cage will be closed then the motor will be stopped.



**Figure 5.1** System Recommendation or Further Expansion

This is suggested on order to save the power supply to the system. It is also suggested that the system could use batteries for the dc supply. This is because to the system portable and can be use at any desired places. Appendix V illustrates the timing diagram for the recommend further expansion

### 5.2.2 Motor System

The motor system is one of the important part in the project. In this project, the motor should run the conveyor in three different speeds accordingly with the activation of the certain pair of infrared sensor. The difficulties happened when the student tried to vary the speed by varying the power supplied to the motor.

There are two factors defined that relate to the problem faced. The first one was the selection of the motor used and the other one is the lack of knowledge. Thus, for the motor system part, it is recommended that more suitable motor should be selected. It can be four wires of DC motor. The first wire is for the common wire and other three wires, each represent certain speed for the motor. Type of motor that recommended to be selected is attached as appendix VI.

### 5.2.3 System Implementation

Beside the electronic project approaches, there are many other ways to implement the same system. Each system will has its own advantages and disadvantages. This project implemented the electronic approaches since the writer wanted to build up the knowledge in the electronic side.

May be the Computer System's student can develop the system by implementing PIC controller or the Instrumentation and Control System's student can implement it by using Programmable Logic Controller. Table 5.1 shows the advantages and disadvantages of the system implementation.

**Table 5.1** PLC Controls

Advantages	Disadvantages
<ul style="list-style-type: none"><li>- High reliability after earlier development problems.</li><li>- Simple trouble-shooting, due to plug-in design.</li><li>- Simple installation.</li><li>- No standardisation required (means more flexibility).</li><li>- Low space requirements.</li><li>- Low power consumption.</li><li>- No moving parts.</li><li>- Rapid modification of program.</li><li>- Production and programming can be carried out in parallel.</li></ul>	<ul style="list-style-type: none"><li>- High purchase price.</li><li>- Not very widespread.</li><li>- No uniform programming language.</li><li>- Slower than parallel logic system since processing is carried out cyclically.</li></ul>

**Table 5.2** Electronic Controls

Advantages	Disadvantages
<ul style="list-style-type: none"><li>- High reliability after earlier development problems.</li><li>- Extremely high operating speed.</li><li>- Low space requirements.</li><li>- Low power consumptions.</li><li>- No moving parts.</li><li>- Low costs.</li></ul>	<ul style="list-style-type: none"><li>- Frequent failures in the initial phase.</li><li>- Unclear layout</li><li>- Modifications are difficult.</li><li>- Highly paid specialists are required.</li></ul>

## REFERENCES

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# Appendices

Appendix I: Project Gantt Chart

Appendix II: List of Component for Infrared Sensor

Appendix III: Detail Wiring Connection

Appendix IV: A Few Images Related to a Real Smart Mouse Trap

Appendix V: Timing Diagram for The Recommendation for Further Expansion

Appendix VI: Type of motor that recommended to be selected for Further Expansion

# Appendix I

Project Gantt Chart



No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic														
	-Propose Topic														
	-Topic assigned to students														
2	Preliminary Research Work														
	-Introduction														
	-Objective														
	-List of references/literature														
	-Project planning														
3	Submission of Preliminary Report														
4	Project Work														
	-Reference/Literature														
	-Practical/Laboratory Work														
5	Submission of Progress Report														
6	Project work continue														
	-Practical/Laboratory Work														
7	Submission of Interim Report Final Draft														
8	Oral Presentation														
9	Submission of Interim Report														

● Milestone  
■ Process

No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Project Work Continue -Practical/Laboratory Work														
2	Submission of Progress Report 1	●													
3	Project Work Continue -Practical/Laboratory Work														
4	Submission of Progress Report 2							●							
5	Project work continue -Practical/Laboratory Work														
6	Submission of Dissertation Final Draft												●		
7	Oral Presentation													●	
8	Submission of Project Dissertation														●

● Milestone  
■ Process

# Appendix II

List of Components for Infrared Sensor

Components list for receiver:

R1 = 10K  
R2 = 470K  
R3 = 10K  
R4 = 10K  
R5 = 1K  
R6 = 220R  
R7 = 10K  
R8 = 10K  
R9 = 100K  
R10 = 510R

C1 = 47uF / 100uF  
C2 = 10uF  
C3 = 0.001 (102) / 0.01 (103)  
C4 = 4.7uF / 10uF  
C5 = 0.1(104) / 0.01(103)  
C6 = 0.001(102) / 0.01 (103)

D1 = 4148  
Q1, Q2 = 9013 or A42  
RELAY = 9V DC SPDT  
IC-1 = 741 (8PIN)  
IC-2 = 555 (8PIN)

Components list for transmitter:

**Resistor:**

R1 = 1.2K  
R2 = 39K  
R3 = 47R

**Capacitor:**

C1 = 1UF

**Others:**

IC-1 = 555 (8pin)

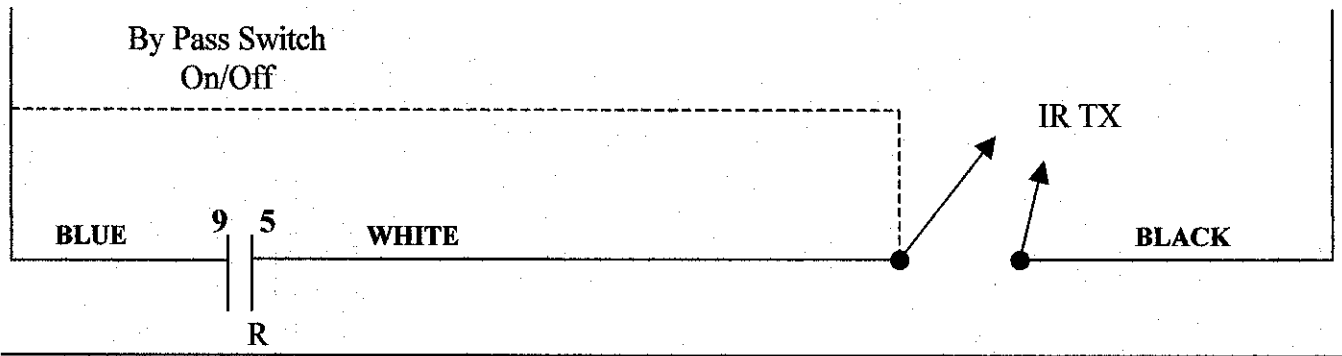
LED = Infrared red diode X 2

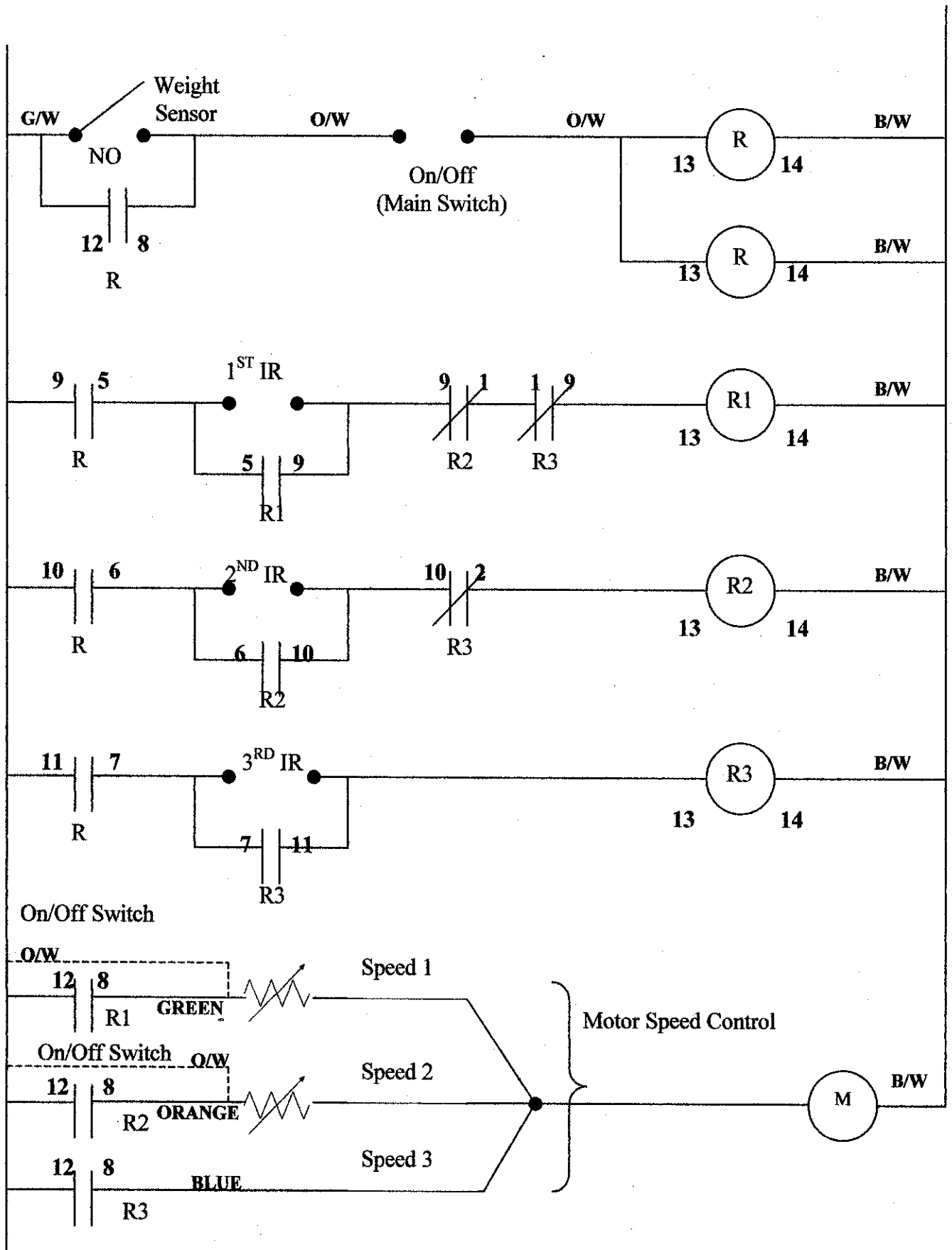
<b>RESISTOR</b>				
<b>No</b>	<b>Resistance</b>	<b>Quantity (for 1 infrared)</b>	<b>Total (for 3 infrared)</b>	<b>Color</b>
1	10K	5	15	Brown-black-yellow
2	1K	1	3	Brown-black-red
3	470K	1	3	Yellow-violet-yellow
4	220R	1	3	Red-red-brown
5	100K	1	3	Brown-black-yellow
6	510K	1	3	Green-brown-brown
7	1.2K	1	3	Brown-red-red
8	39K	1	3	Orange-white-orange
9	47R	1	3	Yellow-violet-black
<b>CAPACITORS</b>				
<b>No</b>	<b>Resistance</b>	<b>Quantity (for 1 infrared)</b>	<b>Total (for 3 infrared)</b>	<b>Color</b>
1	47 $\mu$ F	1	3	-
2	10 $\mu$ F	1	3	-
3	0.001(102)	2	6	-
4	4.7 $\mu$ F	1	3	-
5	0.1(104)	1	3	-
6	1 $\mu$ F	1	3	-
<b>MISCELLANEOUS</b>				
<b>No</b>	<b>Item</b>	<b>Quantity (for 1 infrared)</b>	<b>Total (for 3 infrared)</b>	<b>Description</b>
1	741 (8pins)	1	3	IC
2	555 (8pins)	2	6	IC
3	Push on switch	1	3	switch
4	9013	2	6	Transistor (Q1,Q2)
5	4148	1	3	diode
6	Red LED	2	6	
7	Green LED	2	6	
8	Relay	1	3	9V SPDT
9	Infrared diode	2	6	LED

# Appendix III

Detail Wiring Connection

LADDER DIAGRAM FOR  
SMART MOUSE TRAP







# Appendix IV

A Few Images Related to a Real Smart Mouse Trap

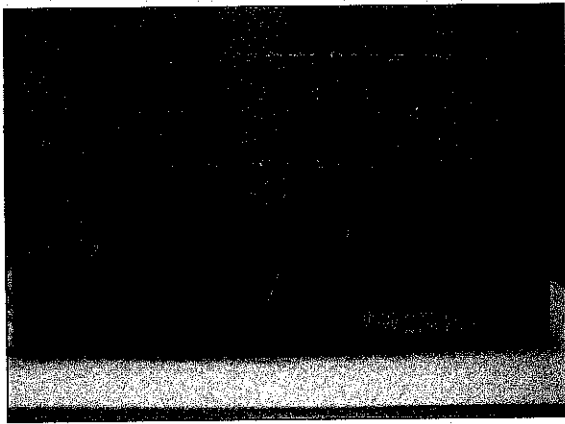


Image 1: Smart Mouse Trap (Side View)

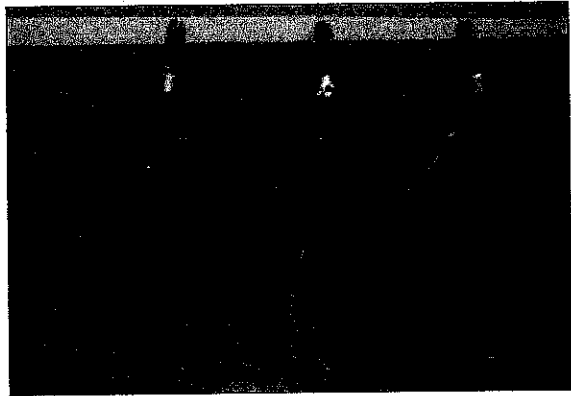


Image 3: Infrared sensors circuit on the  
Electronic Board

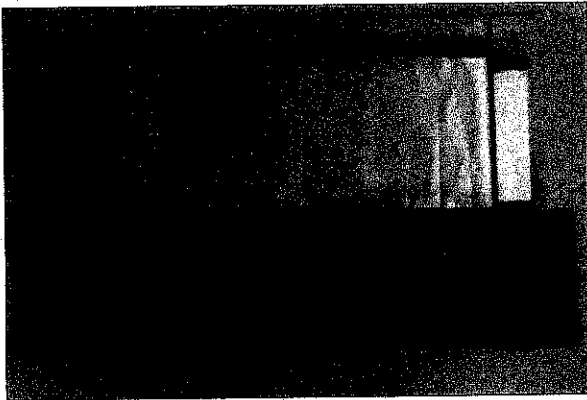


Image 2: Smart Mouse Trap (Top View)

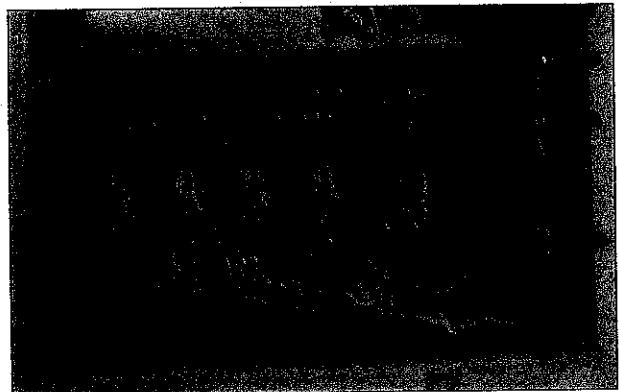
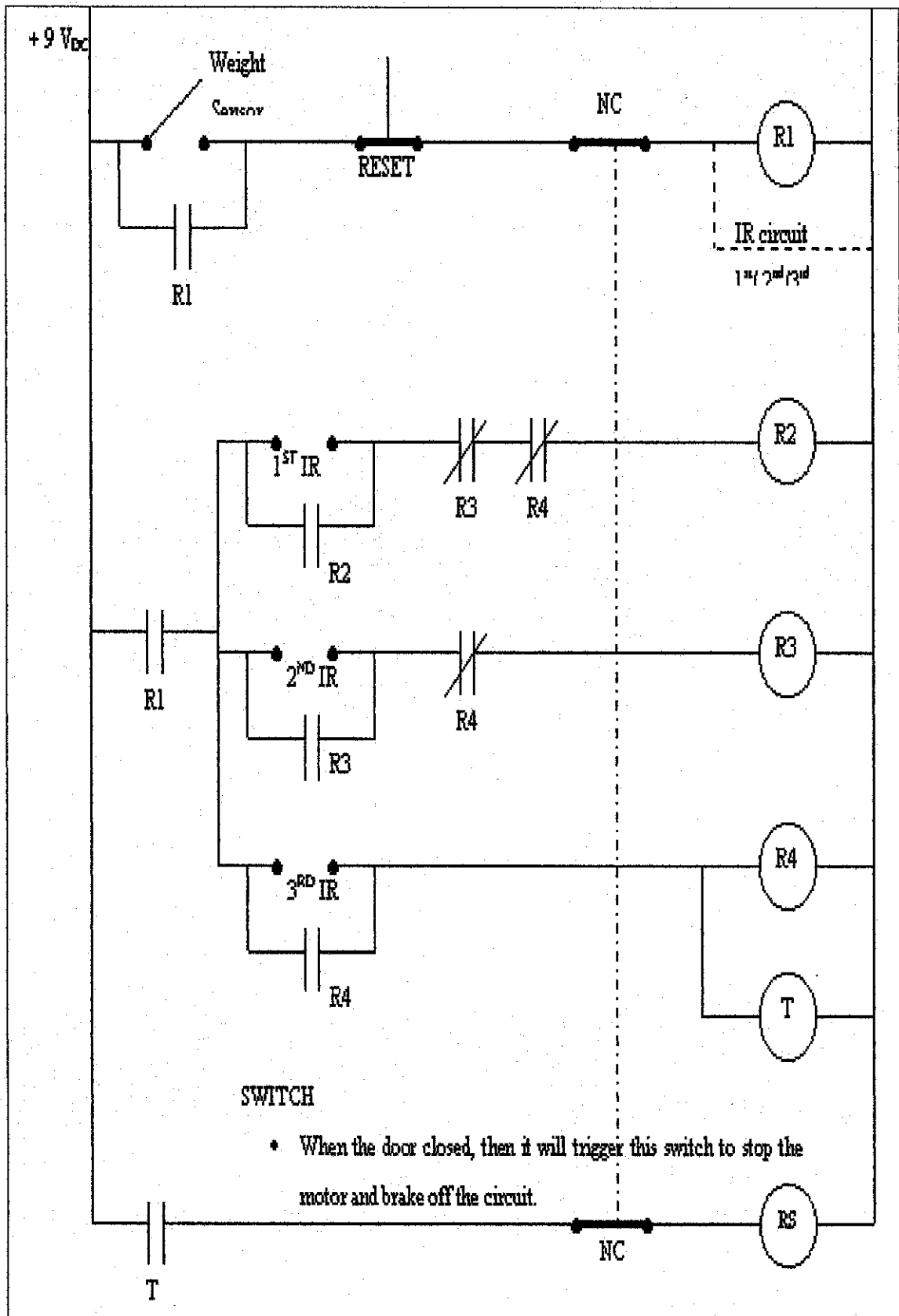
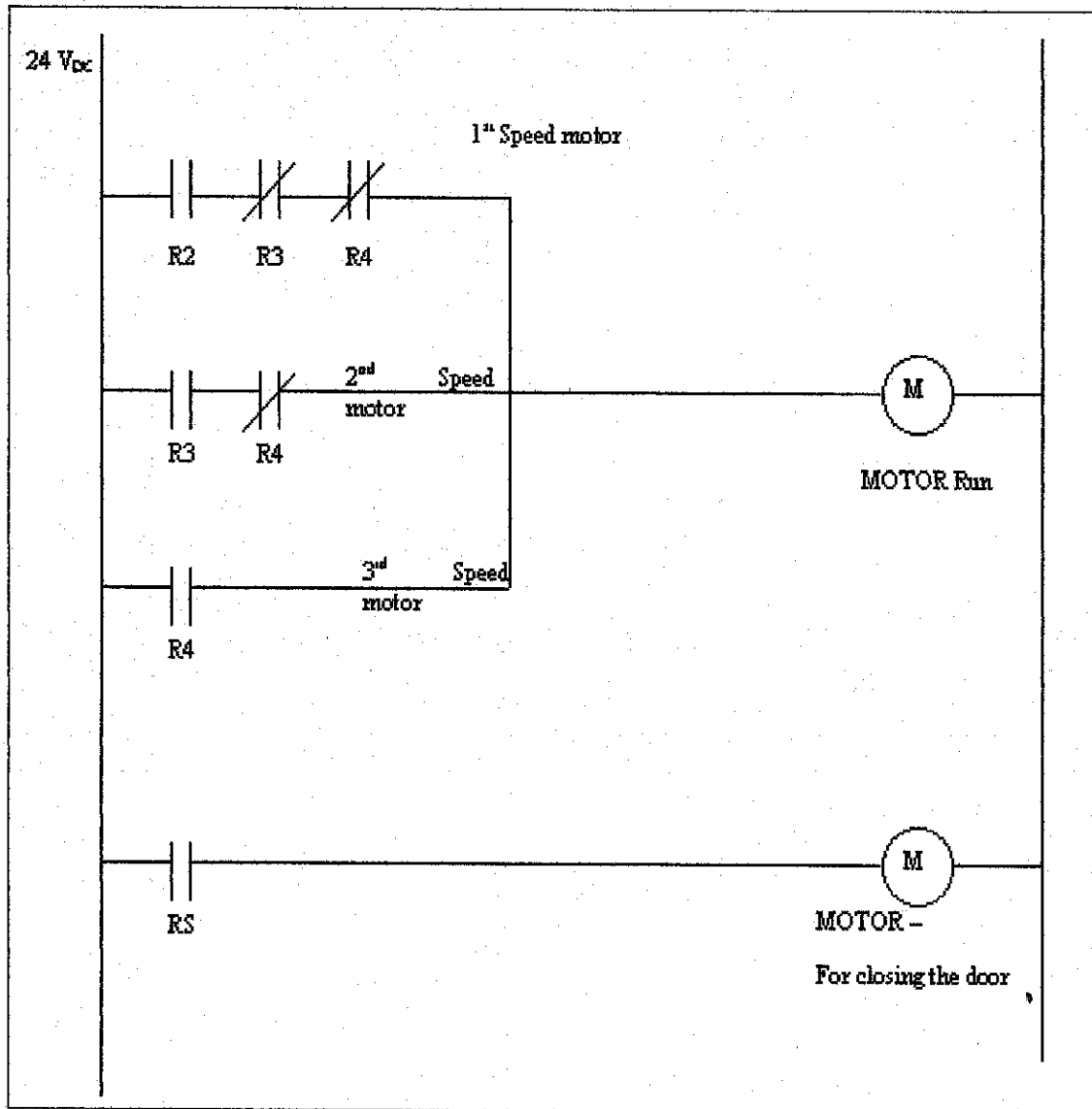


Image 4: Relays' Area

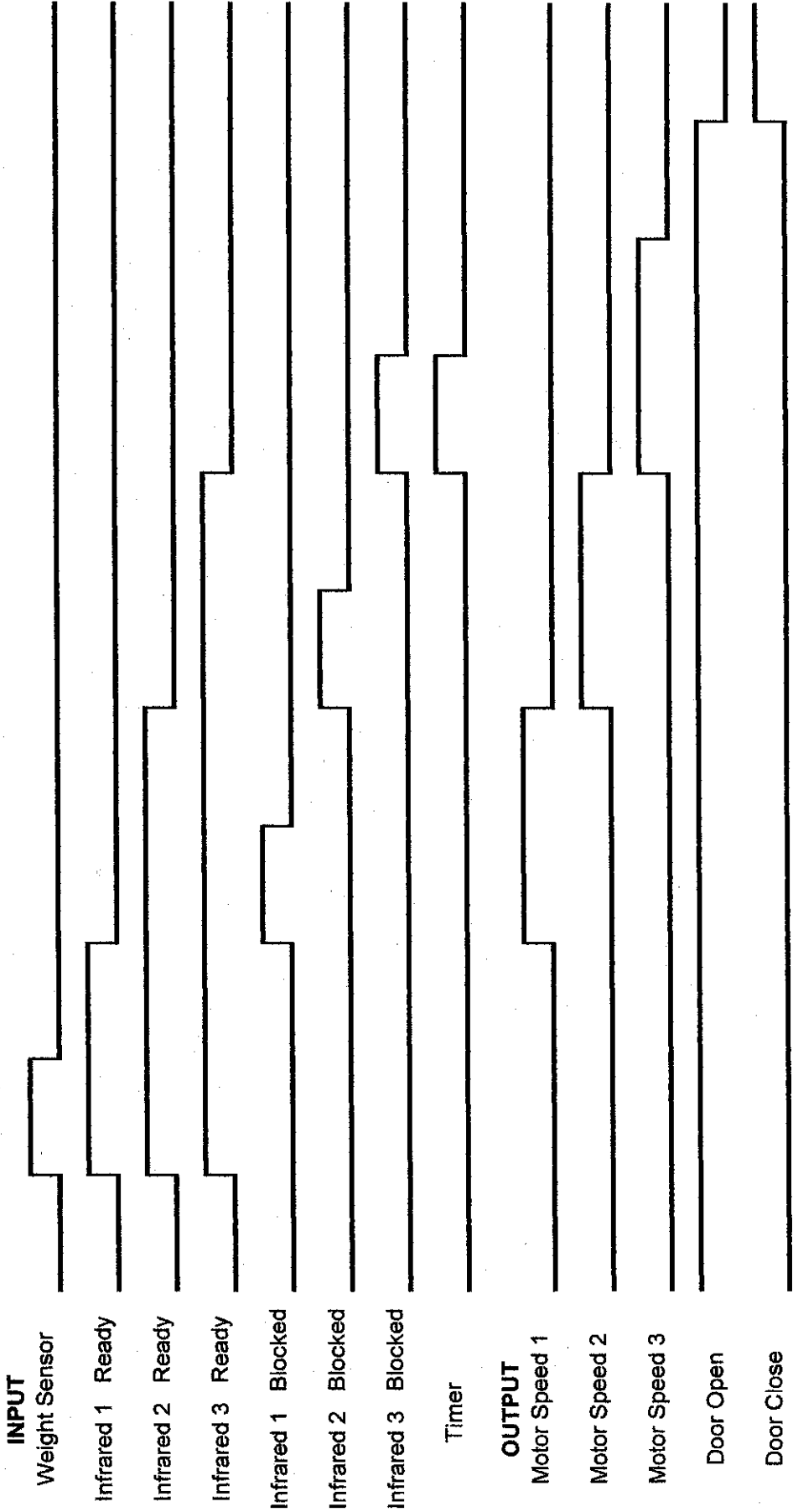
# Appendix V

Ladder diagram & Timing Diagram for The Recommendation for  
Further Expansion





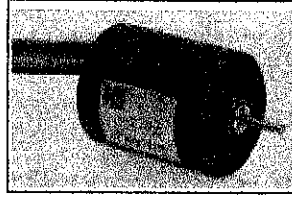
TIMING DIAGRAM FOR SMART MOUSE TRAP



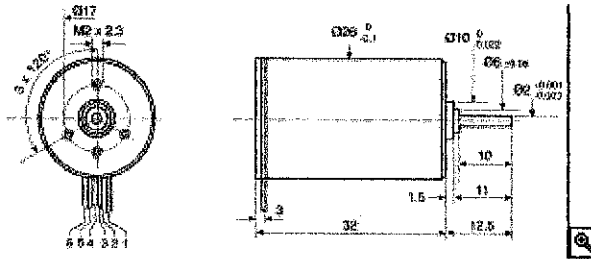
# Appendix VI

Type of motor that recommended to be selected for Further  
Expansion

## Precision dc Servo System Motors Brushless



d.c. motors both brushed and brushless that can be simply assembled with the ovoid, spur or planetary gearboxes. Full fitting instructions are provided with each gearbox. Each motor/gearbox combination has its own characteristic detailed in the data sheet.



### Connection data

- 1 brown GND
- 2 red +V motor
- 3 orange CW/CCW
- 4 yellow start/stop
- 5 green +V logic
- 6 blue speed signal

### Dimensions

Body L.32

Shaft L.10

Body D.26

Shaft D.2



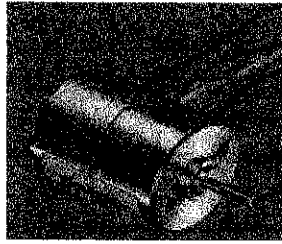
A brushless servo motor with integral control electronics. The motors can be connected to our range of ovoid, spur and planetary gearboxes to increase torque and reduced speed.

- Long life due to brushless construction. Therefore high reliability and low maintenance
- Linear speed characteristics for precision speed control
- No cogging
- High temperature range capability
- Electrical interference free
- Ease of control via 6 wire lead

#### **Technical specification**

No load speed at 15V	8800
No load current (mA)	72
Max. cont. torque (mNm)	4.4
Torque constant (mNm/A)	13.4

## 16mm Dia Disc Magnet



### **Unipolar permanent magnet type**

12V bi-directional stepper motors suitable for many applications. Applying the correct electrical pulses sequence (dual phase energisation) to the winding of the stepper motor results in the specified step angle of rotation of the shaft. This gives 48 steps per revolution for the  $7.5^\circ$  motors and 24 for the  $15^\circ$  motor. The step angle can be halved if the motor is driven by a modified pulse sequence. The speed and direction of rotation are determined respectively by the input frequency and step sequence. This provides an ideal solution for both speed and non-feedback position control.

### Applications include:-

Photocopiers, typewriters, computer peripherals, X-Y plotters, mechanical pumps, drip feeders, vending machines, gaming machines etc.

These motors are directly compatible with the RS stepper motor drive boards stock no. 217-3611 (see later in this section) giving excellent torque speed performance.

These boards also allow half stepping if required, resulting in higher resolution, good performance stability and fast step rates. Alternatively the RS range of stepper motor IC's in the Semiconductors - Analogue Section can be utilized to control the motors.

If complex movement profiles are required then the RS stepper motor control board can be used in conjunction with the drive cards to vary step rate acceleration/deceleration, velocity etc., (stock no. 440-098).

The multipolar rare earth disc magnet design, enables a small but powerful stepper to be constructed, with performance associated with larger motors. Among the features are high power to size ratio, with fast acceleration and good angular resolution in micro step mode. As the motors require a 24Vdc power source and are very compact, they are

ideal for use in portable, miniature or remote operation equipment, performing such tasks as X-Y movement, pumping, positioning.

### Dimensions

Overall length	35
Body length	19
Shaft length	6.2
Body diameter	16
Shaft diameter	1.5

### technical specification

RS		
stock no.	<u>235-7768</u>	<u>221-4734</u>
Step angle	15°	15°
Phase resistance( $\Omega$ )typ	65	2.5
Phase inductance @1Hz(mH)	46	2.2
Nom. Phase current 1ph on(A)	0.17	0.9
Nom. Phase current 2ph on(A)	0.12	0.65
Holding torque(mNm)	6.4	7.6
Detent torque(mNm)	0.6	1.5
Operating ambient temperature(°C)	-30 to +50	
Angular accuracy 2ph on full step mode(%)	±3	