CHAPTER 1
INTRODUCTION

1.1 Background of Study

This eye blink sensor is an analogue circuit which consists of an infrared light emitter and an infrared light detector as the main component. Infrared optoelectronics has been chosen as it did not give disturbance to driver's eyes physically.

The concept of difference amount of light being received has been used in detecting the driver fatigue. The position of eyelid is important to determine the driver fatigue in terms of sleepiness. A period of time 3 seconds has been selected to be an indicator of driver fatigue. Whenever the eyelid stay closed longer than 3 seconds constantly, the buzzer will be activated. The buzzer will be off if the driver pushed the reset button which is located on the electronics board.

Generally, driver fatigue is a common issue that causing road accident in the world including Malaysia as the driver himself did not realized he is in fatigue mode. But the driver cannot be blamed alone because fatigue and sleepiness is an uncontrolled natural phenomenon. This project is expected to detect driver fatigue especially during the early stage of sleepiness and will activate a buzzer to warn the driver that he is in fatigue mode.

1.2 Problem Statement

One of major problems in dealing with the road safety impact of driver fatigue is the difficulty in detecting drivers who are experiencing fatigue on its exact time. Moreover, there is still no direct device to measure fatigue. As fatigue is closely related to the movement of eyelid, thus direct measurement between the device and the movement of eyelid could be a great approach in detecting driver fatigue.

Besides, the increasing in on road accident number caused the research of a way that can help to reduce those numbers and most important thing is that way can save life and reduce personal suffering.

Taking an example of Sani Express Bus Tragedy that happened at Km272.8 of the North-South Expressway early in morning on 26th December 2009. The tragedy caused 10 passengers killed and two injured. Unfortunately, the bus driver has admitted that he was falling asleep at the wheel. The driver's poor work ethic and carelessness caused tragedy that tarnished the company's name. Thus it is vital for researchers to develop a system that can detect driver fatigue while driving as it will give benefit to the citizen safeties. Many people are still searching for the best technique to detect driver fatigue.

1.2.1 Problem Identification

Different techniques and methods always been used in preventing the driver fatigue such as electrooculography (EOG), electromyography (EMG), infrared-oculography (IR-OG) and image based methods called video oculography (VOG). Each of the techniques has their own advantages and disadvantages [2].

This project has selected eye blink sensor as the method to detect driver fatigue. Eyes are brilliant part to be monitored in order to recognize the fatigue and drowsiness. In particular the eyelid, the pupil and the gaze can also be observed [2]. From research, normal human eye blink rate is around 30-50 blinks per minute, with each blink lasting about 200-300 milliseconds. As a person gets tired or sleepy, eye blinks will get longer and slower until eyes begin to close for a short period [5]. It is crucial to choose a suitable sensor to detect the eye blink with zero disturbances.

1.2.2 Significant of Project

The aim of the project is to study on electronics materials and devices that can contribute benefit outcomes to society. Researchers are still searching for the solutions that can detect driver fatigue which is a common cause of on-road accident. Thus, this project can be the answer for it. Furthermore, electronics materials are the simplest and low cost material that can be used. This project also emphasize on using the minimum budget that is affordable to the society in any level.

1.3 Objectives

The objective of this project is to develop a prototype that will detect the movement of eyelid which can be an indication of driver fatigue. Besides, this prototype will warn the driver with its buzzer. As fatigue is closely related with human eye blink and rate, so research on eye blink sensor can give benefit to the driver as well as the passengers. In advance, this project is aiming to slow down the vehicle to a safe speed to alert the driver

1.4 Scope of Study

The scope of the project:

- Understand the working principle of each electronics materials and devices that been used.
- Understand the principle of IR light, transmitter and receiver module.
- Expose and understand the Assembly language and Programmable Interface Controllers

1.4.1 The relevancy of the project

This project is relevant to the study of Electronics Engineering. Plus this project is relevant due to the increasing of on road accident due to driver fatigue and drowsiness. As a student of Electrical and Electronics Engineering, it is a responsibility to apply the theoretical knowledges and invent devices or systems that can give benefit to human daily life, easy to be used and affordable. Moreover, as part of the society, people in this field need to play their role to ensure that we can give priceless contribution to the society with our own ability.

1.4.2 Feasibility of the Project within the scope and time frames

This project starts by searching and collecting the material related to the topic such as articles, books, journals, websites and technical papers especially on eye blink sensor that can be used to prevent driver fatigue. Research is done week by week. Next, as the accurate data and information has been received, the desired electronics material is then being purchased.

CHAPTER 2
LITERATURE REVIEW

2.1 Driver Fatigue Measurement Device

Many serious on-road accidents occur because of the vehicle's driver often fall asleep while driving. Thus, driver fatigue has been listed as the second ranking of accident causes. Therefore, people are still searching for the best method to detect early stage of driver fatigue.

2.1.1 Head Movement Detector

Universiti Teknologi Malaysia (UTM's) has successfully invents 'Smart Nap Alert System' which is a head movement device that can trigger an alarm to warn the driver when he is falling asleep [1]. The device will sense the movement of driver's head. When the driver is in fatigue mode, their head tend to be lower than in normal mode.

Figure 1: Smart Nap Alert System [1]

2.1.2 Drowsy Driver Detection System (camera-based)

The main aim of this project was to use the retinal reflection as a method to find the eyes on the face and then using the reflection as a way of detecting when the eyes are closed. Unfortunately, it was found that this method might not be the best method of monitoring the eyes for two reasons. Firstly, in lower lighting conditions, the amount of retinal reflection will decrease. Next, if the person has small eyes the reflection may not appear [2].

Figure 2: The prototype of Drowsy Driver Detection System [2]

2.1.3 Face, Mouth and Eyes Detector (video based)

The system based on eyes closer count & yawning count of the driver. It is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident by monitoring the eyes and mouth. When the driver is in fatigue mode, the eye blink frequency will increase beyond the normal rate [9].

Figure 3: Condition of the driver that have been captured [9]

2.2 IR sensor as a device of measuring fatigue

This project is focusing on human eyes as a medium of fatigue measurement. Eyes are an excellent method to be measured in order to recognize fatigue. The eyelid, the pupil and the gaze can be observed frequently [4].

There are two types of eyes blink which are the voluntary eye blink and spontaneous eye blink. The voluntary blinking is a rapid eyes movement. The spontaneous eye blink is in a rate of 5-30 movements per minute and it is an indicator of fatigue. In order to detect fatigue, the spontaneous eye blink will take a serious part to be observed [4].

Realising that most of accidents involve buses, trucks and cars, this project is aiming to serve a highly recommended and safe invention for all the users. In order to invent a wearable infrared eyes blinking sensor, the smallest possible sensor will be used such as couple diode/ photodiode as IR detector. Besides, a frame is needed to be a base for the systems to be plug onto.

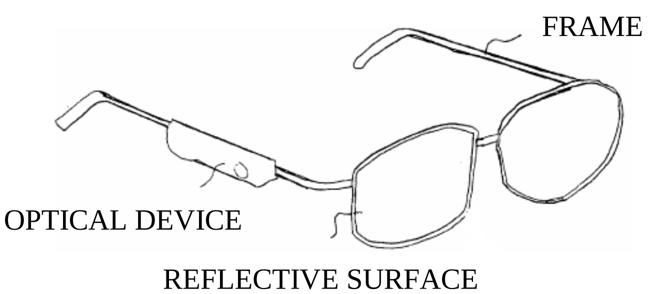

Figure 4: Sketch of an optical device being plugged onto a frame [7]

The IR sensor has been determined to be a good method to detect driver fatigue. It has been chosen for this project as IR light is invisible to the eye. Thus it has less distraction to the eyes. Obviously it deals with light intensity that will be received by the receiver from the light emitter. Thus perfect distance between light emitter and receiver will lead to an accurate interpretation of fatigue.

In addition, comparisons need to be made to determine the best technique to detect the fatigue. A narrow light beam of IR light from an IR light emitter, placed in one side of the eye of the driver will be directed through the narrow channel between the eyelids just above the surface of the eye, to an IR light detector which is placed close to the other side of the eyes [5]. When the driver's eyes are open, the IR light detector will detect the existence of IR light as clearly shown in Figure 5.

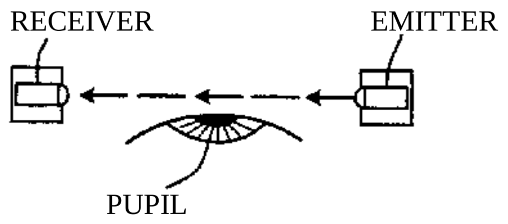

Figure 5: IR light detector receive the light from the IR light emitter [5]

While the driver's eyes are closed, the eyelids are in the path of IR light beam. So the light from the emitter will be disturbed by the eyelids as shown in Figure 6. Therefore no light will be detected by the receiver and it will activate the alarm [5].

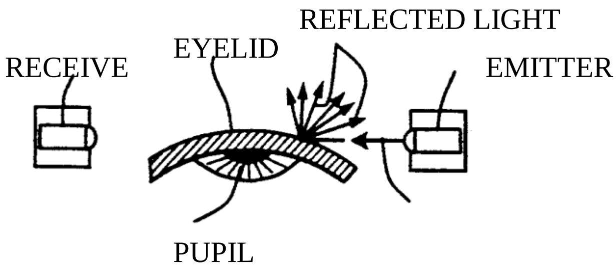

Figure 6: IR light detector failed to receive the IR light [5]

A non-modulated IR Blink Detector for rabbits has been invented with the concept of the light from an IR Light Emitter Diode (LED) is bounced off the rabbit's eye. When the eye closed, the amount of light reflected changes and same goes to the amount of light being received by the photodiode. The output of the amplifier swings to match the current through the feedback resistor to the current through the photodiode [6].

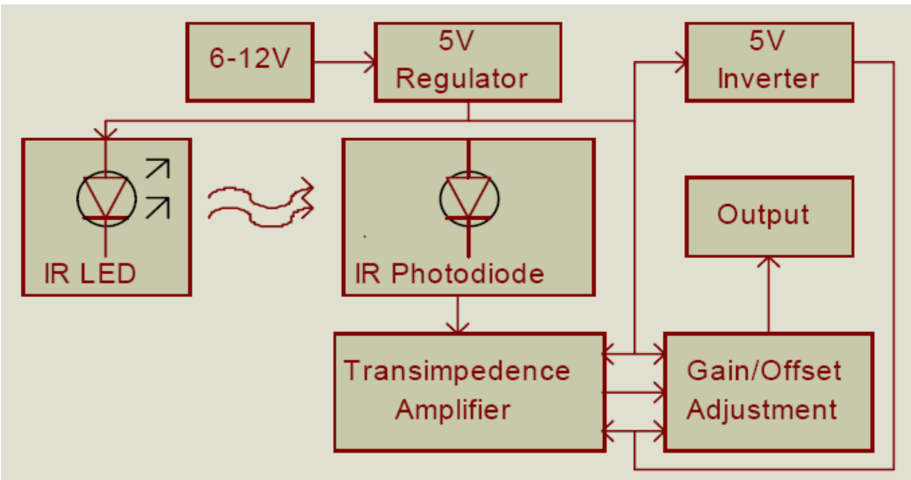

Figure 7: Block Diagram for Non-modulated Infrared Blink Detector [6]

Next, a system for detecting eye closure through optical observation of the eye include a frame chosen to be worn by the driver, a light source and one eyepiece connected to the frame. Reflective surface, which is formed by a coating on the eyepiece, is needed to reflect light emitted from the light source (IR light emitting diode) onto the eye. A sensor (photodiode) is used to detect light reflected by the eye [7].

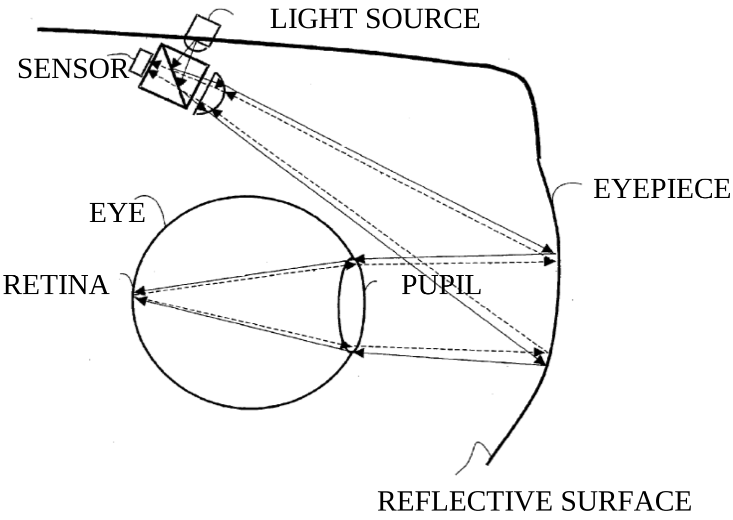

Figure 8: Reflecting surface plays vital role in Fergason's design [7]

The intensity of the light reflected off of the eye differs and it depends on whether the eyes are open or closed. The retina will be a retro-reflector that will reflect the light back to the reflective surface. Light intensity that been received by the sensor, will be sent to the processor that will converts the received data to a suitable signal.

The alarm will be triggered when the sensor detects eyelid closure for a minimum specified duration or when the frequency of eye blinks increase above a specified predetermine limit. In addition, the alarm may be initiated when a driver starts blinking slower than normal for a specified time. The alarm can be in audible alarm, visual warning light, vibrating devices and others [7].

In addition, the sensor used in detecting the driver fatigue need to be safe and less intrusive to avoid disturbances and hazards to the driver. A standard IR emitting diode pair with an IR photodiode sensor has been used. The sensor uses the techniques of the modulation of an IR beam to be less sensitive to the head movements and environmental light changes.

The IR is usually used to measure horizontal rather than vertical eye movements and the size of the smallest movement can be detected wisely. Knowing that IR sensor will emit an IR light that is pointed directly towards the eyes, eyes safety are so important to be considered [4].

Table 1: Eyes pathologies related to the infrared radiation wavelength [4]

Spectral region	**Eye**	**Skin**
Infra-red A (780-1400nm)	Cataract, retinal burn	Skin burn
Infra-red B (1.4 – 3.0µm)	Aqueous flare, cataract corneal burn	
Infra-red C (3.0µm– 1mm)	Corneal burn only	

Emitter will be located at a specific location, that can be change from 0.01 to 1m depends on the detector that been used. Different usage hours for the eye blink detector also need to be considered as vital matters [4].

The proposed prototype is an infrared device as shown in Figure 9. The device circuitry is divided in two electronics board; one is plugged on the temple containing the sensor, while another one is used to drive the emitter LED. The emitter and detector characteristics are shown in Table 2.

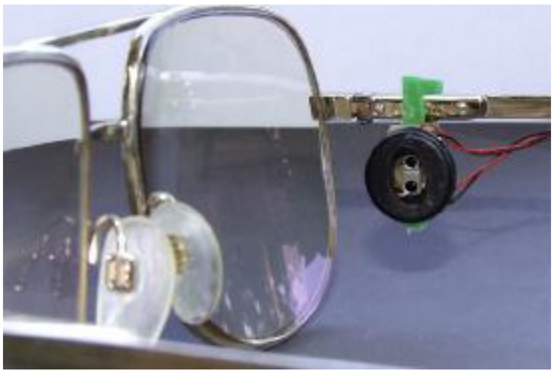

Figure 9: A sensor is plugged onto the spectacle's frame [4]

Table 2: Infrared emitter (transmitter) and detector (receiver) characteristics [4]

Parameter	Value	Unit
Wavelength,λ	940	nm
Bandwidth	50	nm
Diameter, tx	1.8	mm
Diameter, rx	2	mm
Apparent source size	0.8 x 0.8	mm
Junction, Δ*V*	0.9 – 1.5	V
Beam divergence (^{o})	26[a]	degree
Radiant flux	7.6[b]	μW

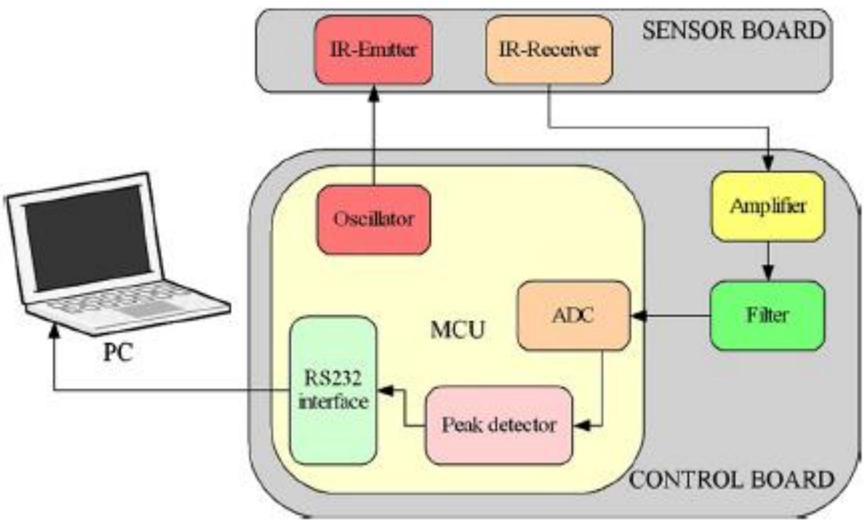

Figure 10: Flow chart of Fabio's proposed eye blinking detector [4]

The working principle of this design is shown in Figure 10. The main part of the control board is a microcontroller (MCU) that also been used as an oscillator to drive the IR-LED at the frequency around 1KHz. Amount of light being reflected back on the photodiode will produce current proportional to the light received. Again the signal will tend to change depends on eyes open and closed.

The output signal needs to be amplified and filtered, using an envelope detector. Then it will be converted in digital form by A/D converter so that the data can be analyzed by the MCU. In this design the digital signal can be sent through the RS232 interface to a personal computer for record purpose and being analysed in order to give an alarm.

Besides, the proposed device must work typically for 8 hours per day and eye is always expose by the LED, so information on the safety provided by the datasheets have to be considered with a great caution. Basically, the one of the most severe standard is in IEC 60825-1 as the device is safe to eye and skin under all reasonably foreseeable conditions of operation [4].

Figure 11: Eye-Com Biosensor, Communicator & Controller [8]

First envisioned of Eye-Com in 1998 which is using the idea of an infrared beam on the eyelid that can read the blinks of an eye and then connect the sensor to a buzzer which will give alarm to the patient as he first realise the idea of inventing the eye blink sensor while attending to a paralyzed hospital patient. After further researches and collaboration with a team of engineers, the Eye-Com Biosensor, Communicator & Controller has been invented in 2009 [8].

It can distinguish the longer blinks that been an indicator to fatigue and trigger an alarm to rouse the driver. Plus it is able to send the alarm to a remote source such as 911 and 999. Recently, Torch have had created a wireless fatigue detector that could prevent accidents and expects the Eye-Com will be in the market for all users within two years. Figure 11 shows Torch's Eye-Com which is an unobtrusive, wireless electronics device on an eyeglass-type frame. This invention is still not yet being commercialized in United States but Torch is expecting his Eye-Com will be in market within two years times [8].

CHAPTER 3

METHODOLOGY

3.1 Procedure Identification

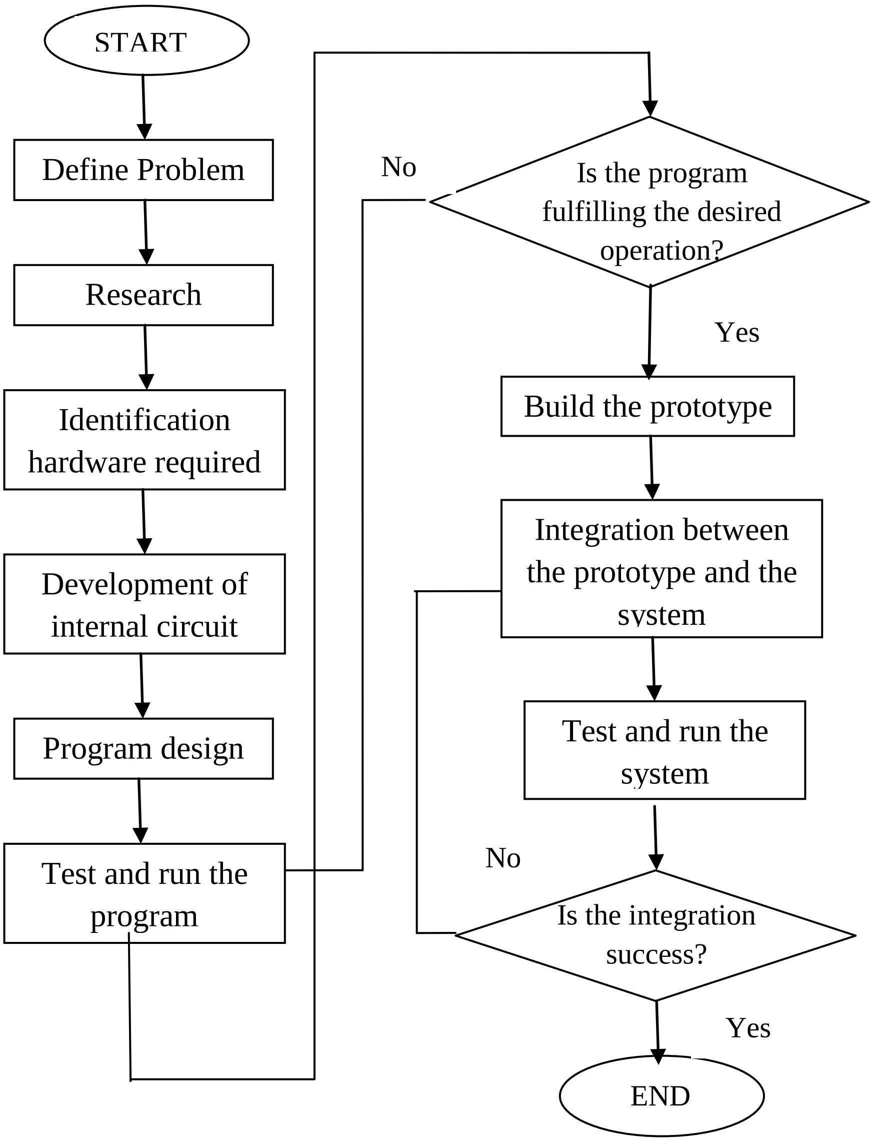

Figure 12: Procedure Identification of Final Year Project

Step 1. Define problem – Define fatigue and technique to measure the movement of eyelid.

Step 2. Research – Research is conducted to generate alternatives and solutions to the problems discussed. All finding is summarized in the literature review section which will include the solution to detect the security breach.

Step 3. Identification hardware required – The process includes identification of components that meets the requirement for the project.

Step 4. Development of internal circuit – Build the circuit of Eye Blink Sensor including the buzzer and vibration motor.

Step 5. Program the design – Programmed the transmitter and receiver module to communicate and transmit appropriate signal. Also, the microcontroller is program using the control program.

Step 6. Test and run the control program – The sequence of the operation is also checked.

Step 7. Build the prototype – Include the necessary modification on the hardware, the control equipment and the system.

Step 8. Integration between the internal circuit and system – The integration between the internal circuit and system must be programmed to handle signals from sensors, to trigger an alarm, and to interface with the computer to handle the general administrative actions.

Step. 9 Test and run the prototype – Experiment is been done to checked 3 stages of fatigue which are NORMAL, WARNING and DANGER.

Step 10. Modification – Modification need to be done to achieve the objectives.

3.2 Overall Project Flow Chart

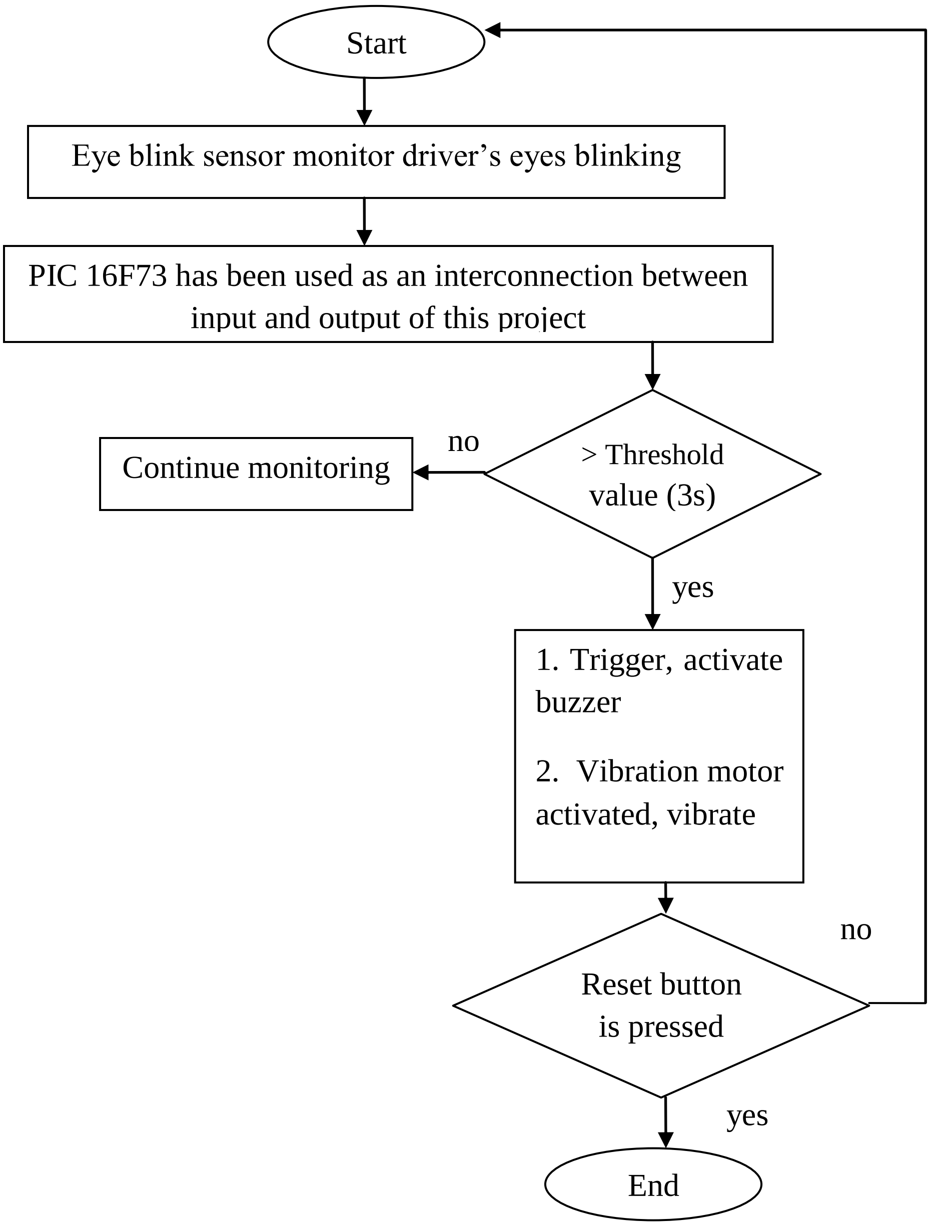

Figure 13: Series process of the project

Figure 13 shows the overall system flowchart. Firstly the eye blink sensor is plugged onto a frame of spectacle. Next, it will operate and monitor driver eyes blinking. The intensity of the light being reflected back by the eyepiece depends whether the eye is open and closed. A Programmable Interface Controller (PIC) has been used as an interconnection between the input (sensor) and the output of this project which are the vibration of the motor and warning by a buzzer. PIC 16F873 has been used. A set of assembly language coding is compiled in MPLAB Integrated Development Environment (IDE). Then, a predetermine value of 3 seconds as been set as the maximum duration for eyelid closure. If the driver's eyes are close more than 3 seconds, a buzzer will give warning to the driver and a motor will tend to vibrate in order to wake up the driver.

In addition, the electronics board which consist of the power supply, motor and buzzer will be placed in the driver's pocket. Next, the sensor is attached to the temple of the shade. Besides, a Dot Matrix Liquid Crystal Display Controller (LCD) is placed to indicate the condition of the system and the passengers can easily check on the condition of the driver and also the prototype. Reset button is important to be recognised by the driver as the buzzer will only turned off if the reset button is being pushed. Figure 14 and 15 show the illustration of the optical system in details.

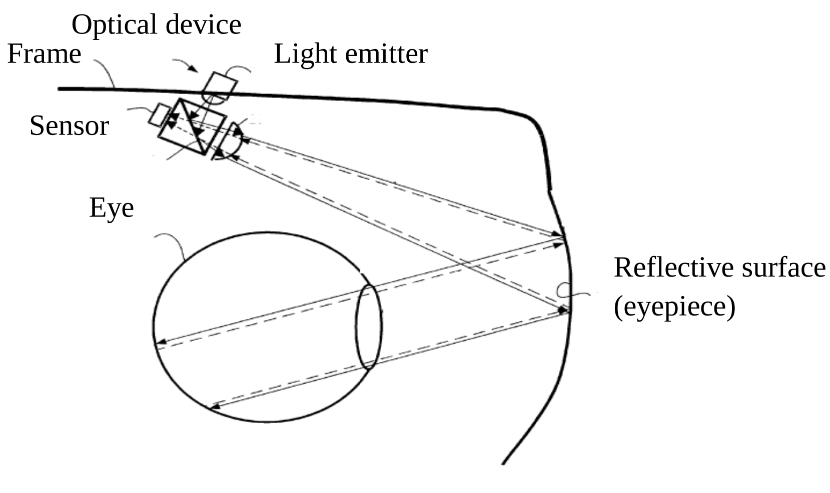

Figure 14: Sketch illustration of the optical system

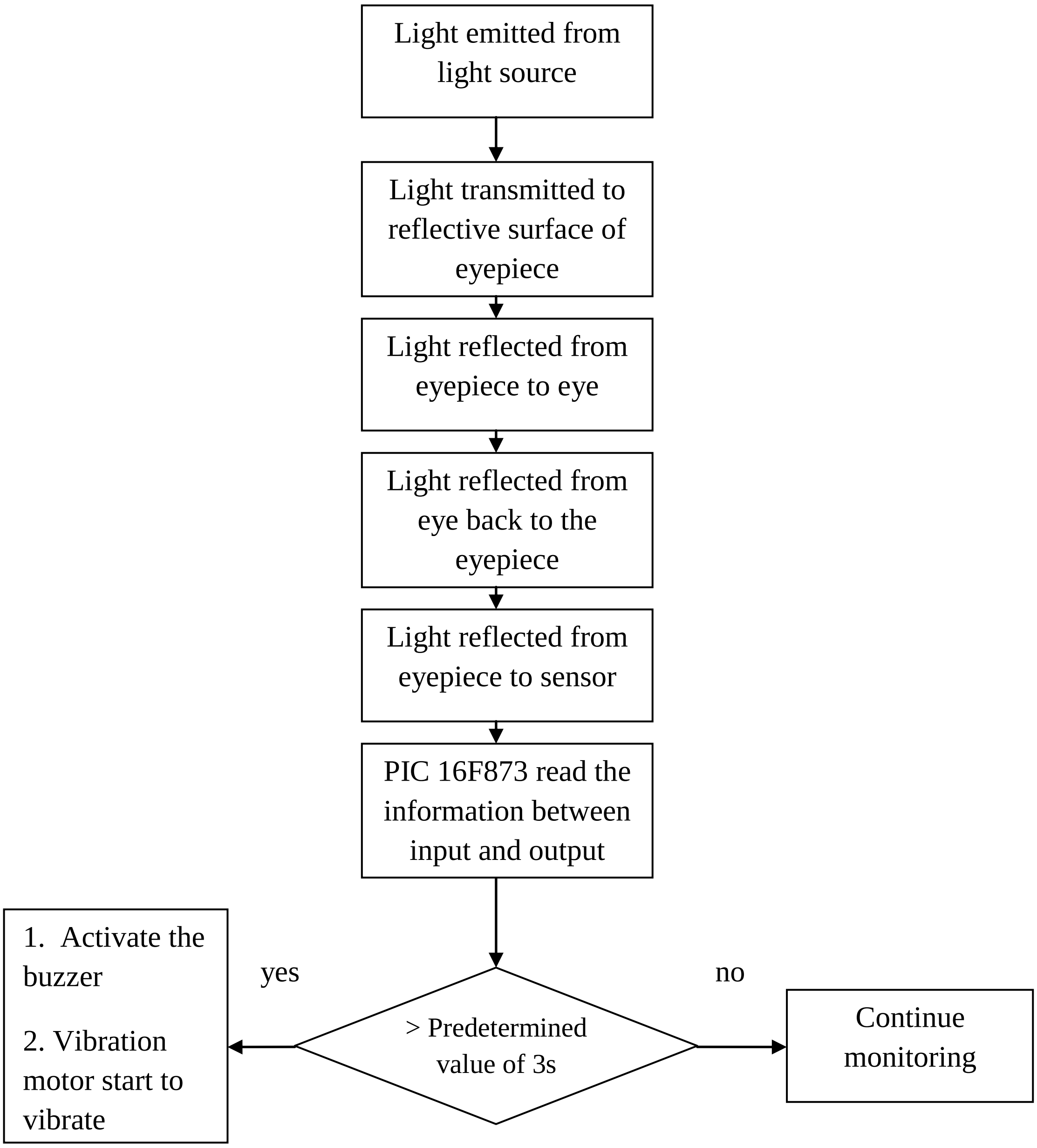

Figure 15: Flowchart illustrating operation of the prototype

3.3 Tools and equipments used

3.3.1 Hardware

Table 3 and 4 shows the tools and equipments used in this project and the costing for each of them. There are two separate costs which are the direct and indirect costs. Direct cost is the cost that has been spends by the author herself which indirect cost is the cost that is not spent for this project since the equipments are available in lab and electronics store.

Table 3: The Tools and Equipments Used (Indirect Cost)

Tools and Equipments	**Cost (RM)**
Resistors , Capacitors, LED	RM 20.00
Transistor, Single core wires	RM 6.00
Crystal Clock	RM 2.50
Total	**RM 28.50**

Table 4: The Tools and Equipments Used (Direct Cost)

Tools and Equipments	**Cost (RM)**
Dot Matrix LCD	RM 5.00
PIC 16F873	RM 42.00
Buzzer	RM 6.00
Vibration Motor	RM 6.80
L7805 voltage regulator	RM 0.90
12Vdc Relay	RM 3.50
Bread Board	RM 22.00
Energizer 9V Battery	RM 19.80

Mr Mark Shade	RM 35.00
LED SFH229FA	RM 28.00
LED SFH 485	RM 2.70
Total	**RM 171.70**

3.3.2 Software

Software is used for simulation, Printed Circuit Board (PCB) developing and Programmable Interface Controller (PIC) coding loader. These are the related software that has been used:

- Crocodile Technology Simulation
- PSpice Schematics 9.1
- MPLAB IDE [11]
- PICkit 2 Programmer [17]

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 Overall Project Configuration

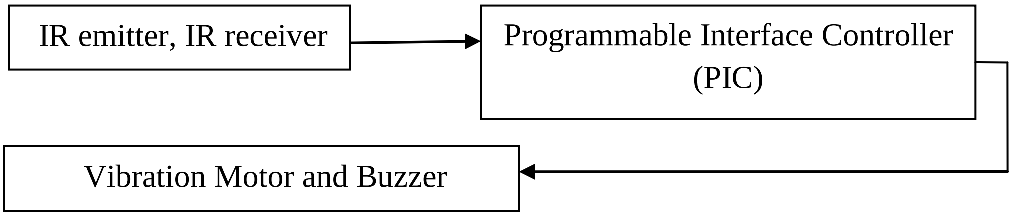

Figure 16: The Overall Project Configuration

As shown in Figure 16, basically this project consists of an eye blink sensor circuit with the help of PIC 16F873 that has been used as the interface between inputs and outputs for this project. The eye blink sensor is focusing on IR emitter and receiver. An electronics board consist of 12 V power supply, Dot Matrix Liquid Crystal Display (LCD), buzzer, vibration motor, resistors, capacitors, voltages regulator, reset button and other common electronics devices is build in rectangular size with a housing.

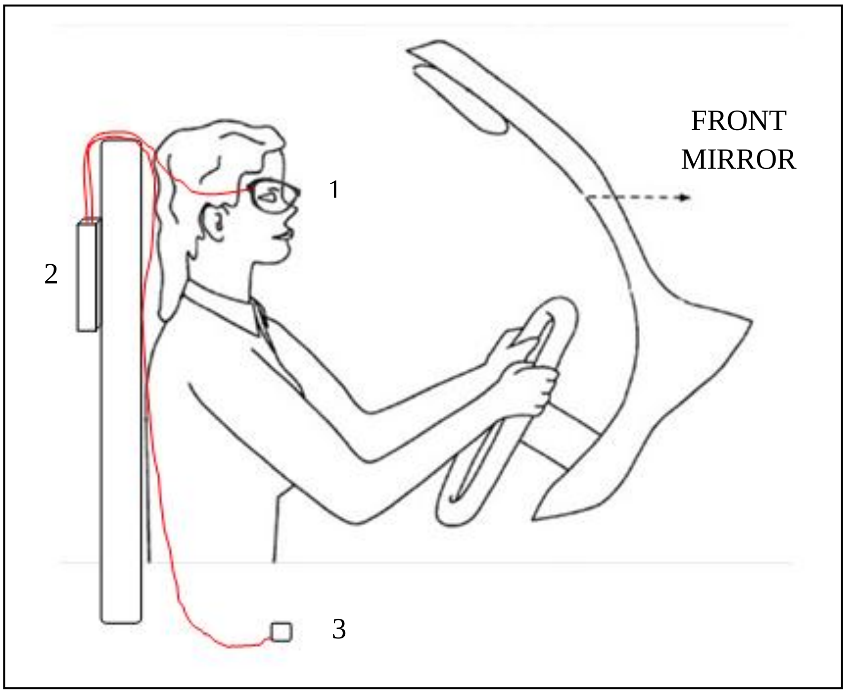

Figure 17: Illustration of actual position for prototype

Figure 17 shows the actual position of the prototype. The prototype has 3 parts which are:

1. Shade
2. Portable Electronic Board
3. Vibration Motor

Regular shade that been used among the drivers can be wear for this project. Both IR emitter and receiver will be plugged onto the inner side of the shade. Then, a portable electronic board is suggested to be place on any place that is under observation of the passengers. Thus, they can observe and analyst when is actually the driver is in fatigue mode. For this project, the suggested location for the electronics board is on the back side of driver’s seat. Reset button and buzzer are also soldered onto the electronics board. Buzzer will give output in the form of sound to warn the driver that he is in fatigue mode.

A small vibration motor will constantly vibrate as an output to warn the driver other than sound of the buzzer. The vibration motor is suggested to be put in the driver's pocket so that the driver himself can feel the vibration directly.

4.2 Execution of the project

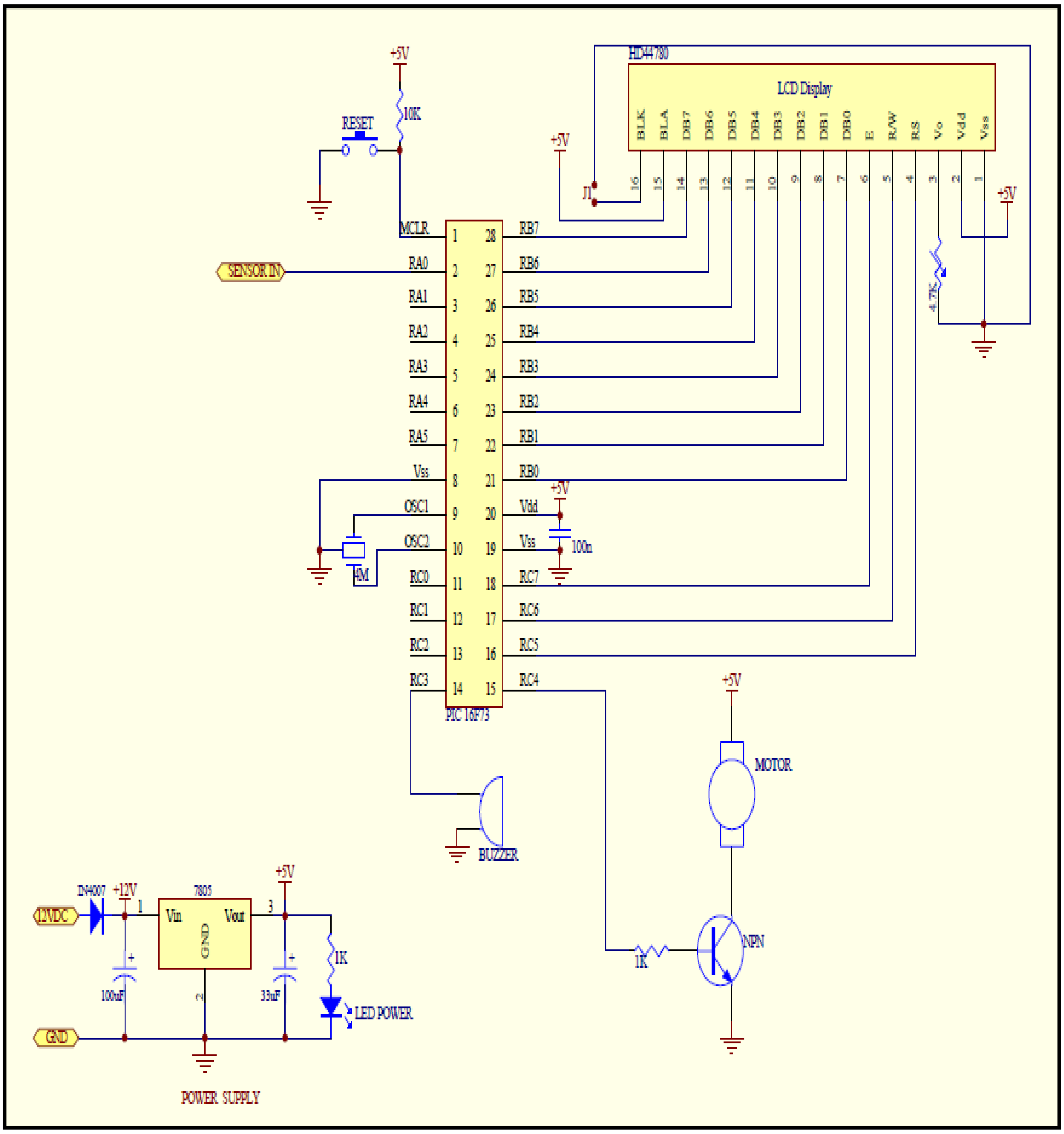

Figure 18: Schematic for components on the electronics board

Figure 18 shows the schematic circuit diagram of the project. LCD is used to display any indicator of fatigue level defined such as NORMAL, WARNING and DANGER. The LCD is important for the passenger observation, so they will also notice the condition of the driver.

An experiment has been done to check the output voltage drop of IR emitter and receiver. Appropriate distance between the emitter and receiver will ensure that user can use the optical system safely and give accurate reading of driver fatigue.

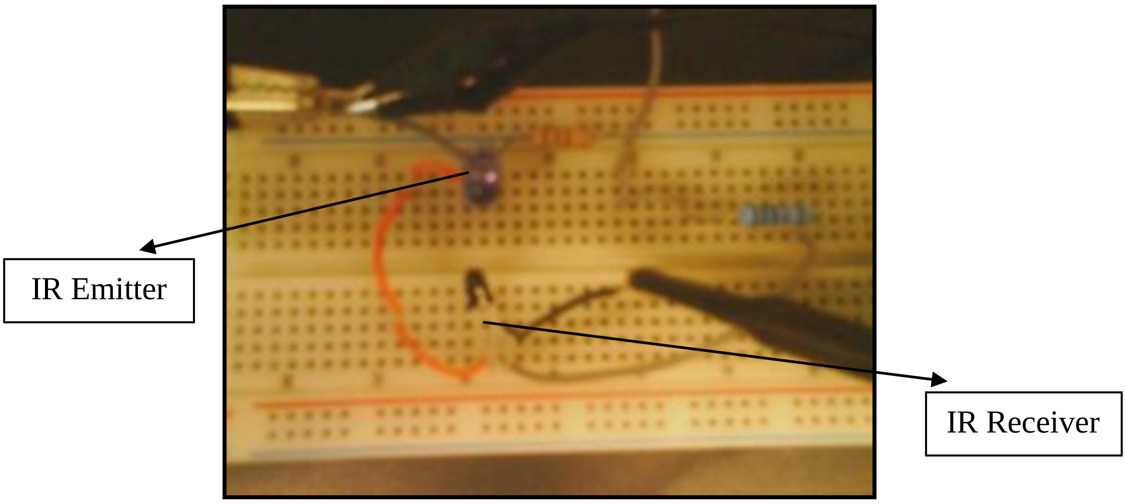

Figure 19: IR emitter and receiver

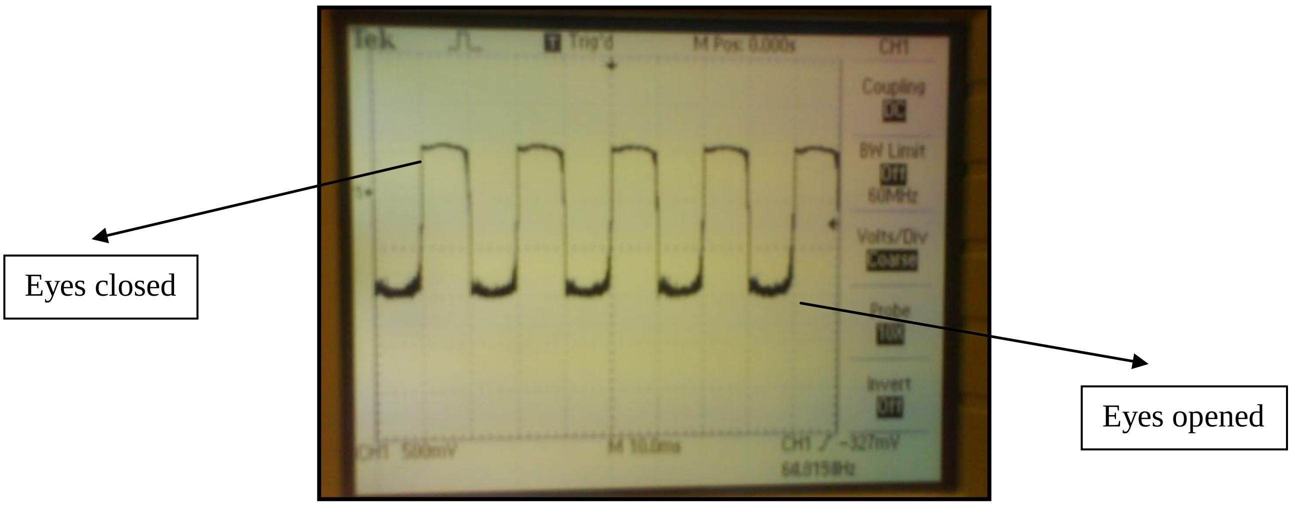

Figure 20: Output voltage of the IR receiver from digital oscilloscope

It is clearly shows that, when eyes are open, the IR receiver is able to sense the existence of light, so that the voltage will drop to approximately 1 V while when eyes are closed, the eyelid will block the IR light so that the receiver did not able to detect any light. Thus output voltage will remain at 5 V.

- Output voltage when eyes open = approximately 1 V
- Output voltage when eyes closed = approximately 5 V

4.2.1 5 V Power Supply

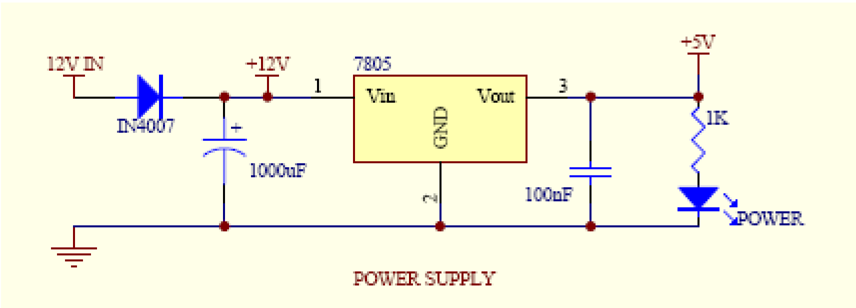

Figure 21: Power Supply, 5 V

IC 7805 has been used so that the voltage supply can be regulated from 12 V to 5 V. The operating voltage for the electronics circuit is 5 V. Diode IN 4007 acts as the rectifier. Resistor (1KΩ) is used as the load to limit the current that will go through it and turn on the Light Emitter Diode (LED).

4.2.2 Relay Driver

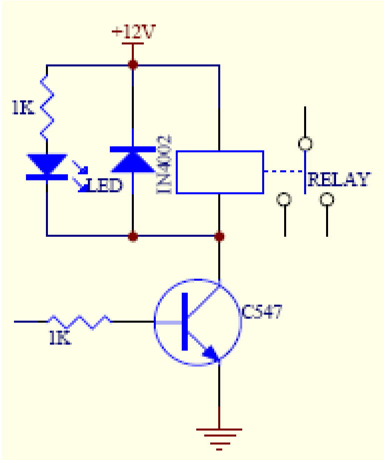

Figure 22: Relay Driver

Transistor C547 is used as a switch to control the operation of relay. When voltage base is greater than 0.7 V, the transistor will be in ON mode. Otherwise if the voltage base is less than 0.7 V, its means that the transistor is in OFF mode. Current will go through the resistor, transistor base and lastly on the ground. The relay is in normally closed. Once the 12 V power supply is being supplied, the relay will be in normally opened mode.

4.2.3 Programmable Interface Controller (PIC) 16F873

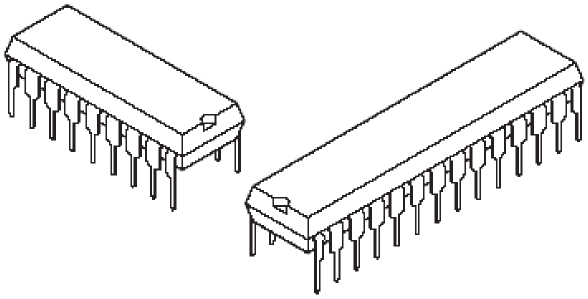

Figure 23: PIC 16F873 [14]

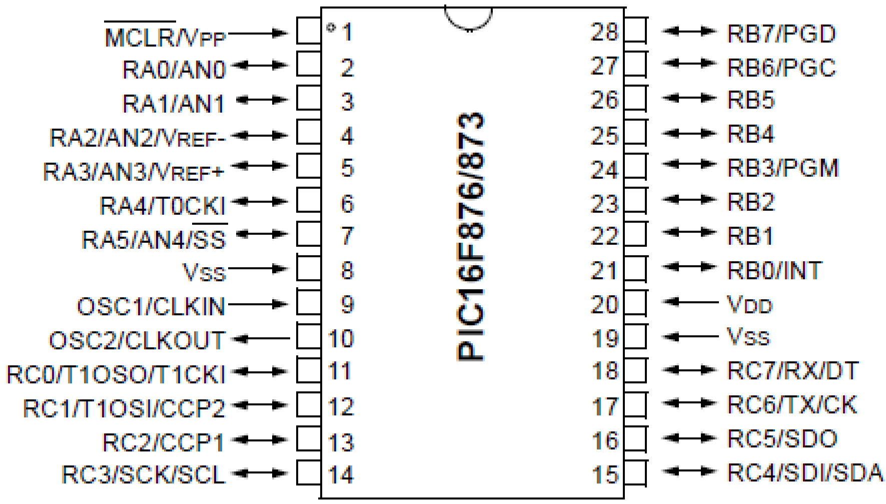

Figure 24: Pin diagram of PIC 16F873 [14]

A microcontroller is a single integrated circuit (IC) which is small in size but consist all the integrated circuits such as Central Processing Unit (CPU), Eraser Programmable Read Only Memory (EPROM), Random Access Memory (RAM) and Input/ Output interface. All of these functions are included within one single package, making them cost effective and easy to use. For this project PIC 16F873 is selected to be used. PIC Microcontroller is a programmable microcontroller ICs manufactured by MICROCHIP.

Programming language:

Low Level Language:

- Assembly

Software tools to write program:

- MPLAB IDE [11]

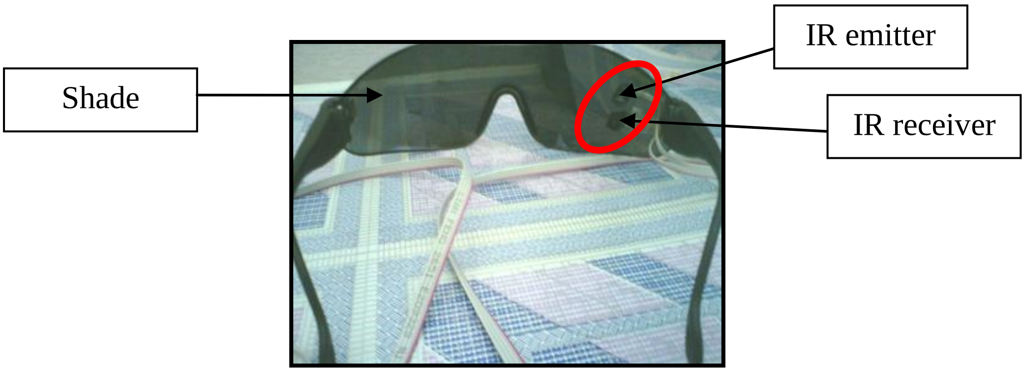

Figure 25: IR Transmitter and receiver at the corner of the shade

Figure 26: ‘Eye Blink Sensor [FYP]’ is displayed on the LCD

Once the project is connected to the power supply, ‘Eye Blink Sensor [FYP]’ will be displayed to indicate that the system is ready to operate. As a result of eyelid blocking the transmitter and receiver in less than 3 seconds, the receiver cannot detect any presence of light. So that, ‘WARNING’ will be displayed in the LCD. If the time of blocking is greater than 3 seconds, it means the driver is in fatigue mode and ‘DANGER!’ will be displayed on the LCD and the motor which is in the driver pocket will vibrate simultaneously with the buzzer warning until a reset button is then pressed.

In Figure 27, the electronics board has been transferred to Printed Circuit Board (PCB) to ensure it is portable and easy to be place anyway as desired by the user.

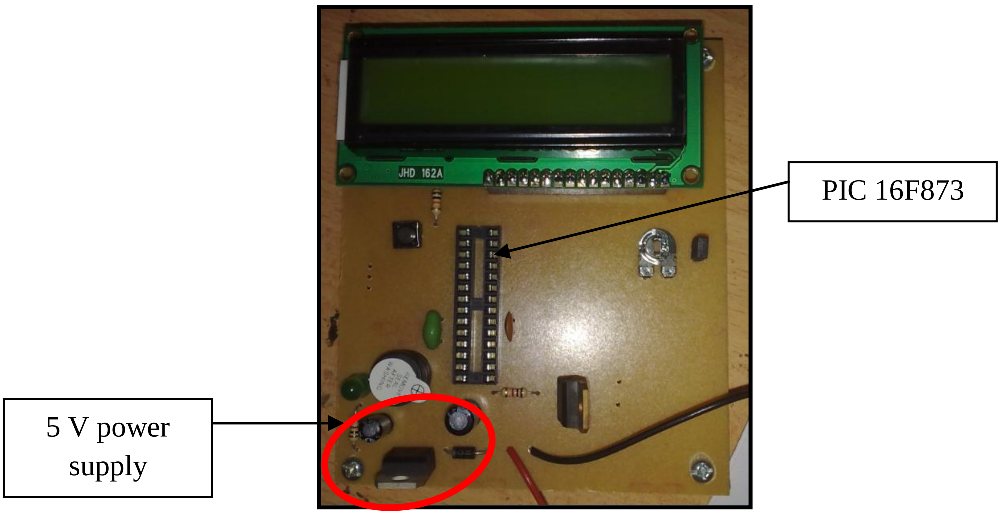

Figure 27: The electronics board in PCB

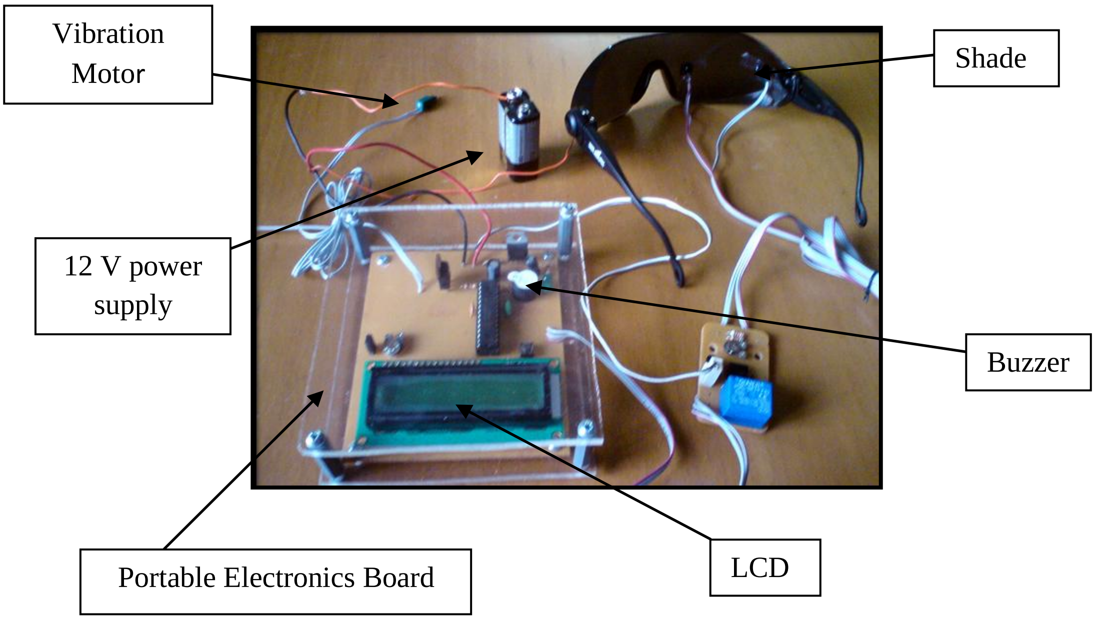

Figure 28: Overall project overview

4.3 A suitable technique to detect driver fatigue

There are many techniques that can be used to detect driver fatigue. Thus, comparison between eye blink sensors and video camera and head movement techniques has been done to prove that eye blink sensor is a suitable technique to detect driver fatigue.

Table 5: Comparison between eye blink sensor and others techniques

Video camera/ head movement	**Eye blinks sensor**
Advantages: 1) accurate reading of signal can be analyze 2) signal can be monitored by third party (manager/supervisor)	Advantages: 1) user friendly as it will be plug onto an eyeglass 2) no restriction for driver movement 3) cheap and easy to handle (light)
Disadvantages: 1) expensive as highly reliable camera need to be used 2) driver need to maintain constant eye contact with the device	Disadvantages: 1) infrared light may harm human eyes

In order to develop the whole prototype, there are some characteristic for the project that need to be consider which are:

- Safe to wear

Development of a safe prototype is highly important as for public transport drivers they will need to use it up to 8 hours. Eyes are so sensitive and special attention need to be taken when it deal with IR light.

- Light in weight and easy to handle

Users always demand for light, easy to handle and user friendly devices. The arrangements of electronic components will determine the size of electronics board. Size of the electronics board is approximately 12 cm x 11 cm.

- Zero disturbance to the driver

Both the IR emitter and receiver will be place at the inner side of the shade and at the same time they should not disturb the driver's area of foreseen.

4.4 Measuring the movement of eyelid

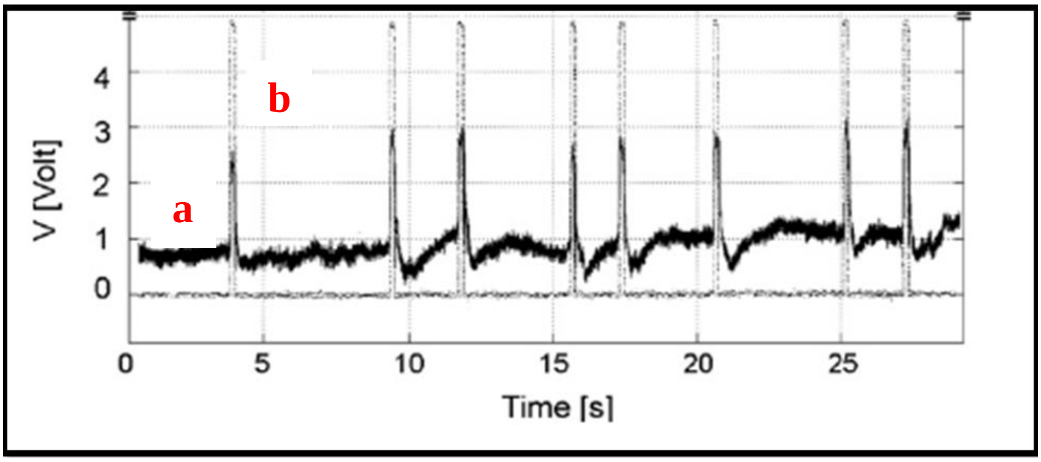

Figure 29: Sample of eye blink signal

a = eyes open

b = eyes closed

The eye blink signal pattern which is shown in Figure 25 shows that output signal is high, approximately 1 V when the eyes are open. Otherwise, when eyes are closed, the output signal is in the highest peak which is greater than 4 V. It proves that the movement of eyelid can be measured and this technique will be able to detect driver fatigue.

4.5 Real testing of prototype

A session of testing the prototype has been done on 15 students which are from the same age and gender. They are assigned as A, B, C, D, E, F, G, H, I, J, K, L, M, N and O. The length of their right eyes has been measured using a standard ruler. The measurement is in millimeters (mm). The measurements are taken from horizontal and vertical axis. For the horizontal side, the length taken is between the edges of the eyelid. In the other hand, for vertical side, the length is taken when eyes are opened normally. The students head and eyes need to be in straight position.

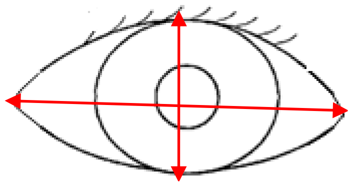

Figure 30: Horizontal and vertical axis of the eyes

There are 3 main outputs being observed which are the LCD indicators (NORMAL, WARNING and DANGER), sound of the buzzer and vibration of the vibration motor. The testing shows that the eye blink sensor prototype is working quite well. Most of the students eye blinks give significant inputs to the controller. During the testing, the students have been asked to open and closed their eyes in some specific conditions. Firstly, they need to wear the shade. Then, the reset button is pressed and after a second LCD display should indicate NORMAL mode. The prototype works well on 14 out of 15 students while the prototype is malfunction for the other 1 student.

Next, the students were asked to close their eyes for several seconds. If the eyes are closed between 2-3 seconds, the LCD display should indicate WARNING and buzzer is activated. For this condition, this prototype works well on 7 out of 15 students. After that, if the students were still closing their eyes more than 3 seconds, both the buzzer and vibration motor will be activated. Vibration motor reaction is in line with danger mode condition, thus if the prototype failed to work in danger mode so the vibration motor cannot vibrate as well. The prototype is successfully working on 4 out of 15 students during the testing session. The results of the testing are shown in Table 6.

Table 6: Result of the prototype testing session

Subject	Eyes measurement (mm)		Output				
			LCD			Buzzer (activated)	Vibration Motor (activated)
	Horizontal	Vertical	Normal	Warning	Danger		
A	34	10	✓	X		✓	
B	38	12	✓	✓		✓	✓
C	35	11	✓	X	✓	✓	✓
D	37	11	✓	X		✓	✓
E	39	12	✓	✓	✓	✓	✓
F	37	11	✓			✓	✓
G	34	11	✓	X	X		X
H	35	10	✓	X	X	✓	X
I	35	11	✓	✓	X	✓	X
J	35	10	✓	X	✓		X
K	37	12	✓	✓		✓	
L	40	11	✓	X	✓	X	✓
M	35	10	X	✓	X		X
N	35	11	✓	X		X	✓
O	40	12	✓	✓		✓	✓

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The development of the eye blink sensor had been discussed in previous section. The main focus of this project is to develop a prototype that can detect the movement of eyelid using IR transmitter and receiver. Through the development process of the prototype, the author was provided with the opportunity to determine the appropriate sensors, programming the microcontroller and interfacing the inputs and outputs of the system. Besides, the author had gained additional knowledge on software application.

This prototype measured the movement of eyelid which can be a good indicator of driver fatigue. When a driver gets tired and sleepy, his eyes blink rate is decreasing with increasing of times. It shows that period of each eyelid closure will increase. This prototype responds well in 26.7% (4 out of 15 students) of the total testing session. Thus, it shows that it can measure the movement of eyelid as desired. Plus a buzzer is activated once the eye blink sensor detects fatigue among the driver. In addition, the author has added in one more output which is the vibration motor as a way to warn the driver.

Apart from that, the development of this device is important for the drivers as it is a helpful device and it can be a life saver. The driver himself can realise when exactly he is in fatigue mode. Besides, the passengers can also observe the condition of the driver by observing the LCD output indicator.

5.2 Recommendation

It is recommended that in future that there will be further development that can be done to this prototype as this invention is still not yet be commercialized. The prototype can be improved by inventing wireless electronic system of eye blink sensor. In addition, it is great if the prototype can also be attached to vehicle so that the acceleration and speed of the car can be slow down whenever the driver is in fatigue mode. Plus, different size of human eyes is among the matter that need to be consider the most in order to develop a better and accurate eye blink sensor.

Next, the prototype is expected to work well for both right and left eyes. The movement of both eyes are then being the input for further development. The use of shade is also not practical during night. Thus, it is good to have a flexible clipped in sensor that can be used for all the drivers in case the driver need to wear their own spectacles.

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APPENDICES

APPENDIX A

Gantt Chart for FYP I Semester Jan 2010

No	Detail/ Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Selection of Project Topic								Mid-semester break							
2	Preliminary Research Work															
3	Submission of Preliminary Report															
4	Project Work; Research on Hardware Design															
5	Submission of Progress Report															
6	Seminar															
7	Project Work Continue; Designing System															
8	Submission of Interim Report Final Draft															
9	Oral Presentation															

Suggested milestone

Process

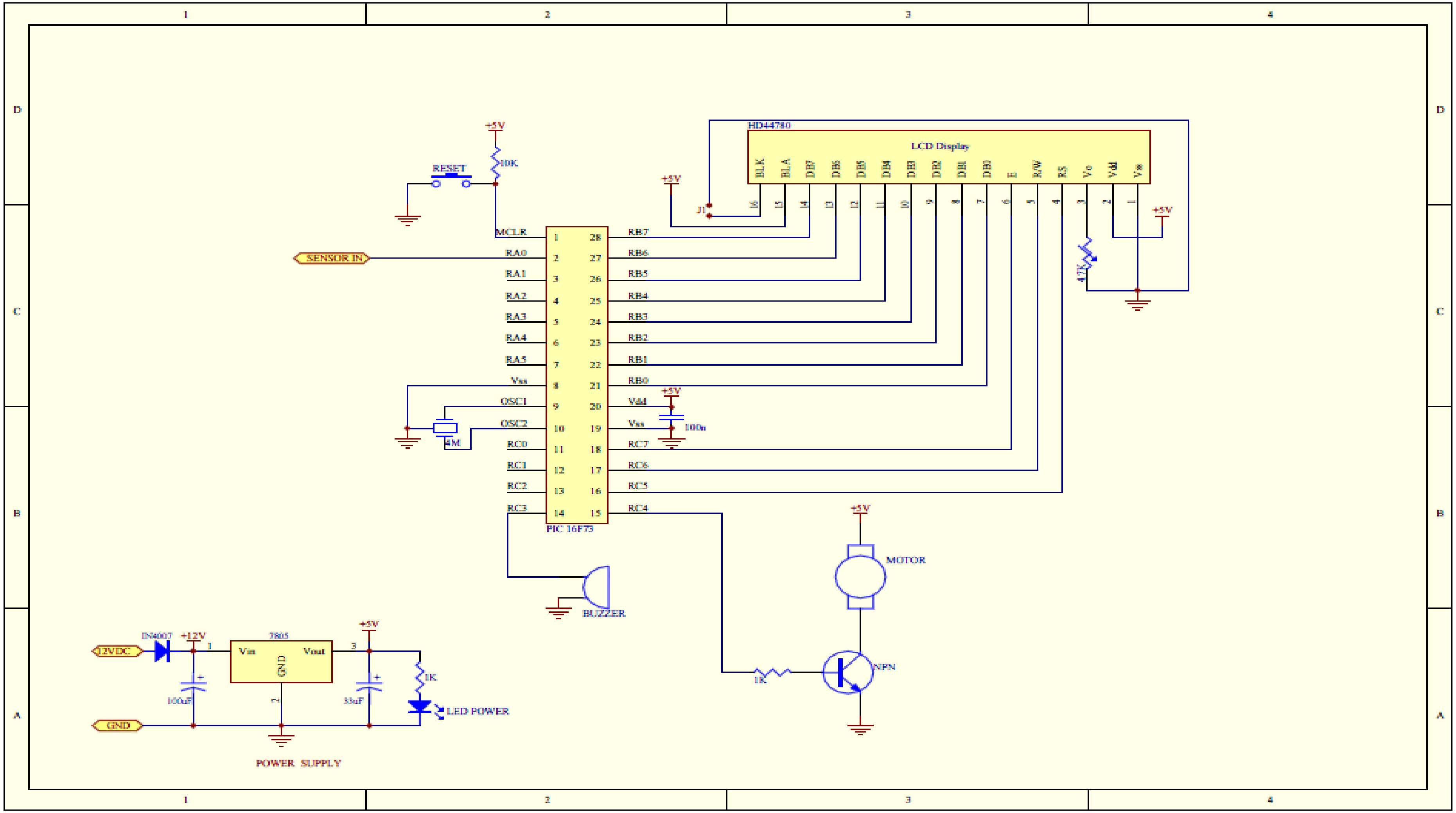
Gantt Chart for FYP II Semester July 2010

No	Detail/ Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Project Work Continue								Mid-semester break							
2	Submission of Progress Report 1															
3	Project Work Continue															
4	Submission of Progress Report 2															
5	Seminar (compulsory)															
6	Project Work Continue															
7	Poster Exhibition															
8	Submission of Dissertation (soft bound)															
9	Oral Presentation															
10	Submission of Project Dissertation (hard bound)															

Suggested milestone

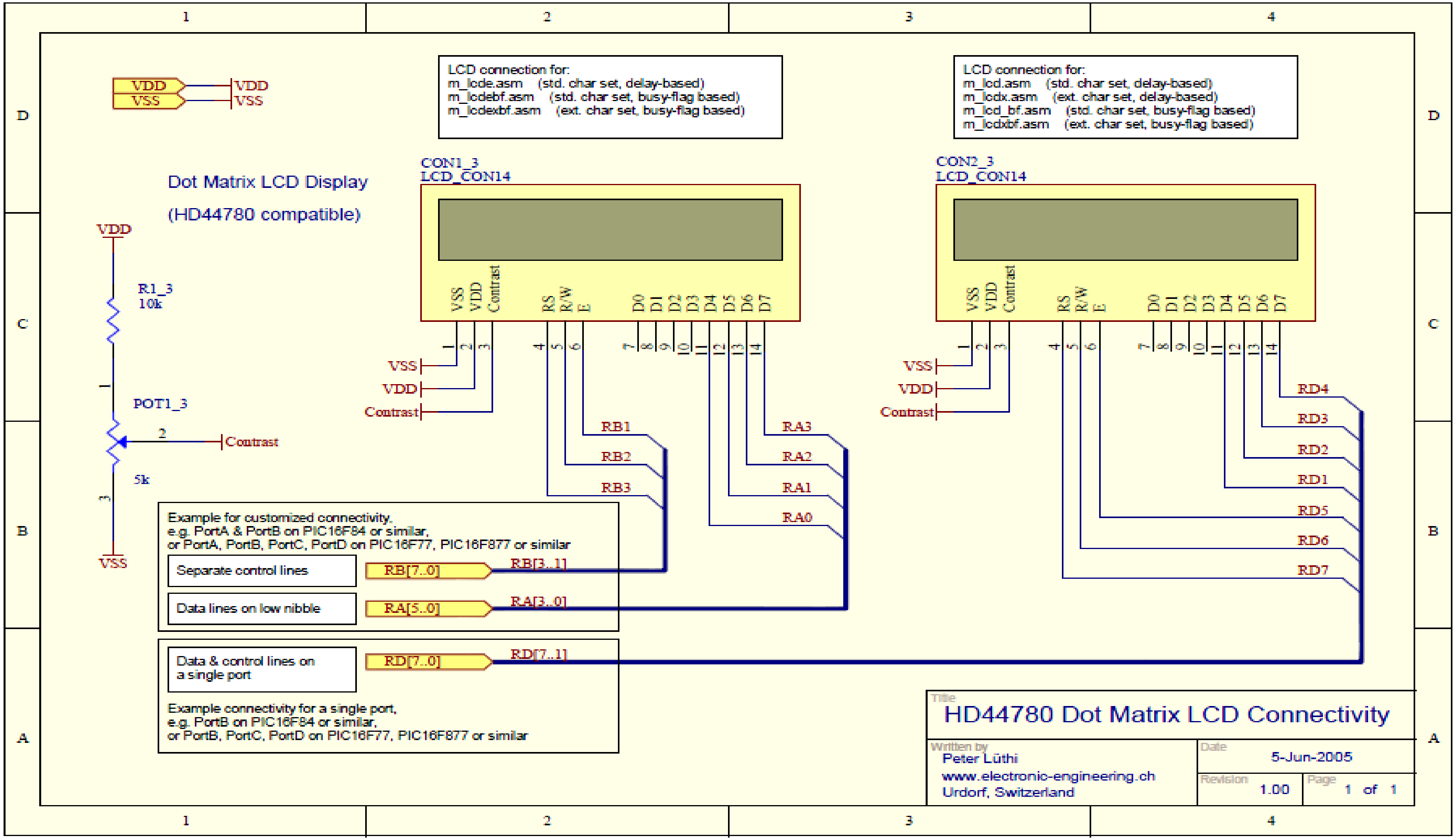
Process

APPENDIX B



HD44780
LCD Display
BLK
BLA
DB7
DB6
DB5
DB4
DB3
DB2
DB1
DB0
E
R/W
RS
Vo
Vdd
Vss
+5V
10K
RESET
MCLR
SENSOR IN
RA0
RA1
RA2
RA3
RA4
RA5
Vss
OSC1
OSC2
4M
RC0
RC1
RC2
RC3
RB7
RB6
RB5
RB4
RB3
RB2
RB1
RB0
Vdd
Vss
100n
RC7
RC6
RC5
RC4
PIC 16F73
J1
4.7K
BUZZER
MOTOR
NPN
1K
12VDC
IN4007
+12V
7805
Vin
Vout
GND
100uF
33uF
LED POWER
POWER SUPPLY

APPENDIX C


LCD connection for:
m_lcde.asm (std. char set, delay-based)
m_lcdebf.asm (std. char set, busy-flag based)
m_lcdexbf.asm (ext. char set, busy-flag based)
LCD connection for:
m_lcd.asm (std. char set, delay-based)
m_lcdx.asm (ext. char set, delay-based)
m_lcd_bf.asm (std. char set, busy-flag based)
m_lcdxbf.asm (ext. char set, busy-flag based)
Dot Matrix LCD Display
(HD44780 compatible)
CON1_3
LCD_CON14
CON2_3
LCD_CON14
R1_3
10k
POT1_3
5k
Contrast
VDD
VSS
RB1 RB2 RB3 RA3 RA2 RA1 RA0
RD4 RD3 RD2 RD1 RD5 RD6 RD7
Example for customized connectivity,
e.g. PortA & PortB on PIC16F84 or similar,
or PortA, PortB, PortC, PortD on PIC16F77, PIC16F877 or similar
Separate control lines
RB[7..0] RB[3..1]
Data lines on low nibble
RA[5..0] RA[3..0]
Data & control lines on a single port
RD[7..0] RD[7..1]
Example connectivity for a single port,
e.g. PortB on PIC16F84 or similar,
or PortB, PortC, PortD on PIC16F77, PIC16F877 or similar
Title
HD44780 Dot Matrix LCD Connectivity
Written by
Peter Lüthi
www.electronic-engineering.ch
Urdorf, Switzerland
Date
5-Jun-2005
Revision
1.00
Page
1 of 1

APPENDIX D

```
LIST P=16F873
                    INCLUDE "p16f873.inc"
                    ERRORLEVEL -302
                    __CONFIG _PWRTE_OFF & _HS_OSC & _WDT_OFF & _WRT_ENABLE_ON & _LVP_OFF &
_BODEN_OFF;  configuration switches
                              CBlock 0x20
                              N                                                ; Delay registers.
                              N1
                              N2
                              T0
                              T1
                              T2
                              T3
                              counta
                              countb
                              countc
                              FIXDELAY
                              visdelay
                              dataL
                              rmng_num                    ; Digit breaker registers.
                              quotient
                              temp_num
                              END

                              org 0x00
start                         call initports              ; Initialize Ports as output/inputs.
                              call INITLCD                ; Initialize LCD.
main1                         call READY
                              call visualdelay
                              call SECOND_1
                              call SECOND_1
                              call SECOND_1
CONTLOOP                      btfsc PORTA,0                ;Check sensor (close)
                              goto Scanning
                              goto CONTLOOP
Scanning                      call Delay_TT               ;Timer
                              call Delay_TT
                              call Delay_TT
                              btfsc PORTA,0               ;Check sensor (open)
                              goto WARNING
                              call DisNormal
                              call visualdelay
                              goto CONTLOOP
WARNING                       call Delay_TT
                              call Delay_TT
                              call Delay_TT
                              btfsc PORTA,0
                              goto DANGER
                              call DisWarning
                              call visualdelay
                              goto CONTLOOP
DANGER                        call DisDanger
                              call visualdelay
                              goto CONTLOOP
;  END OF MAIN PROGRAM-----------------------------------------------------------------------------------------------
```

```
;-------------------------------------------------------------------------------------------------------------------
;  Subroutine for Time&Delay
;-------------------------------------------------------------------------------------------------------------------

MINUTE_1        movlw   d'60'
                        movwf   N1
more1           call    SECOND_1
                        DECFSZ  N1,1
                        goto    more1
                        return

SECOND_1        movlw   d'4'
                        movwf   N2

more            call    Delay_T
                        DECFSZ  N2,1
                        goto    more
                        return


Delay_T         movlw   d'230'                  ;delay 250 ms (4 MHz clock)
                movwf   countc
d1
                movlw   0xC7
                movwf   counta
                movlw   0x01
                movwf   countb
Delay_0
                decfsz  counta, f
                goto    $+2
                decfsz  countb, f
                goto    Delay_0

                decfsz  countc   ,f
                goto    d1
                retlw   0x00

Delay_TT        movlw   d'250'                  ;delay 250 ms (4 MHz clock)
                movwf   countc
d1T
                movlw   0xC7
                movwf   counta
                movlw   0x01
                movwf   countb
Delay_0T
                decfsz  counta, f
                goto    $+2
                decfsz  countb, f
                goto    Delay_0T

                decfsz  countc,f
                goto    d1T
                retlw   0x00
```

```
;-----------------------------------------------------------------------------------------------------------------------
; Subroutine to initialize the PORTs as Inputs or Outputs.
;-----------------------------------------------------------------------------------------------------------------------
initports
                    clrf PORTB
                    clrf PORTC

                    MOVLW   0x06                ;CONFIGURED ALL PIN AS DIGITAL I/O
                    MOVWF   ADCON1
                    movlw   b'00011111'
                    movwf   TRISA

                    banksel TRISB               ; All PORTB pins as output.
                    movlw b'00000000'
                    movwf TRISB

                    banksel TRISC               ; All PORTB pins as output.
                    movlw b'11000000'
                    movwf TRISC

                    return

;-----------------------------------------------------------------------------------------------------------------------
; Subroutine to Initialize the LCD.
;-----------------------------------------------------------------------------------------------------------------------

INITLCD
                    BANKSEL PORTB               ; Select Bank for PORTB.
                    MOVLW   0xE6                ; Call for 46ms delay
                    CALL    NDELAY              ; Wait for VCC of the LCD to reach 5V

                    BCF     PORTC, 3            ; Clear RS to select Instruction Reg.
                    BCF     PORTC, 4            ; Clear R/W to write

                    MOVLW   B'00111011'         ; Function Set to 8 bits, 2 lines and 5x7 dot matrix
                    MOVWF   PORTB
                    CALL    ENABLEPULSE
                    CALL    DELAY50
                    CALL    ENABLEPULSE
                    CALL    DELAY50
                    CALL    ENABLEPULSE
                    CALL    DELAY50             ; Call 50us delay and wait for instruction
completion

                    MOVLW   B'00001000'         ; Display OFF
                    MOVWF   PORTB
                    CALL    ENABLEPULSE
                    CALL    DELAY50             ; Call 50us delay and wait for instruction
completion

                    MOVLW   B'00000001'         ; Clear Display
                    MOVWF   PORTB
                    CALL    ENABLEPULSE
                    MOVLW   0x09                ; Call 1.8ms delay and wait for instruction
completion
                    CALL    NDELAY
```

```
                        MOVLW   B'00000010'          ; Cursor Home
                        MOVWF   PORTB
                        CALL    ENABLEPULSE
                        MOVLW   0x09                 ; Call 1.8ms delay and wait for instruction
completion
                        CALL    NDELAY

                        MOVLW   B'00001100'          ; Display ON, Cursor OFF, Blinking OFF
                        MOVWF   PORTB
                        CALL    ENABLEPULSE
                        CALL    DELAY50              ; Call 50us delay and wait for instruction
completion

                        MOVLW   B'00000110'          ; Entry Mode Set, Increment & No display shift
                        MOVWF   PORTB
                        CALL    ENABLEPULSE
                        CALL    DELAY50              ; Call 50us delay and wait for instruction
completion

                        BSF     PORTC, 3             ; Set RS to select Data Reg.
                        BCF     PORTC, 4             ; Clear R/W to write

                        RETURN

;------------------------------------------------------------------------------------------------------------------------
; Enable Pulse for writing or reading instructions or data
;------------------------------------------------------------------------------------------------------------------------

ENABLEPULSE     BCF     PORTC, 5                     ; 2us LOW followed by 3us HIGH Enable Pulse
and 2us LOW.
                        NOP
                        NOP
                        BSF     PORTC, 5
                        NOP
                        NOP
                        NOP
                        BCF     PORTC, 5
                        NOP
                        NOP
                        RETURN

;------------------------------------------------------------------------------------------------------------------------
; N DELAY SUBROUTINE, delay in multiples of 200us up to 200us*255 = 51ms (or more)
;------------------------------------------------------------------------------------------------------------------------

NDELAY
                        MOVWF N                      ; N is delay multiplier
NOTOVER                 CALL DELAY200                ; Call for 200us
                        DECFSZ N, 1                  ; Decrease N by 1
                        GOTO NOTOVER                 ; The delay isn't done
                        RETURN

;------------------------------------------------------------------------------------------------------------------------
; FIXED 200us DELAY (Possibly more due to execution time of the DECFSZ instruction.)
;------------------------------------------------------------------------------------------------------------------------

DELAY200
                        MOVLW 0x42                   ; 66 LOOPS
```

```
                    MOVWF FIXDELAY          ; 200us fixed delay
NOTDONE200      DECFSZ FIXDELAY, 1          ; Decrement of FIXDELAY
                    GOTO NOTDONE200         ; If 200us isn't up go back to NOTDONE200
                    RETURN                  ; If 200us is up then return to instruction.

;-----------------------------------------------------------------------------------------------------------
; FIXED 50us DELAY (Possibly more due to execution time of the DECFSZ instruction.)
;-----------------------------------------------------------------------------------------------------------

DELAY50
                    MOVLW 0x10              ; 16 LOOPS
                    MOVWF FIXDELAY          ; 50us fixed delay
NOTDONE50           DECFSZ FIXDELAY, 1      ; Decrement of FIXDELAY
                    GOTO NOTDONE50          ; If 50us isn't up go back to NOTDONE50
                    RETURN                  ; If 50us is up then return to instruction.

;-----------------------------------------------------------------------------------------------------------
; Visual delay subroutine.
;-----------------------------------------------------------------------------------------------------------

visualdelay movlw 0x06
                    movwf visdelay

seetemp             movlw 0x10
                    call NDELAY
                    decfsz visdelay, 1
                    goto seetemp
                    return

visualdelay2 movlw 0x02
                    movwf visdelay

seetemp2            movlw 0xFF
                    call NDELAY
                    decfsz visdelay, 1
                    goto seetemp2
                    return

;-----------------------------------------------------------------------------------------------------------
; Fast Directive to write characters to LCD.
;-----------------------------------------------------------------------------------------------------------
PUTCHAR
                    MOVWF PORTB
                    CALL ENABLEPULSE
                    CALL CHKBUSY
                    RETURN

;-----------------------------------------------------------------------------------------------------------
; Subroutine to check for the BUSY flag.
;-----------------------------------------------------------------------------------------------------------
CHKBUSY
                    bcf     PORTC, 3        ; Clear RS to select Instruction Reg.
                    bsf     PORTC, 4        ; Set R/W to read.

                    banksel TRISB           ; Select Bank for TRISC.
                    movlw 0xFF              ; Define all PORTC Pins as Inputs.
                    movwf TRISB
```

```
                    goto CHKBUSY

                    banksel TRISB               ; Select Bank for TRISB.
                    movlw 0x00                  ; Define all PORTC Pins as Outputs.
                    movwf TRISB

                    banksel PORTC               ; Select Bank for PORTA, B, and C.
                    bsf PORTC, 3                ; Set RS to select Data Register.
                    bcf PORTC, 4                ; Clear R/W to write.

                    return

;------------------------------------------------------------------------------------------------------------------------
; Position Cursor to the next line.
;------------------------------------------------------------------------------------------------------------------------

nextline
                    banksel PORTC
                    bcf PORTC, 3        ; Select Instructions Register.
                    bcf PORTC, 4        ; Select Write.

                    movlw b'11000000'           ; Shift cursor to second line at 0x40 RAM address
on LCD.
                    call PUTCHAR

                    return

;------------------------------------------------------------------------------------------------------------------------
; Clear screen and Cursor home.
;------------------------------------------------------------------------------------------------------------------------

clrscreen
                    banksel PORTC
                    bcf PORTC, 3                ; Clear RS to select Instructions Register.
                    bcf PORTC, 4                ; Clear R/W to select Write.

                    banksel PORTB
                    MOVLW B'00000001'           ; Clear Display
                    call PUTCHAR

                    return

;------------------------------------------------------------------------------------------------------------------------
; Position Cursor to home position.
;------------------------------------------------------------------------------------------------------------------------
cursorhome
                    banksel PORTC
                    bcf PORTC, 3                ; Select Instructions Register.
                    bcf PORTC, 4                ; Select Write.

                    movlw b'00000010'           ; Position cursor to home position.
                    call PUTCHAR

                    return

;------------------------------------------------------------------------------------------------------------------------
; Wait 20us for Acquisition time in order for holding capacitor to charge up.
;------------------------------------------------------------------------------------------------------------------------
```

```
delay20
                banksel FIXDELAY        ; A loop to generate 20us delay.
                movlw 0x0A
                movwf FIXDELAY

notdone20       decfsz FIXDELAY, 1
                goto notdone20

                return

DisNormal       call nextline
                        movlw A'N'
                        call PUTCHAR
                        movlw A'o'
                        call PUTCHAR
                        movlw A'r'
                        call PUTCHAR
                        movlw A'm'
                        call PUTCHAR
                        movlw A'a'
                        call PUTCHAR
                        movlw A'l'
                        call PUTCHAR
                        bcf PORTC,3
                        bcf PORTC,2
                        return
DisWarning      call nextline
                        movlw A'W'
                        call PUTCHAR
                        movlw A'a'
                        call PUTCHAR
                        movlw A'r'
                        call PUTCHAR
                        movlw A'n'
                        call PUTCHAR
                        movlw A'i'
                        call PUTCHAR
                        movlw A'n'
                        call PUTCHAR
                        movlw A'g'
                        call PUTCHAR
                        bsf PORTC,3
                        call Delay_TT
                        bcf PORTC,3
                        call Delay_TT
                        bsf PORTC,3
                        call Delay_TT
                        bcf PORTC,3
                        call Delay_TT
                        bsf PORTC,3
                        call Delay_TT
                        bcf PORTC,3
                        call Delay_TT
                        bsf PORTC,3
                        call Delay_TT
                        bcf PORTC,3
                        call Delay_TT
```

```
                bsf PORTC,3
                call Delay_TT
                bcf PORTC,3
                call Delay_TT
                bsf PORTC,3
                call Delay_TT
                bcf PORTC,3
                call Delay_TT

                return

DisDanger       call nextline
                movlw A'D'
                call PUTCHAR
                movlw A'a'
                call PUTCHAR
                movlw A'n'
                call PUTCHAR
                movlw A'g'
                call PUTCHAR
                movlw A'e'
                call PUTCHAR
                movlw A'r'
                call PUTCHAR
                movlw A'!'
                call PUTCHAR
                bsf PORTC,3
                bsf PORTC,2

                return
READY           call clrscreen
                call cursorhome          ; Reposition cursor to home.
                movlw A'E'
                call PUTCHAR
                movlw A'y'
                call PUTCHAR
                movlw A'e'
                call PUTCHAR
                movlw A' '
                call PUTCHAR
                movlw A'B'
                call PUTCHAR
                movlw A'l'
                call PUTCHAR
                movlw A'i'
                call PUTCHAR

                movlw A'n'
                call PUTCHAR
                movlw A'k'
                call PUTCHAR
                movlw A' '
                call PUTCHAR
                movlw A'S'
                call PUTCHAR
                movlw A'e'
                call PUTCHAR
                movlw A'n'
```

```
call PUTCHAR
movlw A's'
call PUTCHAR
movlw A'o'
call PUTCHAR

movlw A'r'
call PUTCHAR
call nextline
movlw A' '
call PUTCHAR
movlw A' '
call PUTCHAR
movlw A' '
call PUTCHAR
movlw A' '
call PUTCHAR
movlw A'['
call PUTCHAR
movlw A'F'
call PUTCHAR
movlw A'Y'
call PUTCHAR
movlw A'P'
call PUTCHAR
movlw A']'
call PUTCHAR
movlw A' '
call PUTCHAR

return

;----------------------------------------------------------------------------------------------------------------------
; End of Programme.
;----------------------------------------------------------------------------------------------------------------------
```