SURVEILLANCE SYSTEM FOR UNDERGROUND CAR PARK MONITORING

LEOW SZE RONG

ELECTRICAL & ELECTRONICS ENGINEERING
UNIVERSITI TEKNOLOGI PETRONAS

JUNE 2009

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

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Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Electrical & Electronics Engineering Programme
Universiti Teknologi PETRONAS
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Bachelor of Engineering (Hons)
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Approved:

AP Josefina Barnachea Janier
Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

June 2009

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.

LEOW SZE RONG

ABSTRACT

The title of this project is Surveillance System for Underground Car Park Monitoring, which is an integrated smart system which uses the concept of preventive control to monitor the car park. This system will be utilizing sensors to detect the number of cars going in and out of the car park on the ground level as well as the underground level. The main objective of this project is to construct a reliable sensing system and control system to improve the condition in the car park which is economical compared to other existing system. The input comprises of vehicle sensor and flood sensor. The microcontroller and programmable logic controller (PLC) is programmed to display the amount of parking space and to activate the control valve respectively. The output is the control valve, alarm system, and also 7-segment display. The preventive action will be dependent on the number of parking bays available and the water level in the car park.

Since most of the existing car parks do not display the number of parking bays, this project will mainly focus on developing an affordable system to effectively detect the vehicles and display the available parking bays to the users. For this project prototype, the specified parking bays available would be 2 levels of car park and of 10 parking bays on each level. It could display a maximum of 20 bays available parking lot and it will display as FULL when there is no more parking bay available. On an actual underground car park system, we will have much more parking bays to be taken into account.

ACKNOWLDEGMENT

First and foremost I would like to express my gratitude to my project supervisor AP Dr. Josefina Barnachea Janier for providing me guidance towards the completion of my project. The comments given had been taken into account positively and there is improvement in the project. Also, I would like to thank my parents who have been very supportive throughout this period. Besides, I would like to thank Puan Salina, Kak Siti Hawa, Kak Siti Fatimah, Kak Siti Hajar, Mohammad Azhar, Mr. Iznani, Chris Lee, Yim Soon Yen, Hazim Idris and many more people for being so kind and has been very supportive towards my project. Without their contributions, I would not have gone through this far in my project. Thank you very much and your contributions will always be remembered.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
INTRODUCTION

1.1 Background of Study

Car parks are mostly found in large apartments, business premises, hospitals, shopping complexes, stadiums, airports, convention center, and universities. In some of the car parks around the world, they do have a system of keeping track of the vehicles inside, but they do not display it for the vehicles owners before entering the car park. The users will have to find the parking bays without having first-hand knowledge on the availability of the parking bays inside the car park. Usually, finding an available car park bay takes time especially in a busy commercial centre or shopping complexes. Someone might spend some time looking for the parking bay which could result in getting to work late or missing important meetings. Also, vehicle owners will waste their car petrol by looking for an empty bay in a fully parked parking lot. Even if they do provide a system for tracking system, such a system is expensive as they use electronic sensing system on each parking bay. Also, especially for underground car parks, we cannot avoid the flood caused by rain. It could cause damage to the vehicles parked inside as well as properties. A lot of the car parks do not provide proper drainage system to reduce the water level inside the car park. Warning must be given to the vehicle owners to remove their cars before the water level reaches a critical height. Cars entering the car park are not given sufficient warning in case of flood inside the underground car park.

1.2 Problem Statement

1.2.1 Problem Identification

Most of the car parks do not display the number of parking bays available to inform the users. Thus, this project will focus on developing sensors to detect the flow of cars both outside and inside the underground car park which provides information on the parking bays available at each level. Instead of putting sensors on each parking bay which is expensive, we have sensors at the entrance and exit of car park of each level. We could utilize the existing scanning system inside the car park if it is provided. The limited availability of parking results in traffic congestion, air pollution as well as driver frustration. As for flood monitoring system, because of cost factor, most of the car parks do not provide a proper drainage system when it rains. When the water level reaches certain height, the warning LED will be displayed both in the control room and to the users. Therefore, in order to complement the cost factor, a control valve will be activated only if the water level of car park reaches dangerous level.

1.2.2 Significance of Project

This project will mainly integrate a few sensing systems together to implement an all-in-one-board system which can monitor number of vehicles and flood level. The vehicle counter monitoring system provides sensors which can save time for the users by indicating the number of bays available at each level. For some existing systems, they actually install sensor on per bay basis which makes the whole system expensive. For this project, it will not be costly as we only place it at the entrance and exit of each level, however, we could still display the number of parking bays available to the users before entering car park. For flood monitoring system, we will be using sensors to detect the water level. A warning will be given to the control center and the users if it reaches certain height which is not dangerous yet, however, once it reaches the dangerous level, the control valve will be activated to divert the flood water through the drainage system. This could protect the cars as well as properties inside the car from the flood waters.

1.3 Objective

1.3.1 The Relevancy of the Project

The aim of this project is to design a system which can detect the number of parking bays as well as monitoring the flood hazard in the car park. The number of parking bays specified in this project is 100 parking bays with 50 bays in the ground level and 50 bays on the underground level. This new system is expected to have a relatively lower cost than the products available in the market. This project consists of a parking bay monitoring system and a flood sensor. The vehicle counter monitoring system will consists of PIC microcontroller to monitor the vehicle flow. For flood sensor, PLC would be used to activate the alarm and control valve when necessary. Also, there might be new additional systems introduced in the later part to make sure that this project would have better applications.

1.3.2 Feasibility of the Project

The systems will integrate the microcontroller and PLC so that it can take preventive action to warn the vehicle owners from flood hazard. The system operates based on signals sent by the sensor, the signals are then sent to the microcontroller and PLC. Method to operate the control valve is simple by using the relays to differentiate the voltage levels [1]. Programming needs to done for microcontroller and PLC. For the given time frame, to construct this integrated system, it would be sufficient to carry out the project. Therefore, this project should be able to complete with the resources and time frame given.

CHAPTER 2
LITERATURE REVIEW

2.1 Vehicle Counter Monitoring System

The system of providing information on parking bays had already existed in the market. Once the sensors spot an empty parking lot, the sensors would detect it and the LED will turn green. In other words, the vehicle owners will spot for the green light for available parking bays. One of such system is Parking Bay Sensor which uses sensors on each bay had already been commercialized. One of the shopping complexes here which adopted the parking bay sensor on each bay is the shopping complex of Sunway Pyramid. It installs sensor on every bay inside the car park and displays the number of parking bays available on the road before the vehicles enter the car park [2]. However, such a system is expensive. By installing every sensor on each bay, the cost of wiring and construction is exorbitant, not to mention maintenance work. There is another form of sensors which utilizes RFID. Each transmitter sends a unique ID via AM radio frequency to the converter and the data is sent to the control center [3]. There are also other existing systems such as the wireless sensor network, the data would be sent to the nearest wireless access point and evaluate the data [4].

There were other alternative such as parking bay tracking using camera or CCTV. In car detection, it implements feature extraction. The feature detection will extract some features from the input image that will decide the existence of the car in the parking lot [5]. Similar method was used by using real time video streaming. By refreshing the image in at certain rate, it integrates algorithm which detect the change and movement of a car [6]. However, the area coverage of the camera is limited. For a large area parking space, at least a few cameras would be needed to fully detect all the parking space. One of the disadvantages of this tracking system is that there might be a few "blind spots" for the camera which in turn make the system inaccurate. Similarly, some overlapping parking space might occur for cameras at different locations. The cost of purchasing the cameras and a microprocessor to process the correlation or streaming is generally more expensive than using just a microprocessor and 7-segment displays.

For this project, I propose that the system be utilizing the existing scanning mechanism at the boom barriers at the entrance and the exit of the car park to keep track on the number of cars. For different levels of the car park, sensors would be installed at the entrance and exit of each level. By doing this, each car going in and out from each level would be detected and we could display it in the 7-segment display. Another alternative is by using pressure sensors. Digital output signal would be produced by using resistive sensor bridge. This alternative is considered as it is low in cost but it has high sensitivity [7]. A microcontroller will be used to program the counter to display the number of parking bays available using sensors as input.

2.2 Flood Monitoring System

As for flood, especially in Malaysia, flash floods often occurs in Malaysia and it is always important to have precautions to warn the people. Early detection system should be installed especially in a flood-prone city center[8]. The maximum rainfall recorded on 126mm in Gombak rainfall station in Kuala Lumpur shows how unprepared the car parks in dealing with flash flood without the flood detection system [9]. Until now, infrared sensor is the cheapest yet effective solution which could be used to detect the water level and by using PLC, the control valve would be activated to divert the water flow. Another example is the Malaysian mega project referred to as SMART tunnel, where excess flood water of SMART tunnel is diverted out through the different levels by detecting the amount of rainwater and controlling the flood gate [10]. Another alternative is that the underground car park will be reserving some empty space in the basement for storing the flood water. The system has two primary pump units operated with line current, a battery-operated back-up pump unit, and a sensor arrangement for sensing water level in the collection basin [11].

2.3 PLC and Microcontroller

There are several reasons PLC is preferred over microcontroller for the flood monitoring system. PLC and microcontroller both use online programming, can self document code, and have modularity in hardware structure and software design. However, PLC uses ladder logic which is fairly simple and user-friendly compared to microcontroller. It enables the user to view a process or graphical representation of a process and determine how a system runs. It has special input/output interfaces designed to work in industrial environment, not affected by electrical noise inherent in most industrial locations. PLC has a clean failure mode and most importantly has the ability to design a strategy for a failure mode. Generally, for a microcontroller to achieve these, it would be considerable harder as we will need to build extra circuits around which are fairly complex and more expensive. In our case, for flood monitoring system, we need PLC to activate and deactivate the control valve reliably. Also, by using PLC, we have fairly large room for expansion of the system as other applications can be easily added in and processed by the PLC to achieve the desired output.

2.4 Other Applications

Other useful application found is position detection of cars. Illegal parking inside the car park are often and undesirable and most often causing threat to other car owners. Also, if there is some error in the scanning system of boom barrier, in which the boom barrier cannot be opened after scanning, position detectors would detect the block long enough to inform the control center to take action. One such example is to use ALTERA FLEX 8636-ALC-84 SRAM programmable chip so that it can store enough information to detect the cars long enough [12]. These options are considered as it serves a good purpose of detection and reduce the manpower for authorities to monitor the underground car park.

CHAPTER 3
METHODOLOGY

3.1 Procedure Identification

There are 2 major parts of this project which are the vehicle counter monitoring system and flood monitoring system. We shall identify the procedures needed to complete the project. The flow chart of the system is described in Figure 1. A Gantt chart is also provided in Appendix A and B respectively for 2 consequent semesters.

3.1.1 Problem Identification

Firstly we need to identify the problem of an underground car park which does not display the number of parking bays in the car park. Also, we must consider the flood hazard which occurs in the car park and find a way to reduce the impact and control the flood waters.

3.1.2 Designing the System

We need to take into the account of the design constraint of the system. Circuits are designed and programming is done to run the system. For vehicle counter monitoring system, we are using PIC 18F458 while for flood monitoring system, we will be using PLC. Programming of PIC will be done using PIC C Compiler while PLC is CX Programmer. Calculations are also done alongside with designing the circuit.

3.1.3 Simulation

We simulate the system by using CX Programmer and PIC IDE Simulator. If the program has errors, then we will need to debug it. The system will be reevaluated for better efficiency.

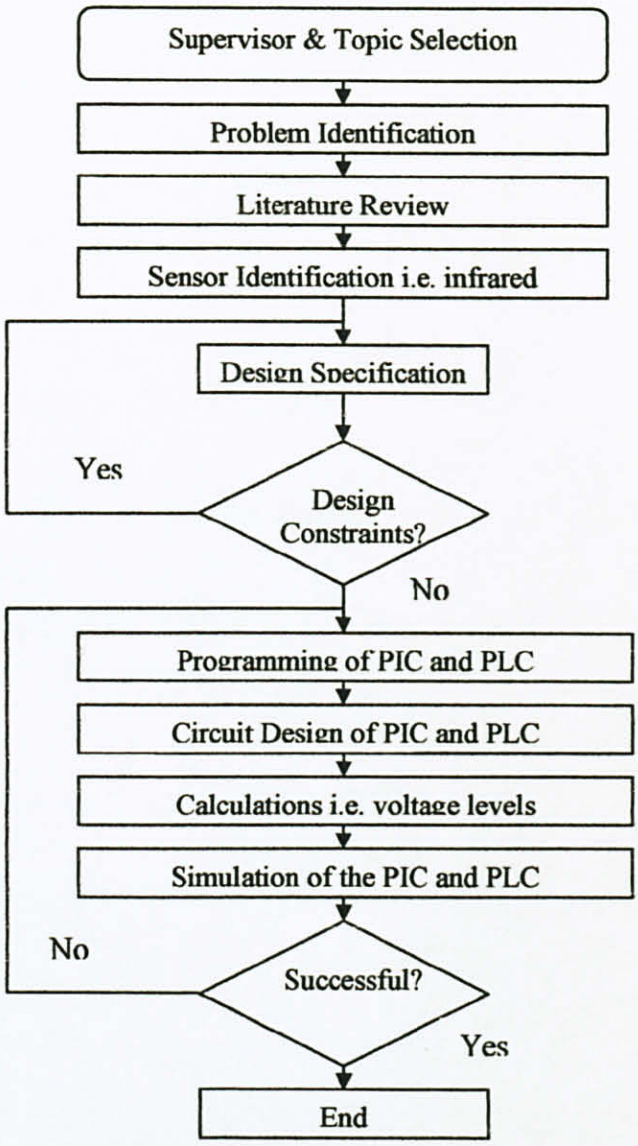

Figure 1: Workflow and Procedure Identification

3.2 Tools Required

For vehicle counter monitoring system, we will need to use sensors to detect the incoming car at the entrance and also outgoing car at the exit. Scanning tag or token will serve as input to the system. After that the input will be processed in microcontroller. The microcontroller identified is PIC 18F452 microcontroller. C Programming would be needed to program the microcontroller so that it can perform the counter mechanism. PIC C Compiler is needed to compile the program. After programming, the software to upload the program to the PIC 18F452 microcontroller is Warp 13. 7-segment displays will be connected to the output of the PIC to display the number of parking bays available. For software application, PIC18 Simulator IDE can be used to simulate the C Program. The 7-segment display will display the maximum of 100 parking bays available or it will display as full if there is no more available parking space.

For flood monitoring system, we will be using infrared sensor to detect the water level. We will be using comparator to compare the voltage and thus stabilizes the output of the infrared sensor. This output will be fed into input of Programmable Logic Controller (PLC). The Programmable Logic Controller will need to be programmed using CX Programmer. Ladder diagram need to be drawn to provide sequential logic to sound the alarm to the authorities and to operate the control valve at certain water level.

Major equipment required:

Table 1: Tools Required

Hardware	Software
PIC 18F452 microcontroller	PIC C Compiler
7-Segment Display	PIC18 Simulator IDE
Infrared Sensor	Warp 13
Programmable Logic Controller (PLC)	Automation Studio
Control Valve	CX Programmer

CHAPTER 4
RESULTS AND FINDINGS

4.1 Overview of the System

In this project, there will be 2 levels of parking bays which is the ground level and underground level. When the car enters the car park through the ground level, the infrared sensors detects it and the input will be processed by the microprocessor to perform arithmetic operations. Then, the output which is the number of parking bays available will be displayed to the users inside and outside alike. Similarly, when the user exits the car park at the ground level, the sensor will detect it and the 7-segment displays will be updated as well. The same goes to the sensors at the underground level where the same principle is applied. This system may be used in multiple levels of car park, however in this project, we will only show 2 levels which are ground level and underground level. The flow chart of the process is described in Figure 2.

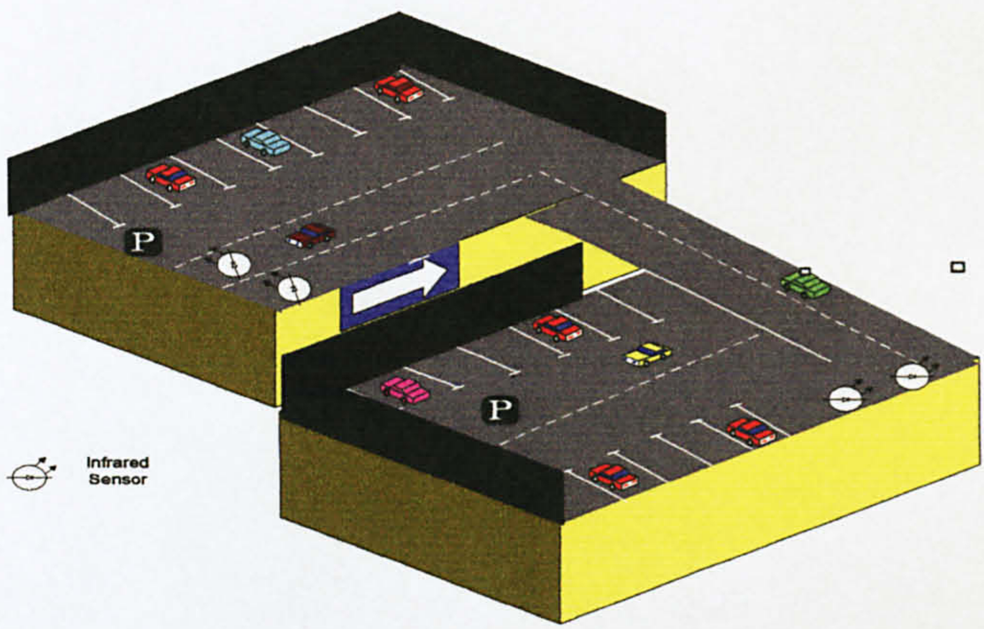

Figure 2: Overview of the system

4.2 Flow Chart of the Vehicle Counter Monitoring System

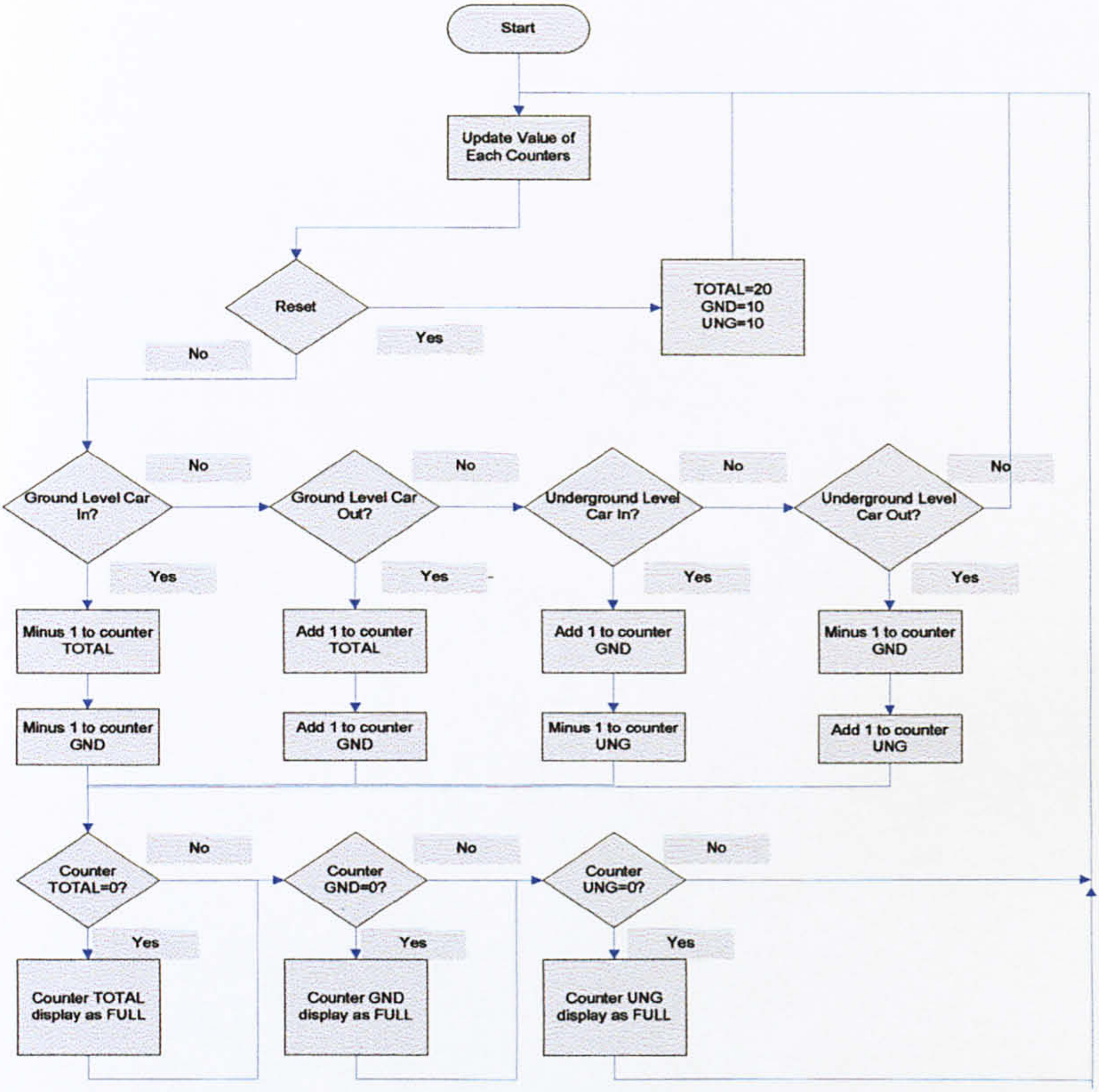

Figure 3: Flow chart of vehicle counter monitoring system

4.3 Flow Chart of the Flood Monitoring System

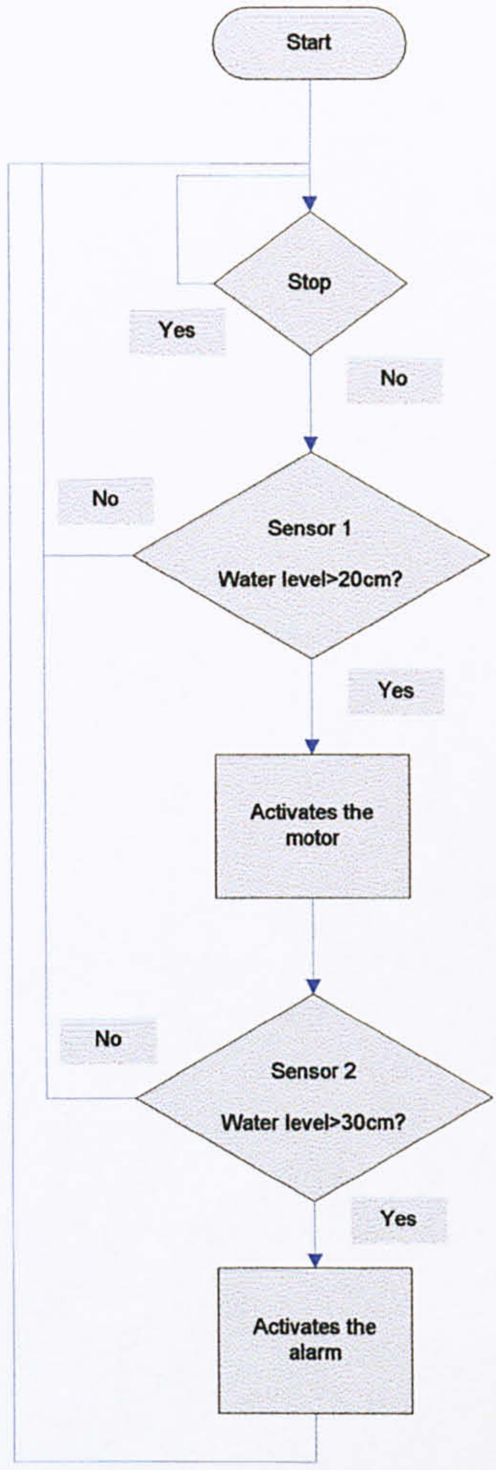

Figure 4: Flow chart of flood monitoring system

4.4 Work Done

4.4.1 Circuit Design for Infrared Sensor (for both modules)

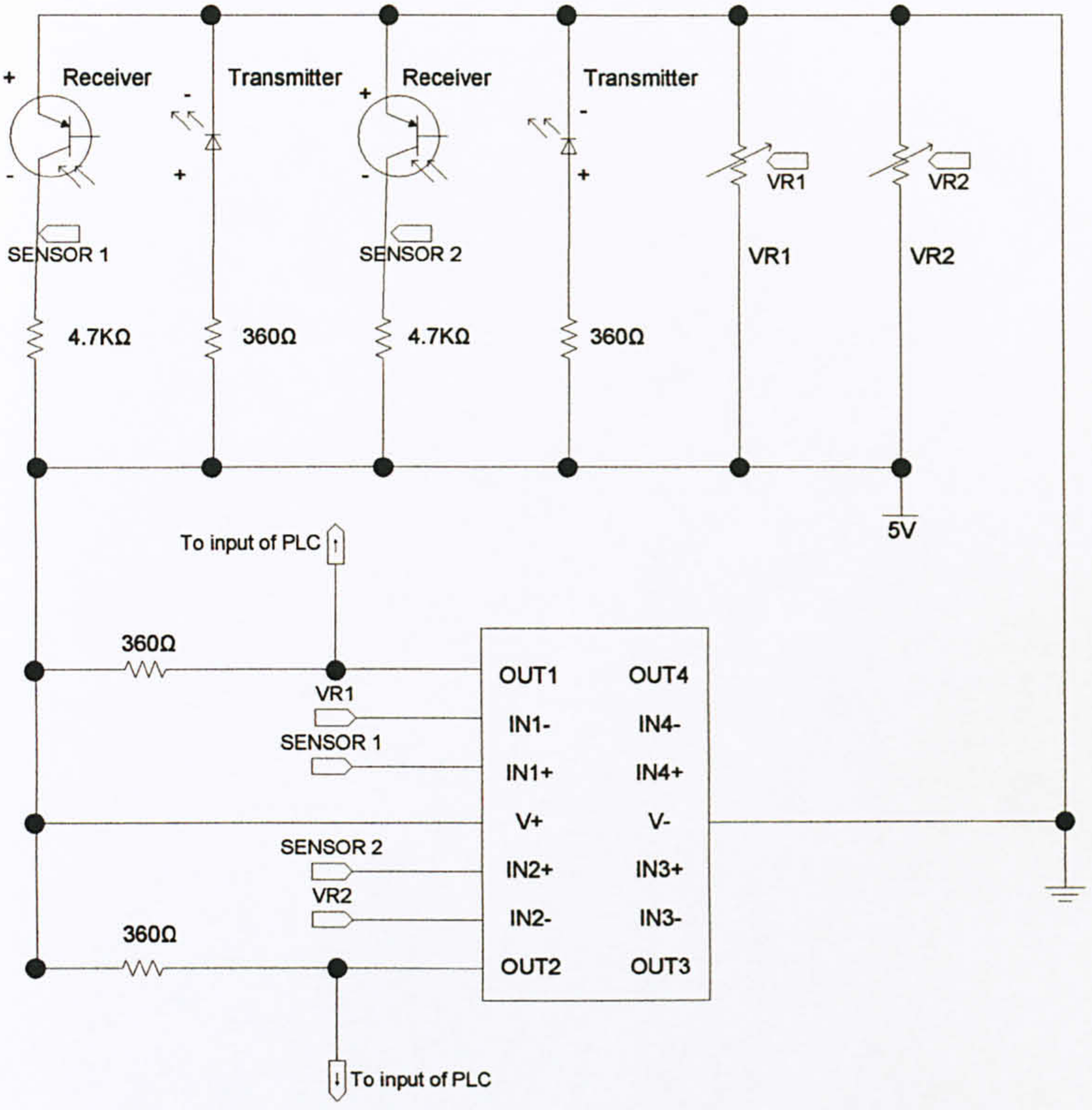

Figure 5: Circuit Design For Infrared Sensor

4.4.2 Circuit Design for PLC

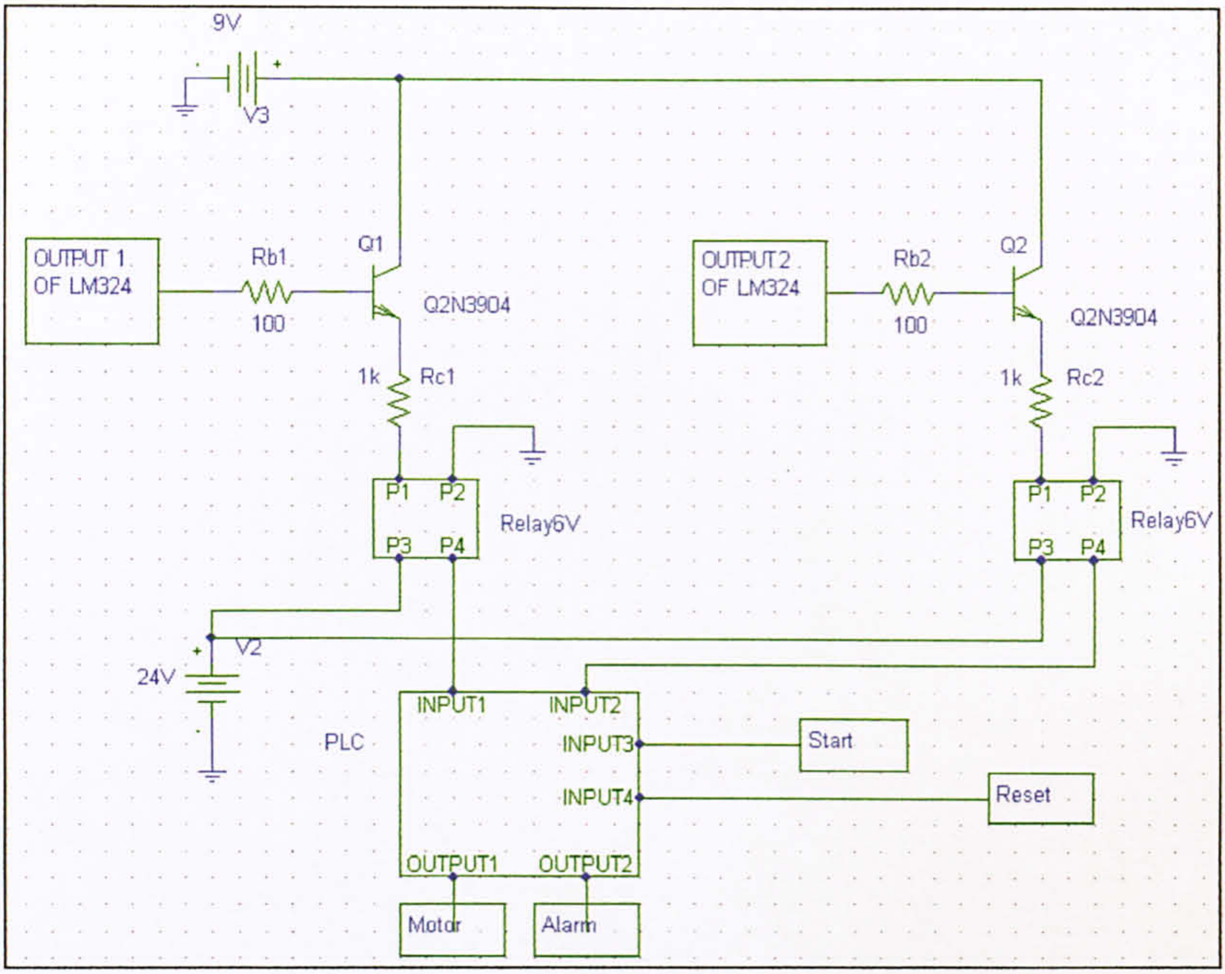

Figure 6: Circuit Design for PLC

4.4.3 Ladder Diagram

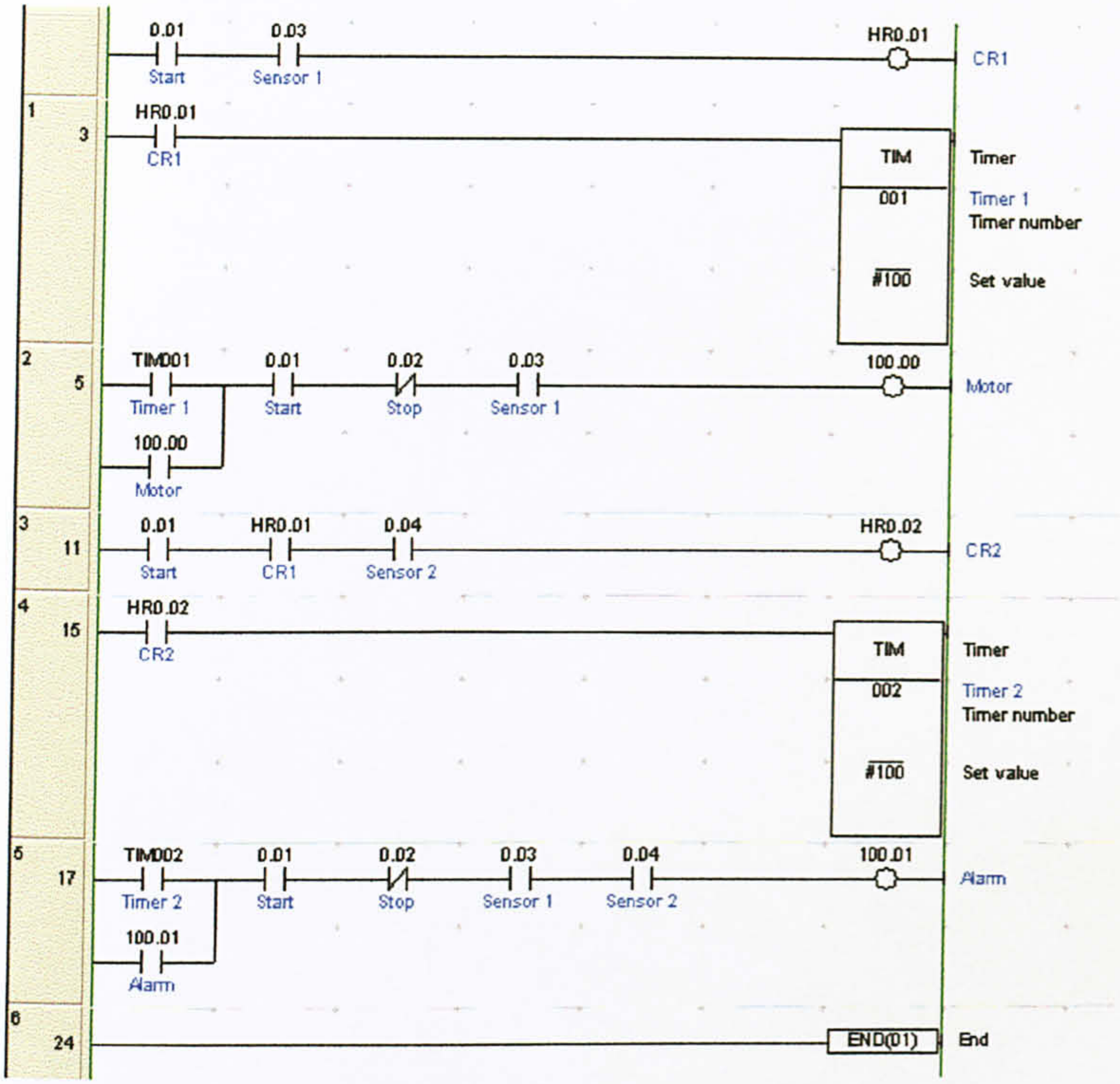

Figure 7: Ladder Diagram (Flood Monitoring System)

4.4.4 *Circuit Design for PIC 18F458*

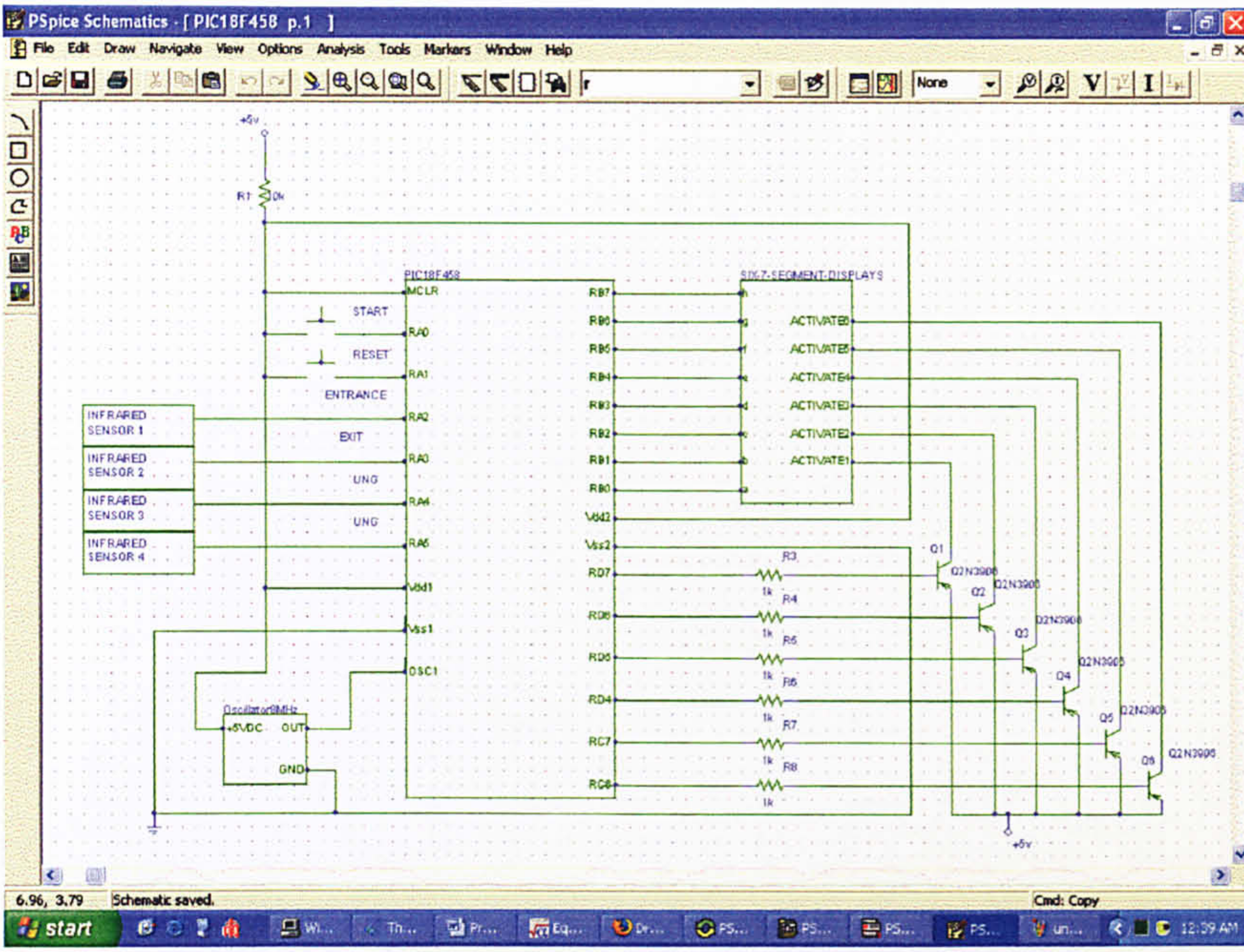

Figure 8: Circuit design for PIC 18F458 and 7-segment displays

4.4.5 Calculations

Based on Figure 5, the input voltage is 5V. However, in practical applications, 9V battery is being supplied and a voltage regulator is used to step down the voltage to 5V. The output voltage of the LM324 comparator is:

$$\text{Vout} = \text{V x sgn } (V_{+} - V_{-})$$

It will compare voltage at infrared sensor with the input voltage of 5 V. The output of comparator will be in either 0V or 5V. It is fed into the input of PLC through a 24V relay. For example input voltage is 5V while output sensor is 3V therefore the equation becomes

$$V_{out} = 5 \times \text{sgn}(5-3)$$

$$V_{out} = 5 \times \text{sgn}(+2)$$

$$V_{out} = 5 \times \text{sgn}(+)$$

$$V_{out} = 5V$$

The sensing circuit consists of 2 main parts i.e. transmitter & receiver and variable resistor. From Figure 5, we put a 4.7kΩ resistor on the receiver side so that we can limit the current which flows through the infrared sensor. If the transmitter and receiver circuit is complete, the theoretical current which flows through the transmitter is

$$Current_{Tx} = 5V \div (4.7k\Omega + 360\Omega) = 0.988mA$$

For the variable resistor, the practical resistance to put is 10kΩ, however resistance such as 1kΩ still can be used. Therefore the theoretical current which flows through the variable resistor assuming we are using the 10kΩ resistor is

$$Current_{Tx} = 5V \div 10k\Omega = 0.5mA$$

As for the voltage of VR1, it will always stand at 5V. Based on Figure 5, the voltage of VR1 will compare voltage from SENSOR 1. The output voltage OUT1 will be high if there is a difference of voltage. The output OUT1 will be fed into PLC where we will use relay to step up the voltage from 5V to 24V. The results of these calculations will be discussed later in the section.

Based on Figure 8, we put a 10kΩ resistor on the MCLR side to prevent overcurrent on that particular pin. Theoretically, the current going through the pin number 1 which is the MCLR pin is

$$Current = 5V \div 10k\Omega = 0.5mA$$

The purpose of putting a resistor on the MCLR side is to limit the current through the pin so that the circuit will only be reset when necessary i.e. using a switch. On the 7-segment display side, 2kΩ resistor is placed at the base of the transistor 2N3906. The purpose of the resistor is again to limit the current at the base which is

$$Current, I_b = 5V \div 2k\Omega = 2.5mA$$

Depending on the transistor used, the gain of the transistor is set to 100 for convenience as the formula for transistor implies which is

$$I_c = KI_b$$

where K is the gain of the transistor

I_c is the collector's current

I_b is the base current.

Theoretically, the collector's current will be

$$Current, I_c = 100 \times 2.5mA = 0.25A$$

This value is enough to power up each 7-segment display for activation and deactivation which will be discussed later in the section on the multiplexing technique.

4.4.6 C Program for Counter

The C Program for the vehicle counter monitoring system is almost complete as shown in Appendix C. The program basically includes the header file for PIC 18F458. The header defines the address and the basic function of the PIC. After that we need to define the FUSES category for example no brownout voltage, in this case, it is NOBROWNOUT. A delay is also set so that the results of the simulation can be seen clearly. The inputs are of the PIC are also defined like Port A and Port B. The example in the program is set_tris_a(1), which means Port A is the input as the value is 1 while set_tris_b(0) means setting Port B as output. The same case applies for Port C. Some fixed values like TOTAL=20 and UNG=10 are defined first. Next, the main program functions as a counter as described in Appendix C. The infrared sensor will provide the input i.e. the cars entering and exiting the car park and feed into the input of PIC which is PINA0.

The circuit design for the PIC18F458 is shown is Figure 8, only the connected pins are shown in this diagram. The output will be RB0, RB1, RB2, RB3, RB4, RB5, RB6, RB7, RC6, RC7, RD6, RD7. The inputs are shown as MLCR, RA0, RA1, RA2, RA3, RA4, and RA5. MLCR is the master clear while RA0 indicates the start button. RA1 is the button to reset the parking bays into TOTAL=20 and UNG=10, GND=10. One such example of displaying the six 7-segment displays for total, ground and underground level is described in Figure 9.

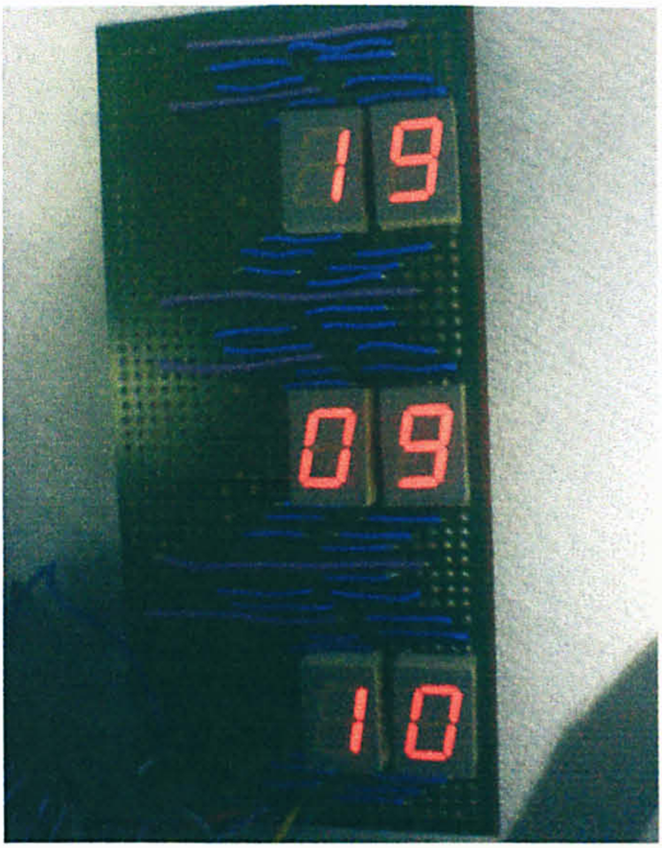

Figure 9: Six 7-segment displays utilizing multiplexing technique

4.4.7 *Prototype Construction*

The prototype model is as shown in Figure 10, 11, 12, 13, 14 and 15. The pairs of infrared sensors are aligned in a straight line so that it can detect the incoming and outgoing cars and PIC microcontroller will do the computation. Also, for the flood sensor, the tube is used to simulate the flood on the whole car park. Instead of flooding the whole car park, we flood the tube to simulate the real flood conditions and the infrared sensors will detect it and activate the motors and high intensity light as shown in the figures mentioned above.

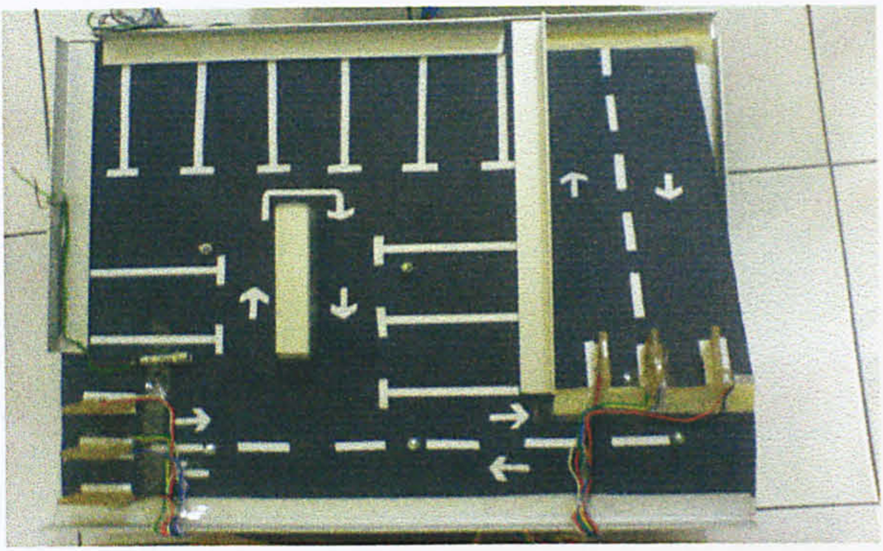

Figure 10: Top View of the Prototype

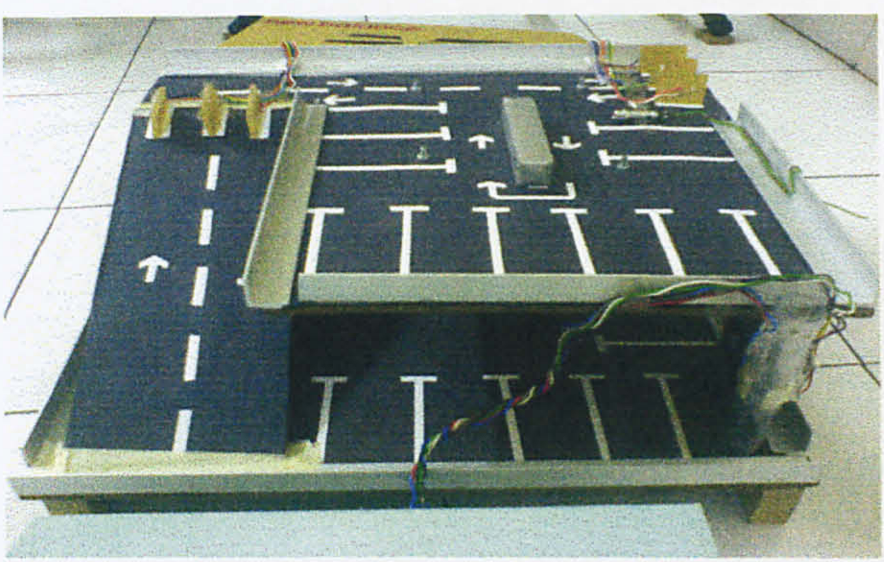

Figure 11: Side View 1 of the Prototype

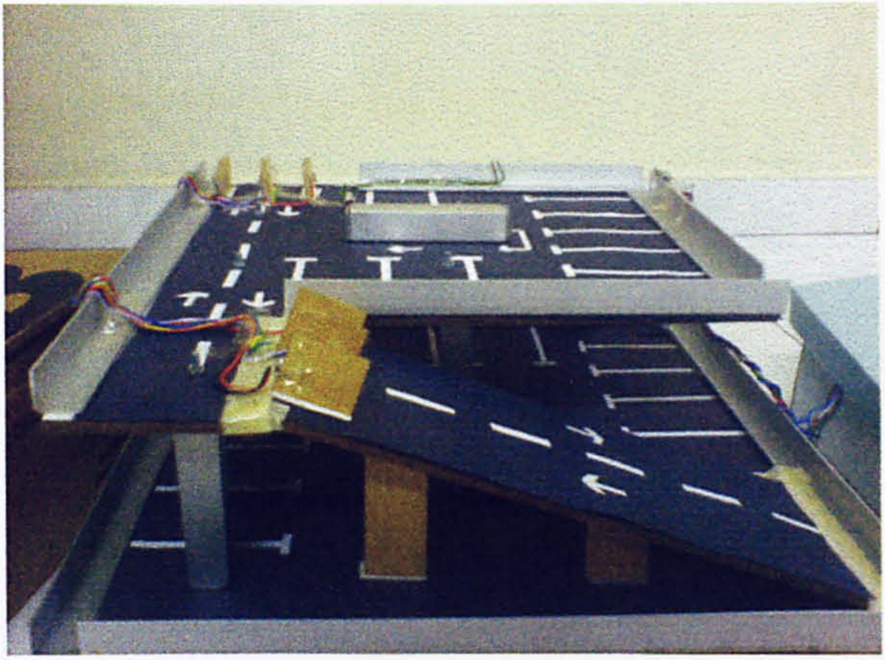

Figure 12: Side View 2 of the Prototype

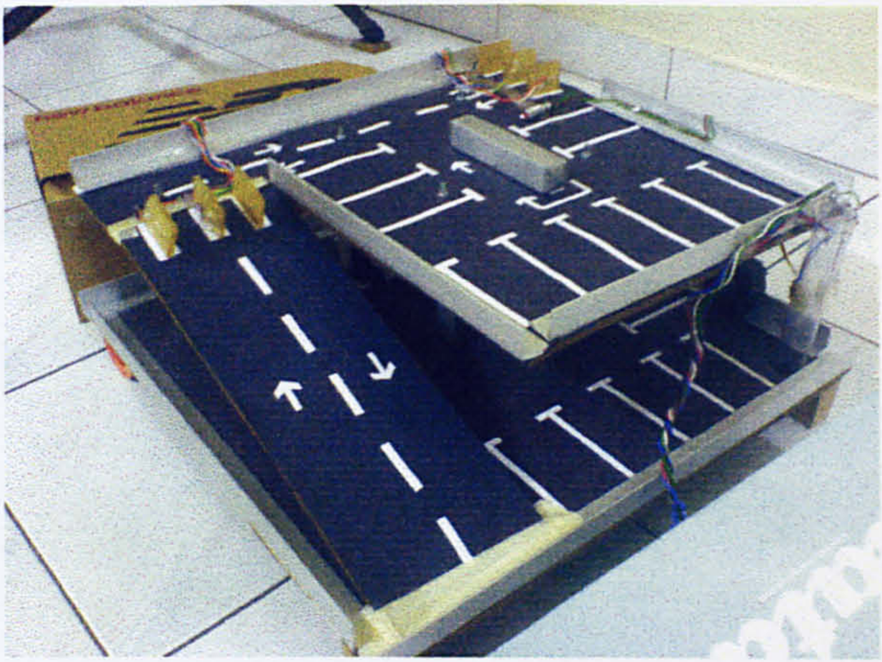

Figure 13: Side View 3 of the Prototype

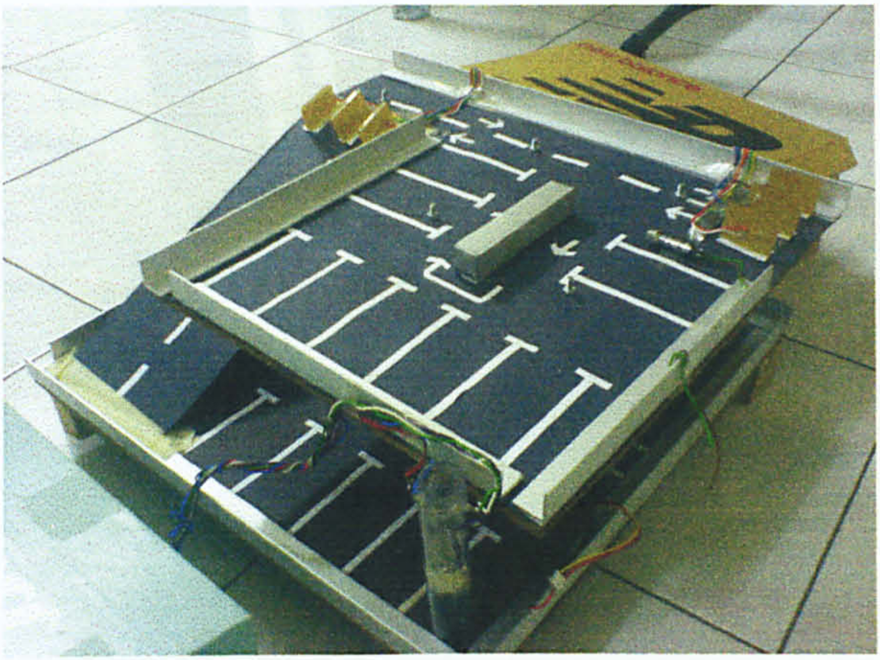

Figure 14: Side View 4 of the Prototype

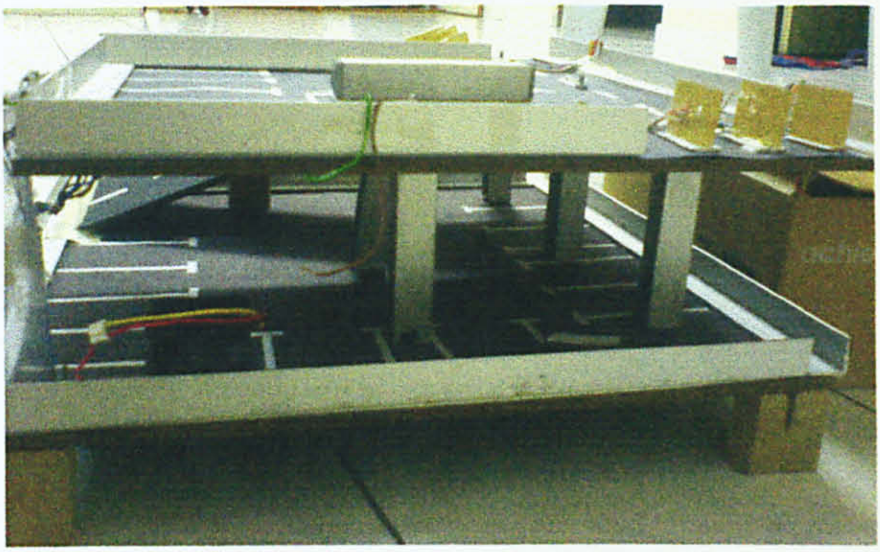

Figure 15: Side View 5 of the Prototype

4.5 Discussion

4.5.1 Discussion of Results

For circuit design discussed in 4.4.1, when the infrared receiver receives infrared signal, it will generate voltage at its pin. The basic operation of this infrared sensor is that when the infrared receives the signal, certain voltage will be generated. If the infrared sensor does not receive the signal, it will become open circuit and will not generate any voltage output. The intensity of the infrared received will determine the generated output voltage, which is from 0V to 5V. As our output voltage here will be fed into Programmable Logic Controller (PLC), it must have a discrete voltage rather than an analog voltage i.e. 2V or 3V for the PLC to have stable input. To do that, the comparator is used. The comparator (LM324) will compare the output voltage from the infrared receiver with the input voltage through a variable resistor. In other words, the output voltage after comparing is either 0V or 5V, where it can connect to the PLC to perform the next action. Although the diagram shown in Figure 4.2 has only 2 inputs of infrared sensor, the system could be expanded into 4 inputs as there are still room for another 2 sensors i.e. output 3 and output 4. The circuit could be expanded for this project for more sensors for wider coverage to sense flood of different areas in the underground car park.

From the output of LM 324, a transistor Q3904 was used in order to step up the current. Relay 6V acts as a switch to connect the circuit to PLC from the source of 24V. We also know that the input of PLC must be 24V in order to function perfectly. The relay 6V will need to be energized by more current instead of 2.5mA as stated in the calculations section. After stepping up current, relay 6V is energized and therefore the source of 24V flows directly to the PLC and hence the PLC will read it as a high input.

For ladder diagram discussed in 4.4.2, it is a logic diagram to be programmed into PLC so that the PLC would perform the actions under certain input conditions. The output of the circuit of infrared sensor discussed in 4.4.1 will be fed into the PLC to perform sequential logic. In this case, it is a simple ladder diagram. This ladder diagram consists of 6 rungs, where the first rung is to initiate the contact relay CR1 in case the water level reaches certain height. Then, it will wait for 10 seconds before it rescan the water level again. If the sensor still detects water at this same level, it will activate the motor to divert the motor flow. The purpose of waiting for 10 seconds is that to ensure that the infrared sensor do not detect something abruptly and simply activating the motor, hence enhancing reliability and saving cost for activating the motor. For the last 3 rungs, they are meant for dangerous flood. When the water level reaches dangerous level, the CR2 will be energized and therefore activating the alarm to warn the users to evacuate their cars. Therefore, property losses can be minimized this way.

As for the C Program for the PIC18F458, the initial settings are done in such a way that fits the project. Based on Appendix C, the program indicates a function where the input A0 and A1 is the sensor which is based on the entrance and exit of the car park. The input A2 and A3 is the sensor installed at the underground level so that it can update the number of parking bays both in ground level and underground level. MCLR is used in this case to reset the number of parking bays to its original value i.e. TOTAL=20, GND=10 and UNG=10. Also, when one of the levels is full, say the underground level is full, the UNG display will display as FULL to notify the users from entering the underground level as they will not find any parking bays at the underground level. Another situation is that if the whole car park is full, all 3 displays will display as FULL to notify the users so that they will not enter the car park anymore as they cannot find any parking. However, if cars are leaving the car park from now on, the displays will update and the current available parking bays will be displayed to the users again.

In the C-program in Appendix C, we can see the multiplexing technique being used. As this program is meant for six 7-segment displays, we utilize the activation pins of the 7-segment displays to gradually rotate the activation of the displays. The delay set would be so fast that the human eye will not be able to see the rotation which is going on, instead, we will see as if the six 7-segment displays are switched ON at the same time. Also, in order to get the digit that we want, we separate the figures from each display by using variables such as x and y. For example, if we want to display 13, we divide the figure by 10, which we will get 1.3. Since in C program, we defined x as an integer, it will only display as 1. Next, we use the actual TOTAL value to minus the integer x multiplied by 10, which means for y, we will get 3. This multiplexing technique enables us to reduce pins. Conventionally, we will need to utilize 8 pins for outputs for each 7-segment displays, which means 8 multiplied by 6 which is 48pins .With the multiplexing technique, we only utilized 8 pins for output and 6 pins for control or activation, which means we only have 8 + 6 =14 pins rather than 48 pins.

4.5.2 Cost Consideration

We need to consider the cost of actual system. The approximated costs of each unit and the total cost are displayed in Table 2. For 7-segment display, we need to consider the bigger dimensions as it can increase the visibility of the 7-segment displays to the users. The approximated total cost is around RM4,438.00. Compared to other methods of detecting car park such as sensor on each bay basis, it would costs a lot just to purchase the sensor, not to mention the installation, wiring and maintenance cost. If some modifications to the circuit are done, the total costs should only vary slightly as the main costs of the equipment had already been taken into account.

Table 2: Costs of Equipment

No.	Items	Unit price (RM)	Quantity	Costs (RM)
1	PLC Model CQM1H	2,100.00	1	2,100.00
2	PIC 18F458 Microcontroller	50.00	1	50.00
3	Infrared sensor	20.00	8	160.00
4	6.5" 7-segment display	66.00	8	528.00
5	DC Motor (Parallel Shaft)	500.00	2	1,000.00
6	Miscellaneous items i.e. Resistors, Oscillators, Relays, LM324 etc.	600.00	1	600.00
Total Costs				4,438.00

For shopping complexes and large scale car park and offices,

Assuming 1,500 parking bays. It will have around 6 levels of parking bays.
Each car parks for 3 hours per day on average.
Assuming the charge of parking for 1 hour is RM2.00.

<u>Assumption made:</u>
Civil Construction Costs (5 levels) = RM 1,200,000
Equipment Cost = RM 15,000
Installation Cost = RM 3,000

RM6.00 x 1500 bays x 75% full = 9,000x 0.75=RM6,750 per day
RM6,750 per day x 30 days = RM 202,500 per month

Monthly maintenance cost on average =
maintenance on sensor + maintenance on motor + miscellaneous cleaning and admin cost
RM 150 + RM 300 + RM 32,000

Income=RM202,500 per month
Expenses = RM 32,450 per month

Estimated profit = RM 170,050 per month

To be able to break even on the costs spent earlier on civil construction as well as equipment cost, the number of years needed is

Number of years to break even = (1,200,000 + 15,000 + 3,000) / (170,050)
= 7.16 years

After 7.16 years, the car park will be able to cover the cost of construction and garner around RM170,050 per month in net profit. It is shown in the graph in Figure 8.

Using similar analysis method, a graph of estimated profit and number of years to break even were made to incorporate all major car parks. Note that the existing system is based on the usage of basic sensor-per-bay basis. The maintenance cost for each sensor is taken into account and the graph is plotted. One graph is of the estimated profit in thousands for each month which is described in Figure 12 while the other graph is the number of years to break even the cost which is described in Figure 13.

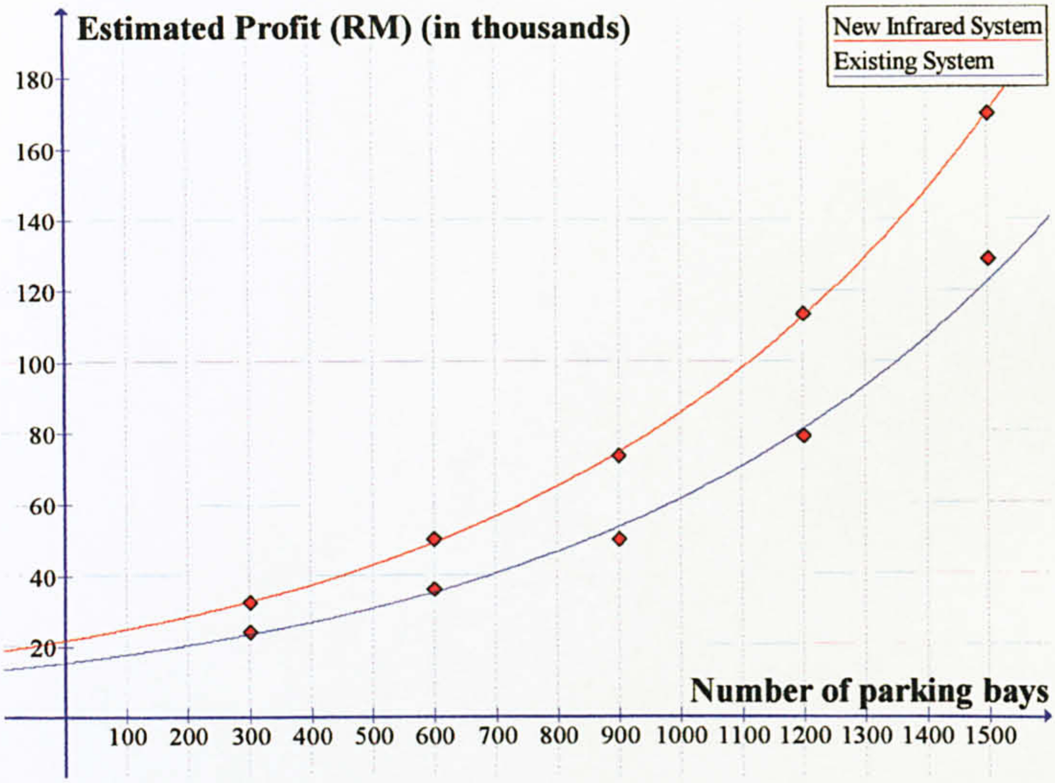

Figure 16: Estimated profit

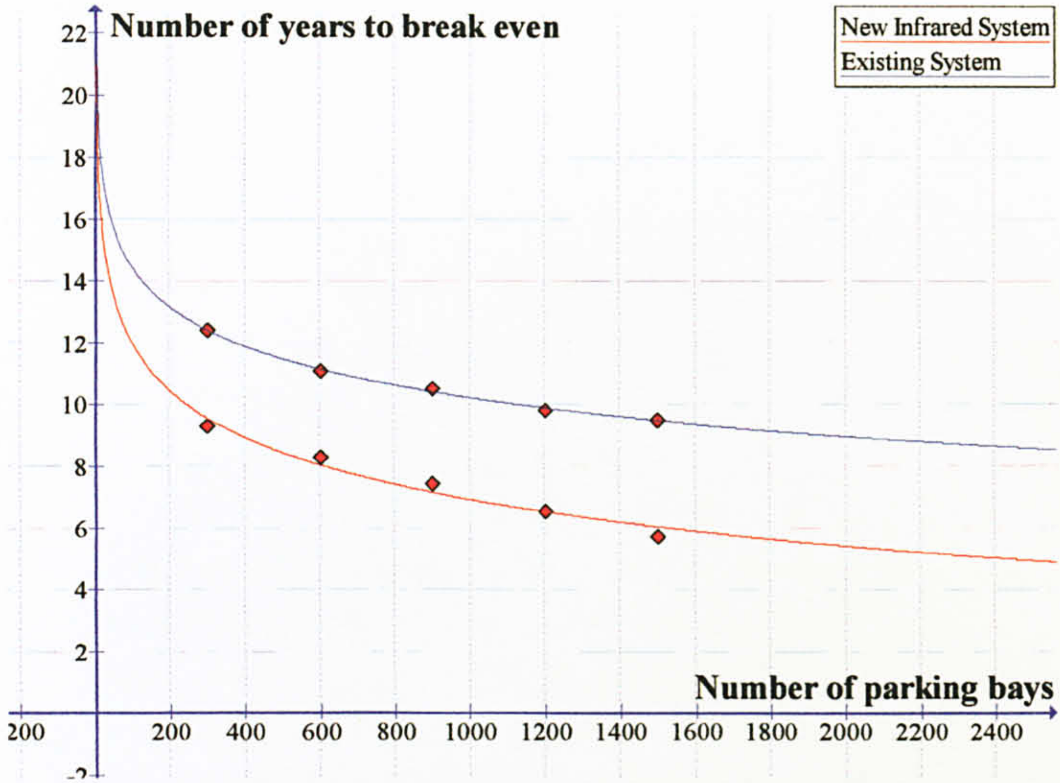

Figure 17: Number of years to break even

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Surveillance System For Underground Car Park Monitoring is an automated system which has vehicles counter monitoring system and flood monitoring system. With this system, we can keep track with the number of cars which is inside the car park, and then display it in the 7-segment display for the convenience of the users. Also, we could monitor the flood level in the car park by sensing the water level. If the water level reaches certain height, it will activate motor to divert the water flow. For dangerous level, it will activate the alarm and warn the users to evacuate their cars from the car park. The mentioned system would be more economical than other existing products in the market, which is the objective of the project.

5.2 Recommendation

This system can be improved or expanded by incorporating other applications like detecting the illegal parking in the car park. Sensors could be installed in certain key areas such as the slope of the car park entering the underground or perhaps a VIP parking bay. Besides, we could consider putting temperature sensors in the car park. If the temperature is high, there might be a possibility where fire would occur in the car park. Therefore, the people would need to be warned. The current system has a great room of expansion for the PLC. In order to make the system cost-effective, the output of the PLC could be fully utilized to fit other applications such as the above-mentioned systems of an underground car park.

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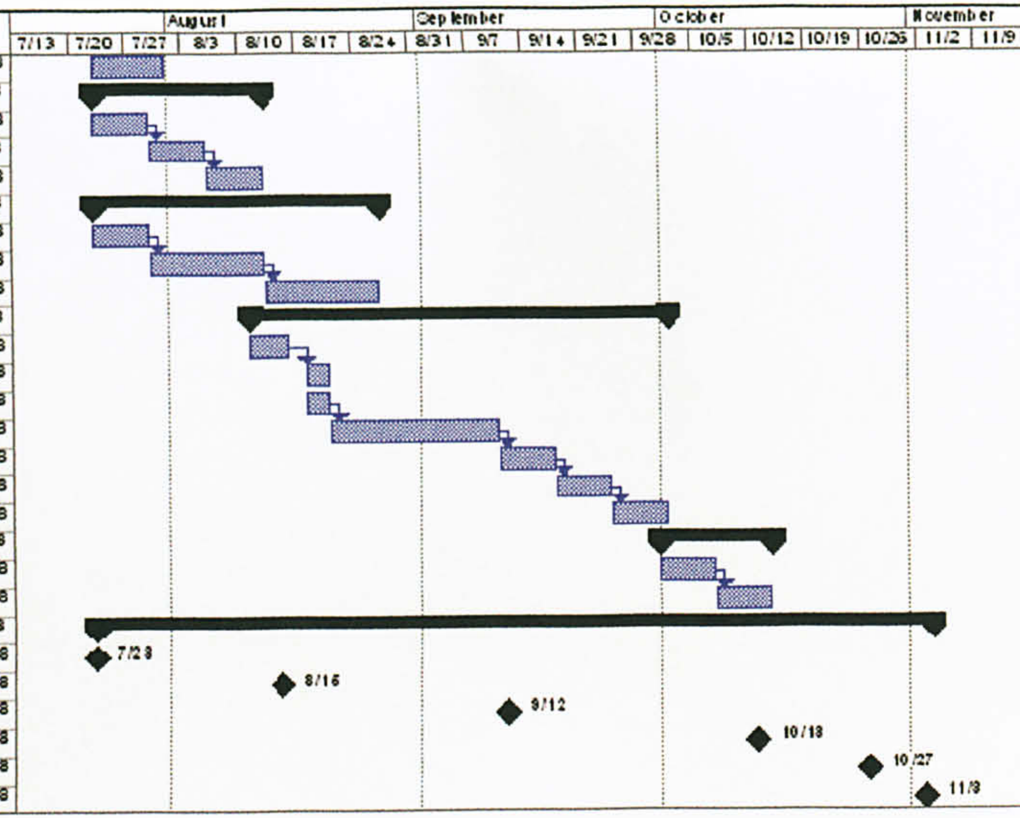
APPENDICES

APPENDIX A

GANTT CHART FOR FYP 1

JULY 2008 SEMESTER

ID		Task Name	Duration	Start	Finish
1		Selection of Project Topic	7 days	Wed 7/23/08	Thu 7/31/08
2		Preliminary Design Stage	15 days	Wed 7/23/08	Tue 8/12/08
3		Problem Identification	1 wk	Wed 7/23/08	Tue 7/29/08
4		Objectives and Scope of W	1 wk	Wed 7/30/08	Tue 8/5/08
5		Project Planning	1 wk	Wed 8/6/08	Tue 8/12/08
6		Literature Review and Resear	25 days	Wed 7/23/08	Tue 8/26/08
7		Product Survey	1 wk	Wed 7/23/08	Tue 7/29/08
8		Design Concept	2 wks	Wed 7/30/08	Tue 8/12/08
9		Theory of System	2 wks	Wed 8/13/08	Tue 8/26/08
10		Design of System	38 days	Mon 8/11/08	Wed 10/1/08
11		Design Criteria	5 days	Mon 8/11/08	Fri 8/15/08
12		Design Specifications	3 days	Mon 8/18/08	Wed 8/20/08
13		Design Constraints	3 days	Mon 8/18/08	Wed 8/20/08
14		Programming	3 wks	Thu 8/21/08	Wed 9/10/08
15		Schematic Diagram	1 wk	Thu 9/11/08	Wed 9/17/08
16		Circuit Design	5 days	Thu 9/18/08	Wed 9/24/08
17		Calculation	5 days	Thu 9/25/08	Wed 10/1/08
18		Testing and Simulation	10 days	Wed 10/1/08	Tue 10/14/08
19		Project Simulation	1 wk	Wed 10/1/08	Tue 10/7/08
20		Simulation and Testing Ana	1 wk	Wed 10/8/08	Tue 10/14/08
21		Project Documentation	74 days	Wed 7/23/08	Mon 11/3/08
22		Topic Selection	1 day	Wed 7/23/08	Wed 7/23/08
23		Preliminary Report	1 day	Fri 8/15/08	Fri 8/15/08
24		Progress Report	1 day	Fri 9/12/08	Fri 9/12/08
25		Draft Report	1 day	Mon 10/13/08	Mon 10/13/08
26		Interim Report	1 day	Mon 10/27/08	Mon 10/27/08
27		Oral Presentation	1 day	Mon 11/3/08	Mon 11/3/08

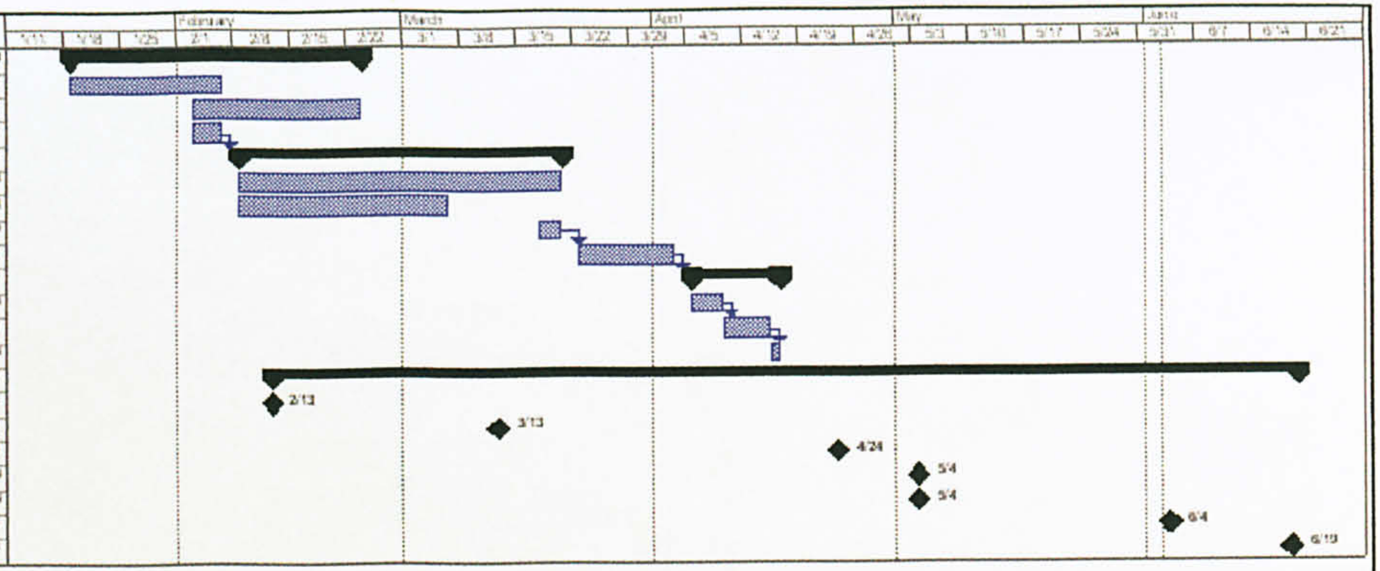


Project: Surveillance System For Underground Car Park Monitoring
Date: 16 August 2008

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

APPENDIX B
GANTT CHART FOR FYP 2
JAN 2009 SEMESTER

ID		Task Name	Start
1		**Design Work**	**Mon 1/19/09**
2		Design Specifications	Mon 1/19/09
3		Design Details	Tue 2/3/09
4		Cost Analysis	Tue 2/3/09
5		**Programming**	**Mon 2/9/09**
6		PIC program	Mon 2/9/09
7		PLC program	Mon 2/9/09
8		Testing and Simulation	Wed 3/18/09
9		Circuit Construction	Mon 3/23/09
10		**Prototype Construction**	**Mon 4/6/09**
11		Assembly	Mon 4/6/09
12		Arrangement	Fri 4/10/09
13		Testing	Thu 4/16/09
14		**Project Documentation**	**Fri 2/13/09**
15		Progress Report I	Fri 2/13/09
16		Progress Report II	Fri 3/13/09
17		Draft Report	Fri 4/24/09
18		Final Report (soft cover)	Mon 5/4/09
19		Technical Report	Mon 5/4/09
20		Oral Presentation	Thu 6/4/09
21		Final Report (hard cover)	Fri 6/19/09



Project: Surveillance System For Units
Date: 02-02-09

Task	Progress	Summary	External Tasks	Deadline
Split	Milestone	Project Summary	External Milestone	

APPENDIX C

C PROGRAM FOR VEHICLE COUNTER MONITORING SYSTEM

```
#include <18F458.h>
#fuses HS,NOPROTECT,NOOSCSEN,NOBROWNOUT,NOWDT,NOPUT,NOCPD,NOSTVREN,NODEBUG
#fuses NOLVP,NOWRT,NOWRTD,NOWRTB,NOCPB,NOWRTC,NOEBTR,NOEBTRB
#use delay(clock=8000000)

void display_segs(char c, int full)      //six 7-segment testing stages
{
if (c==9)                   //display characters 0-9
output_b(111);

if (c==8)
output_b(127);

if (c==7)
output_b(7);

if (c==6)
output_b(125);

if (c==5)
output_b(109);

if (c==4)
output_b(102);

if (c==3)
output_b(79);

if (c==2)
output_b(91);

if (c==1)
output_b(6);

if (c==0)
output_b(63);

if (full==0)            //display 'F' which represents full
output_b(113);
}


void display( int one, int two, int three, int four, int five, int six, int UNG, int GND, int TOTAL)         // multiplexing 7-segment
displays
{
  display_segs(one,TOTAL);
```

```
output_low(PIN_D7);
delay_ms(1);
output_high(PIN_D7);
display_segs(two,TOTAL);
output_low(PIN_D6);
delay_ms(1);
output_high(PIN_D6);
display_segs(three,GND);
output_low(PIN_D5);
delay_ms(1);
output_high(PIN_D5);
display_segs(four,GND);
output_low(PIN_D4);
delay_ms(1);
output_high(PIN_D4);
display_segs(five,UNG);
output_low(PIN_C7);
delay_ms(1);
output_high(PIN_C7);
display_segs(six,UNG);
output_low(PIN_C6);
delay_ms(1);
output_high(PIN_C6);

}


void main () {

unsigned int TOTAL = 20;
unsigned int GND = 10;
unsigned int UNG = 10;
int i,x,y,p,q,g,h;

display(0,2,0,1,0,1,UNG,GND,TOTAL);

while (1){                    //main program

x=TOTAL/10;
y=TOTAL-10*x;
p=GND/10;
q=GND-10*p;
g=UNG/10;
h=UNG-10*g;

if (input(PIN_A0)==1)            //if a vehicle enters car park at the entrance
{
```

```
TOTAL=TOTAL-1;
GND=GND-1;
x=TOTAL/10;
y=TOTAL-10*x;
p=GND/10;
q=GND-10*p;
g=UNG/10;
h=UNG-10*g;

for (i=1;i<200;i++)
display(y,x,q,p,g,h,UNG,GND,TOTAL);

while (input(PIN_A0)==1)
display(y,x,q,p,g,h,UNG,GND,TOTAL);
}


if (input(PIN_A1)==1)          //if a vehicle exits car park at the entrance
{
TOTAL=TOTAL+1;
GND=GND+1;
x=TOTAL/10;
y=TOTAL-10*x;
p=GND/10;
q=GND-10*p;
g=UNG/10;
h=UNG-10*g;

for (i=1;i<200;i++)
display(y,x,q,p,g,h,UNG,GND,TOTAL);

while (input(PIN_A1)==1)
display(y,x,q,p,g,h,UNG,GND,TOTAL);
}

if (input(PIN_A2)==1)          //if a vehicle enters underground level inside the car park
{
UNG=UNG-1;
GND=GND+1;
x=TOTAL/10;                    //separation of variables to get the corresponding digit to be displayed
y=TOTAL-10*x;                   //x,y correspond to TOTAL, p,q correspond to GND, g,h correspond to UNG
p=GND/10;
q=GND-10*p;
g=UNG/10;
h=UNG-10*g;

for (i=1;i<200;i++)
```

```
display(y,x,q,p,g,h,UNG,GND,TOTAL);

while (input(PIN_A2)==1)
display(y,x,q,p,g,h,UNG,GND,TOTAL);
}

if (input(PIN_A3)==1)           //if a vehicle exits underground level inside the car park
{
UNG=UNG+1;
GND=GND-1;
x=TOTAL/10;                     //separation of variables to get the corresponding digit to be displayed
y=TOTAL-10*x;                    //x,y correspond to TOTAL, p,q correspond to GND, g,h correspond to UNG
p=GND/10;
q=GND-10*p;
g=UNG/10;
h=UNG-10*g;

for (i=1;i<200;i++)
display(y,x,q,p,g,h,UNG,GND,TOTAL);

while (input(PIN_A3)==1)
display(y,x,q,p,g,h,UNG,GND,TOTAL);
}


display(y,x,q,p,g,h,UNG,GND,TOTAL);
}
}
```