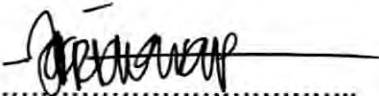


DECLARATION

"I hereby declare that I have read this report and my opinion, it is suitable in terms of scope and quality for the purpose of awarding a Bachelor Degree Of Electronic Engineering (Industrial Electronic)."

Signature : 
Supervisor : ZAHARIAH BT MANAP
Date : 1 April 2005

DECLARATION

“I hereby declare that this report entitled
Designing A Traffic Light Controller Using PIC 16F877
is the result of my own research and idea except for works that I have been clearly
cited in the references.”

Signature : 

Name : ZAIMI BIN AHMAD

Date : 31 MARCH 2005

To the greatest 'success recorder' in my life with love.....

Father, Mother, Family

And last but never the least, all my friend.

ACKNOWLEDGEMENT

Firstly, I would like to say a prayer to Allah the Almighty for always being there for me.

I would like to extend my utmost appreciation and gratitude to Ms. Zahariah Bt Manap for her patient guidance and encouragement throughout the implementation of this project.

Special thanks to my beloved family and relatives for their encouragement, understanding and support.

Not to forget, my all dear friends for their assistance and support.

Lastly, my heartfelt appreciation goes to all who have directly or indirectly played parts in the completion of this project.

ABSTRACT

The objective of this project is to design a traffic light microcontroller that operates based on the current traffic flow. Traffic flows are classified into three conditions that are low level, medium level, and high level. This condition will be decided when the traffic light is in stop condition (red light). This traffic light controller is used at the intersection that consists of a main road and two side roads where the traffic flow is not constant. This traffic light microcontroller is designed using peripheral interface controller (PIC). A state diagram and a flow chart is built to describe the operation of microcontroller. Then, the program is written using Microcode Studio software equips with PIC Basic Pro Language before it is downloaded into PIC. Before the PIC is assembled onto a printed circuit board (PCB), a simulation is conducted to ensure that the result is same as the expected result. It is also to detect any problem if the microcontroller doesn't work as it should be. The final output of this project is a model of traffic light system that controlled by PIC. The advantage of using PIC microcontroller is it can reduce the cost of controlling the traffic light.

ABSTRAK

Projek ini bertujuan merekacipta suatu pengawal mikro lampu isyarat yang beroperasi berdasarkan aliran trafik semasa. Aliran trafik diklasifikasikan mengikut keadaan 'tahap rendah', 'tahap pertengahan' dan 'tahap tinggi'. Keadaan ini diambil kira semasa lalu lintas berada dalam keadaan berhenti (lampu merah). Kegunaan sistem kawalan lampu isyarat ini adalah pada simpang empat yang mempunyai jalan utama dan jalan sisi yang mempunyai aliran trafik yang tidak menentu. Pengawal mikro lampu isyarat ini direkabentuk menggunakan pengawal antaramuka persisian (PIC). Satu gambarajah keadaan dan carta alir dibina untuk menggambarkan operasi pengawal mikro ini. Setelah itu, aturcara dibangunkan menggunakan perisian *Micro Code Studio* dengan bahasa *PIC Basic Pro* sebelum dimuat turun ke dalam PIC. Sebelum PIC dipasang pada papan litar bercetak, simulasi dijalankan untuk memastikan hasilnya adalah seperti yang dikehendaki. Ia juga penting untuk tujuan mengesan masalah jika pengawal mikro tidak berfungsi seperti yang dikehendaki. Hasil akhir projek ini merupakan satu model sistem lampu isyarat yang dikawal oleh PIC. Penggunaan pengawal mikro PIC dapat mengurangkan kos pengawalan lampu isyarat.

CONTENTS

CHAPTER	TITLE	PAGE
	TITLE PAGE	i
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	CONTENTS	vii
	LIST OF TABLES	x
	LIST OF FIGURES	xi
	NOMENCLATURES	xii
	LIST OF APPENDIXES	xiv
I	INTRODUCTION	
	1.1 Introduction	1
	1.2 Problem Statement	1
	1.3 Objectives	2
	1.4 Scope Of Project	3
	1.5 Project Background	3
	1.6 Methodology	5
	1.7 Overview On Report Structure	5

II LITERATURE REVIEW

2.1	Introduction	7
2.2	Traffic Light System	7
2.3	Traffic Light History	8
2.4	Evolution of Traffic Light	9
2.5	Evolution of Traffic Light Controller	16
2.6	Microcontroller	18
2.6.1	The Advantage of Microcontroller	19
2.6.2	PIC Microcontroller	21
2.6.3	PIC 16F877 Microcontroller	21
2.6.4	Memory	22
2.6.5	Peripherals	25
2.6.6	Power Supply	26
2.6.7	Clock Oscillator	26
2.7	PIC Microcontroller Programming	27
2.7.1	PICBasic Pro Compiler	28
2.7.2	PICBasic Pro Commands	28
2.7.2	Microcode Studio	32

III PROJECT METHODOLOGY

3.1	Introduction	33
3.2	Methodology	35
3.3	Software Development	36
3.3.1	Flow Chart	36
3.3.2	Writing The Programme Code	39
3.4	Hardware Development	40
3.4.1	Circuit Design And Explanation	40
3.4.2	Circuit Testing On The Proto-Board	42
3.4.3	Schematic Diagram and PCB Layout	42
3.5	PCB Fabrication	46
3.6	Soldering Process	47

IV	RESULT	
	4.1 Introduction	48
	4.2 Result	48
	4.3 Project Specification	50
	4.4 Project Analysis	52
	4.4.1 Timing Diagram	52
	4.4.2 LED Timing Table	55
V	DISCUSSION AND CONCLUSION	
	5.1 Introduction	56
	5.2 Suggestion	56
	5.3 Discussion	59
	5.4 Conclusion	60
	REFERENCES	61
	APPENDIX A	62
	APPENDIX B	71
	APPENDIX C	80

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	Some 8-bit microcontrollers and their features	20
4.1	Circuit Specifications	51
4.2	LED Period Timing	55

LIST OF FIGURE

FIGURE	TITLE	PAGE
2.1	Police Controlled Devices	10
2.2	Traffic Tower	11
2.3	First Four way Traffic Signal	12
2.4	First Electric Signal	13
2.5	Modern Traffic Light	14
2.6	LED Traffic Light	15
2.7	Electro-mechanical Controller	16
2.8	PLC Traffic Light Controller	18
2.10	Pin Diagram of PIC16F877/874	22
2.11	Program Memory Map and Stack	24
3.1	Project Methodology Flow Chart	34
3.2	Sensor Implementation In Intersection	35
3.3	Main Loop Flow Chart	37
3.4	Emergency Loop Flow Chart	38
3.5	First Side Road Loop	38
3.6	Second Side Road Loop	39
3.7	Circuit Block Diagram	41
3.8	Schematics Diagram	44
3.9	PCB Layout	45
3.10	Manufacturing Process Chart Of a Single-Sided PCB	46
3.11	Component Layout	47
4.1	Control Circuit For PIC Traffic Light	49
4.2	The Complete Prototype of PIC Traffic Light Controller	50
4.3	Timing Diagram For PIC Traffic Light Controller	54
5.1	Traffic Monitoring And Controlling System	58

NOMENCLATURES

ADC	-	Analog-Digital Converter
Asm	-	Assembly
Bas	-	Basic
CAD	-	Computer-Aided Design
CPU	-	Computer Processing Unit
DC	-	Direct Current
DCS	-	Distributed Computer System
E1	-	Emergency 1
E2	-	Emergency 2
EEPROM	-	Electrical Erasable ROM
G1	-	Green LED 1
G2	-	Green LED 2
G3	-	Green LED 3
G4	-	Green LED 4
GPR	-	General Purpose Register
Hex	-	Hexadecimal
I/O	-	Input/Output
ICD	-	In Circuit Debugging
IDE	-	Integrated Development Environment
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diodes
LSI	-	Large-Scale Integration
MCU	-	Microcontroller Unit
MPU	-	Microprocessor Unit
PBC	-	PIC Basic Code

PBPRO	-	PIC Basic Pro
PCB	-	Printed Circuit Board
PIC	-	Peripheral Interfacing Controller
PLC	-	Programmable Logic Controller
R1	-	Red LED 1
R2	-	Red LED 2
R3	-	Red LED 3
R4	-	Red LED 4
RAM	-	Random Access Memory
ROM	-	Read Only Memory
SFR	-	Special Function Register
UV	-	Ultra Violet
VLSI	-	Very Large-Scale Integration
Y1	-	Yellow LED 1
Y2	-	Yellow LED 2
Y3	-	Yellow LED 3
Y4	-	Yellow LED 4

LIST OF APPENDIX

APPENDIX	TITLE	PAGE
A	PIC16F87X Data Sheet	62
B	LM78XX Data Sheet	71
C	Programming Source Code (BAS, ASM,HEX)	80

CHAPTER I

INTRODUCTION

1.1 Introduction

The conventional traffic light controller does not work efficiently in some situations and may cause congestion at a cross junction. This chapter will discuss the problem with conventional traffic light controller to bring out the causes of why this title is selected for this project. This chapter also will include the objectives, scope of the project, background of the project and methodology to carry out the project. At the end of this chapter, it will view the structure of the overall report.

1.2 Problem Statement

In the conventional traffic light controller, the duration allocated for each junction is at a constant cycle time, which is clearly not the optimal solution. Using this system, traffic light cycle time is fixed without care the traffic flow at the time. For example, when the traffic flow at the main road is in low condition and the traffic flow at the side road is in high condition, the traffic light cycle still in the fixed time.

The green light at the main road usually is set in a long period but the side road usually is set in a short period. It makes the side road being congested and sometimes the vehicles stuck at the centre of the intersection.

The conventional traffic light controller system uses the Programmable Logic Controller (PLC). The problem of PLC is the cost of the controller set is expensive. Its make the traffic light at a one intersection become expensive. Besides, the PLC system needs other component for example, CPU, and I/O card, to support the system. PLC also needs the 24VDC to operate and it makes the electricity cost become expensive [1].

1.3 Objectives

The objectives of this project are;

- a) Study the problem of conventional traffic system
- b) Develop the programme of traffic light microcontroller using PIC Basic Pro
- c) Implement the traffic light microcontroller programme in PIC
- d) Implement the circuit design on circuit board
- e) Solve the conventional traffic light congesting problem
- f) Reduce the traffic light controller cost

1.4 Scope Of Project

The scopes of project study are;

- a) Designing the traffic light controller circuit and programming of the PIC designing
- b) Solving the congestion at the side road. Sensors are implemented in side road to detect the traffic condition. The sensors for this project are replaced by switch.

1.5 Project Background

The idea of traffic light microcontroller design project using PIC is an adaptation from conventional traffic light controller system. Traffic light is an important system to control the traffic flow especially at the junctions. But, we find some problem with the conventional traffic light in some time. Conventional traffic light can't operate efficiently as we discuss before. Because of that problem, idea to develop the new intelligent traffic light with low cost is taking into consideration.

During the reference process, three major sources can be referring to do this project. The first reference is study case, Fuzzy Traffic Light Controller [2]. This study case are discussed about how the mathematic method can be use to solve the inefficiently conventional traffic light. For that, traffic flow condition at all junctions is counted and the time cycles of the traffic light are depends to traffic condition. This study case also compares the performance of conventional traffic light controller, human (traffic police) and automatic traffic light (fuzzy). The idea from

this study case to implement on this project is traffic light controller with automatic function.

Second reference is a paper work, Traffic Sensor Using Image Processing [3]. Suggestions from this paper work are, current traffic light condition is monitored with image processing procedure. Using this method, the traffic light condition can be monitored automatically and the traffic light can be control using “traffic police” procedure. Traffic light time cycle can be set as current traffic condition. To implement this system, more equipment are needed, for example image sensor (camera), computer set to process the image and modem to sent the image and more. With this additional equipment, the cost of this system became more expensive and need to maintenance frequently. But, from this reference, the detail idea of traffic flow monitoring and how to flow the traffic using current condition are discovered

Intelligent Traffic Light Control journal [4], discuss how the sensor can be use for traffic condition detection. Sensors are placed at the road junction for traffic condition detection. Three sensors are placed at one side of road to detect the traffic condition, low, medium or high. These sensors are connected to PLC system. The finite state machines are applied with PLC to operate this system. Using this reference, the function of sensor to detect current traffic condition are studies.

All the concept and idea from the reference are combined to get the idea of automatically traffic light controller using PIC. Three sensor are used each side road to check the traffic condition low, medium or high.

1.6 Methodology

In this project, the microcontroller traffic light system is designed using PIC16F877 microcontroller.

This project is guided with following methodology. The detail explanation for methodology of this project will be discussed in chapter III.

The state diagram is design for expected output, from the controller. After that the flow chart are design to view overall state of system.

The PIC programme is written as in the flow cart. After that, the programme is compiled to find the error before convert it to Hexadecimal format (HEX). Before PIC programme are loaded in PIC microcontroller using PIC burner, the programme are simulated using software to check the programme sequence.

After circuit are designed, the circuit are simulated using simulation software. Using this methodology, the circuit operation will be observed. Circuit failure will be detect and troubleshoot.

1.7 Overview report structure

This report consists of five chapters. Chapter I is the introduction of this project. It discuss the objectives and background of the project.

Chapter II describes the literature review of this project. All theoretical and basic idea for this project is explained in a detail manner.

Methodology of this project will be discussed in chapter III. This chapter consist of the step by step of methodology to complete the project. Figures are used to make the discussion on this chapter clearer.

Chapter IV is project result. The project results such as project analysis and project data will be shown in this chapter.

The end of this report is a chapter V, project conclusion and discussion. This chapter will review the project. Some additional idea will be discuss on this chapter to make the project better than other or to implement the project in the actual field.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter will discuss literature review of this project. The content of literature review is one of the important steps to gather information about the project. Literature review will explore the basic history and evolution of traffic light system, microcontroller review especially PIC 16F877 and PIC programming that is used in this project.

2.2 The Traffic Light System

Traffic light system consists of two parts. First part is traffic light and the second part is controller unit. Traffic light is used to control traffic flow at the busy intersection.

Traffic light objective;

- i) Safe and efficient traffic flow
- ii) Assign right of way to maximize capacity, minimize delay and reduce conflict.

Advantages of traffic light;

- i) Provide orderly movement of traffic.
- ii) Minimize conflicting movement.
- iii) Increase traffic handling capacity.
- iv) Means of interrupting heavy traffic.
- v) Coordinated for continuous movement.
- vi) Provide driver confidence by assigning the right ways.

2.3 Traffic Light History.

Even during the horse and buggy days, traffic in big cities was often heavy. Police officers had to be stationed full time directing traffic at busy intersections.

The world's first traffic light came into being before the automobile was in use, and traffic consisted only of pedestrians, buggies, and wagons. Installed at an intersection in London in 1868, it was a revolving lantern with red and green signals. Red meant stop and green meant caution. The lantern, illuminated by gas, was turned by means of a lever at its base so that the appropriate light faced traffic. On

January 2, 1869, this crude traffic light exploded, injuring the policeman who was operating it.

And with the coming of automobiles, the situation got even worse. Police Officer William Potts of Detroit, Michigan, decided to do something about the problem. What he had in mind was figuring out a way to adapt railroad signals for street use. The railroads were already utilizing automatic controls. But railroad traffic travelled along parallel lines. Street traffic travelled at right angles. Potts used red, amber, and green railroad lights and about thirty-seven dollars worth of wire and electrical controls to make the world's first 4-way three colour traffic light. It was installed in 1920 on the corner of Woodward and Michigan Avenues in Detroit. Within a year, Detroit had installed a total of fifteen of the new automatic lights.

At about the same time, Garrett Morgan of the United States realized the need to control the flow of traffic. A gifted inventor and reportedly the first African American to own an automobile in Cleveland, Ohio, he invented the electric automatic traffic light. Though it looked more like the semaphore signals you see at train crossings today, it provided the concept on which modern four-way traffic lights are based.

2.4 Evolution Of Traffic Light

Early mid-1800's, the railroads in both England and the United State were using lanterns, hung from crossbars, to give railroad men a signal visible by night as well as by day. For the control or direction or street traffic by coloured lights however, England appears to have led the way. Until now, traffic light has much

evolution to improve the availability follow the technology. Below are shown the evolution of traffic light;

a) Police Controlled Devices.

The very first traffic signal in the United State were of the railroad switch stand type that is they were rotated manually by 90 degrees to show the indication STOP or GO. At night very often, a lantern was used at the top to show either red or green display. This method was rather labour intensive because an officer had to be located at every busy intersection in which these were use.



Figure 2.1: Police controlled Devices