TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS i

ABSTRACT ii

TABLE OF CONTENTS iii

LIST OF FIGURES vi

LIST OF TABLES viii

LIST OF SYMBOLS AND ABBREVIATIONS ix

CHAPTER TITLE

1. INTRODUCTION

1.1 Introduction of Adaptive Traffic Signal Control 1

1.2 Statement of the Problem 2

1.3 Introduction to Image Processing 2

1.4 Aim and Objectives 3

1.5 Scope of Thesis 3

1.6 Outlines of Thesis 3

2. LITERATURE REVIEW

2.1. Traffic Light System 5

2.2. Traffic Engineering 6

2.3. Traditional Traffic Light Control System 6

2.4. Adaptive Traffic Control Systems 7 2.4.1. InSync Adaptive Traffic Control System 7

2.5. Webster's Method 8

2.6. Image Processing Methods 8 2.6.1. Analogue Image Processing 9

2.6.2. Digital Image Processing 9

2.7. Types of Images 10

2.7.1. Binary Image 10

2.7.2. Grayscale Image 10

2.7.3. Colour Image 11

2.8. Python Programming Language 11

2.9. OpenCV Library 12

2.10. Threading 13

2.10.1. Thread 13

2.10.2. Thread Control Block 14

2.10.3. Multithreading 14

2.11. Real-Time Object Detection with YOLOv3 15

2.11.1. Darknet 15

2.11.2. YOLOv3 15

2.12. Arduino 16

2.13. ENC28J60 Ethernet Module 17

2.14. Categories of Networks 18

2.14.1. LAN 18

2.14.2. WAN 18

2.14.3. MAN 19

2.15. Network Protocol 19

2.15.1. Transmission Control Protocol (TCP) 19

2.15.2. User Datagram Protocol 19

2.16. Internet Protocol Camera 20

2.17. MySQL Database 21

3. METHODOLGY

3.1. System Overview 22

3.2. Video Live Streaming and Data Collections 23

3.2.1. Background Subtractions technique 23

3.3. Vehicles Detection and Counting with YOLOV3 24

3.3.1. Theory 25

3.3.2. Unified Detection 26

3.4. Webster Method 27

3.4.1. Signal Phases 27

3.4.1.1. Four phases signals 27

3.4.1.2. Passenger car unit (PCU) 29

3.4.2. Vehicle Clearance Interval 30

3.4.3. Minimum Cycle Length 31

3.4.4. Green Splitting 31

3.5. Arduino Nano 32

3.5.1. Arduino Nano Pinout 32

3.6. Shift Register (74HC595) 34

3.7. Seven-segment Display Construction 36

3.8. C945 transistor 37

3.8.1. Cut-off Region 38

3.8.2. Saturation Region 39

3.9. Ethernet Communication with UDP protocol 39

3.9.1. Characteristics of UDP 40

3.10. Power System 40

3.10.1. Solar Charge Controller 41

3.10.2. Buck Converter 42