DESIGN OF INTELLIGENT TRAFFIC LIGHT SYSTEM FOR EFFICIENT TRAFFIC FLOW

This report is submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Robotics and Automation) (Hons.)

by

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I hereby, declared this report entitled “Design of Intelligent Traffic Light System for Efficient Traffic Flow” is the result of my own research except as cited in references.

Signature : ……

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Date : 15th June 2017

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for the Degree of Manufacturing Engineering (Robotics and Automation) (Hons). The members of the supervisory committee are as follow:

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(Associate Professor Dr. Zamberi Bin Jamaludin)

ABSTRAK

Kajian projek ini memberi tumpuan kepada reka bentuk dan sistem kawalan untuk lampu isyarat. Dalam sistem kawalan lampu isyarat, keberkesanan lampu isyarat amat penting bagi mengurangkan beban jalan raya. Walau bagaimanapun, kesesatan lalu lintas selalu berlaku terutamanya pada waktu puncak. Oleh itu, sistem kecerdikan telah diaplikasikan ke dalam sistem kawalan lampu isyarat untuk mengurangkan kesesatan lalu lintas. Dalam projek ini, lampu isyarat yang berfungsikan sistem cerdik direka dengan mengaplikasikan teori logik kabur demi mengurangkan kereta yang berkumpul di hadapan lampu isyarat. Pengawal telah direka menggunakan *membership function* dengan bantuan peraturan yang telah disetkan dalam sistem. Pengesahan angka telah dijalankan dengan menggunakan aplikasi MATLAB. Terdapat dua pengawal logik kabur direka dan ia mempunyai 81 peraturan dalam setiap sistem pengawal. Analisis sistem berfokus dalam peratusan jumlah kereta yang terkumpul dalam satu kitaran dalam keadaan lalu lintas yang beban berat. Terdapat 4 keadaan telah disetkan dan kedua-dua lampu isyarat mahupun konvensional atau cerdik telah disimulasikan mengikuti situasi yang telah disetkan. Keputusan yang diperolehi daripada eksperimen telah menunjukkan lampu isyarat yang berfungsi sistem kecerdikan mempunyai kemampuan yang lebih tinggi berbanding dengan lampu isyarat yang konvensional. Dalam situasi 1, lampu isyarat yang cerdik menunjukkan prestasi yang lebih tinggi daripada lampu isyarat yang konvensional iaitu 51.62% dan 40.78%. Dalam situasi 2, lampu isyarat yang cerdik menunjukkan prestasi yang lebih tinggi daripada lampu isyarat yang konvensional iaitu 53.10% dan 31.76%. Dalam situasi 3, lampu isyarat yang cerdik menunjukkan prestasi yang lebih tinggi daripada lampu isyarat yang konvensional iaitu 39.98%, 40.99% dan 44.19%. Dalam situasi 4, lampu isyarat yang cerdik menunjukkan prestasi yang lebih tinggi daripada lampu isyarat yang konvensional iaitu 20.57%% dan 52.18%. Peningkatan selanjutnya adalah mencadangkan bahawa lampu isyarat tersebut diaplikasikan secara fizikal dan situasi lalu trafik yang sebenar.

ABSTRACT

This final year project focuses on design and analysis of traffic light control system. In traffic light control system, the effectiveness of the system is very important to reduce the heavy traffic density. However, traffic jam always happened especially during peak hours. Therefore, an intelligent technology was studied and implemented to the traffic light control system to minimize cars density at traffic light junctions. In this project, an intelligent traffic light was design using fuzzy logic controller to reduce the cars accumulated at traffic light. The controller was designed using membership function with the help of fuzzy rules and all numerical analysis were performed using MATLAB Software. There are 2 fuzzy logic controllers were designed which consists of 81 rules in each controller. The analyses are mainly focus on the percentage of number of cars accumulated per cycle in high traffic car density. There is some traffic implemented and conditions set for both conventional and intelligent traffic light system. The systems were simulated based on the condition designed. Results obtained showed that intelligent traffic light has better performance and effectiveness than conventional traffic light. In condition 1, intelligent system shows 51.62% and 40.78% higher efficiency than conventional traffic light in the jamming lanes. In condition 2, intelligent system shows 53.10% and 31.76% higher efficiency than conventional traffic light in the jamming lanes. In condition 3, intelligent system shows 39.98%, 40.99% and 44.19% higher efficiency than conventional traffic light in the jamming lanes. In condition 4, intelligent system shows 20.57% and 52.18% higher efficiency than conventional traffic light in the jamming lanes. Further improvements are suggested to extend the intelligent traffic light system into physical setup and real traffic environment such as actual average velocity of the cars passing through the junction should be considered.

DEDICATION

To my beloved parents, lecturers, and friends who have guided and inspired me through this education journey. Heartfelt gratitude to their constant support, belief, encouragement, and motivation.

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LIST OF ABBREVIATIONS

E	-	East
FBD	-	Functional Block Diagram
FIS	-	Fuzzy Inference System
IEC	-	International Electrotechnical Commission
IL	-	Instruction List
LD	-	Ladder Diagram
MATLAB	-	Matrix Laboratory
MF	-	Membership Function
N	-	North
NEMA	-	National Electrical Manufacturers Association
PLC	-	Programmable Logic Controller
RAM	-	Random Access Memory
ROM	-	Read-Only Memory
PROM	-	Programmable Read-Only Memory
S	-	South
SCADA	-	Supervisory Control and Data Acquisition System
W	-	West

LIST OF SYMBOLS

Km	-	Kilometre
m	-	Number of hidden layer neuron
m	-	Metre
s	-	Second
t	-	Time
v_{avg}	-	Average velocity

CHAPTER 1
INTRODUCTION

1.1 Background

Nowadays, traffic planning and control has becoming a big issue in Malaysia especially in urban area. According to Road Transport Department Malaysia (also known as JPJ), the vehicle drivers increase linearly from 12,236,524 people (year 2010) to 14764527 people (year 2015). The increasing rate was 20% within these 5 years. Figure 1.1 below shows the total accumulated drivers from year 2010 to year 2015.

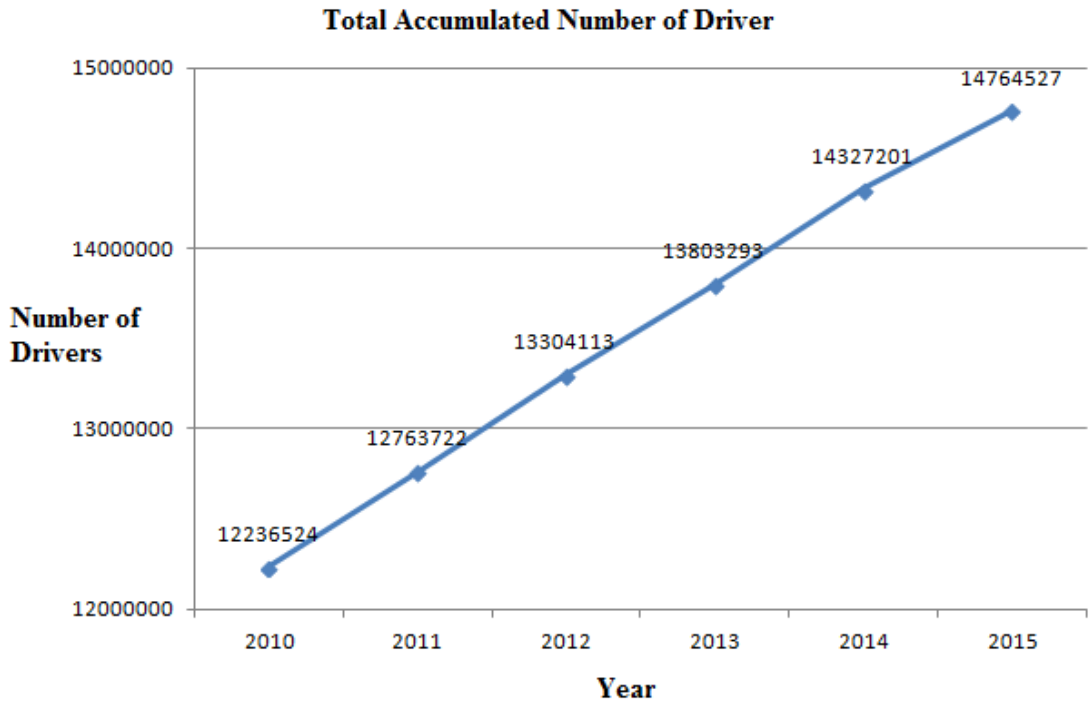

Figure 1.1: Total Accumulated drivers from year 2010 to year 2015. (Jabatan Pengangkutan Malaysia, 2016)

The results indicate a very urgent need for efficient traffic control so that safety of commuters is ensured and loss of time on the road is minimized for greater life efficiency. The continuous increase of the vehicles on traffic will increase the jamming and congestion of traffic to occur especially during the rush hours. It was a critical problem for those who live in a crowded city in which they have to take a very long time in order to reach their destination. With the increasing of the number of vehicle on road, the government had find some solution to overcome this problem, for example, development train service such as train, light rapid transit (LRT), monorails and mass rapid transit (MRT); development of flyovers and ring which also known as beltway or circumferential way; encourage citizens go to work by car sharing and develop traffic monitoring system manually and automatically.

Nowadays, there are some traffic light in Malaysia that are using the digital time counter during red and green light. Count backwards method are used in this digital time counter. This is helpful for the drivers to indicate the remaining time for them to stop when the timing for green light approach zero. Same concept also uses at red light. This kind of traffic light system help drivers to be alert and be ready and reduce the number of car accident.

In this project, design of an intelligent traffic light system for efficient traffic flow by using fuzzy logic technology will be discussed. An intelligent traffic light controller will be designed and operated based on the actual situation on the road. This means that when one of the road is crowded, the green light will be light up for longer time and same concept are used at red light. On the same time, the green light will light up at shorter time for less crowded road. This kind of traffic light fulfill the real traffic condition in Malaysia in which the factory and warehouse are being planned to be built at certain area which known as industrial area or industrial estate. This means that during the morning, most of the car may move towards the industrial area and the car will move to the housing area at evening. For this kind of traffic light, the density of the road is first considered by the system in order to lengthen timing for the red or green light.

1.2 Problem Statement

As mention before, the number of vehicles on roads increases day by day and it causes serious traffic congestion problems especially during peak hours. In this case, government tend to build more traffic control system to fulfil the worsening traffic conditions. Thus, some traffic lights are built between two close junctions for example within as close as 500 meters to 1.5 kilometre of each other. This results in occurrence of constant traffic jams due to accumulation of vehicles at the respective junctions.

Therefore, an intelligent traffic light control system is required that enable to response to current traffic situation so as to give much more comfortable passage of transports between the junctions. As an alternative to this problem, a fuzzy logic based traffic light control system is proposed to fluent the traffic flow by sensing the number of cars pending at the traffic light junctions.

1.3 Objective

i. To study elements of intelligent technology to be applied for traffic light control system design.
ii. To design an intelligent control algorithm for a traffic light system.
iii. To validate the performance and efficiency of the intelligent traffic light system. Its efficiency is compared with conventional traffic light system.

1.4 Scope

In this project, a two four-junction traffic light is applied with close proximity in 1km. Besides that, the sensors used to detect the road density are analyzed so that the number of car may passing through a traffic light at certain timing such as 20 seconds, 40 seconds, and so on can be calculate. The timing on the higher road density may be increased or decreased within two four-junction. In this system, fuzzy logic control is used and applied with MATLAB Simulink environment.

1.5 Content of Report

This report consists of five chapters that are, (1) introduction, (2) literature review, (3) methodology, (4) results and analysis and (5) conclusion and recommendation.

In chapter 2, the historical development of traffic light will be discussed. Previous technology that used to control the traffic light, such as PLC, fuzzy logic, neural networks and so on will be concentrated and this part cover large portion of chapter 2. Some introduction on software used such as Microsoft Visual Basic and MATLAB Simulink that will be used by this project will be discussed.

Chapter 3 will discuss on the methodology of this project. More details on fuzzy logic and MATLAB Simulink will be described after the end of chapter 2. The application of using fuzzy logic control system with MATLAB Simulink will be shown and simulate in this chapter.

Chapter 4 presents and shows all the results obtained with the simulation done based on the real situation. The analysis was present and discuss in chapter 4. The performance of this intelligent traffic light system will be evaluated as well in this chapter.

Chapter 5 discuss the conclusion of this project and the development of intelligent traffic light control system based on fuzzy logic theorem with MATLAB Simulink. Further research suggestions and recommendations will present in this chapter. Besides that, the problems and future development or system modification will also be explained in this chapter.

CHAPTER 2
LITERATURE REVIEW

In this chapter, literature reviews relating to control of traffic light system are illustrated and discussed. These reviews were the basic knowledge and contribute a lot in future researches. In the past, several types of traffic light controller were developed, such as PLC and fuzzy logic.

2.1 Historical Review on Traffic Control

Before the invention of traffic lights, the flows of traffic were control by the traffic police. The first traffic control system was implement in 1722 which three men were needed to instruct and directing the vehicle on London Bridge to ensure the traffic flow smoothly in or out from London to Southwark or vice versa (Sessions, 1971). These methods of traffic control are still implemented in Malaysia for certain junction that always jam at particular time especially during the peak hour.

In 9 December 1868, the first traffic light was implemented and mounted outdoor of the Houses of Parliament in London, in the London borough of Westminster in which the intersection junction of Great George Street and Bridge Street. It was a non-electric and gas-lit traffic lights by using a that proposed by John Peake Knight. This traffic light initially was used to control the flow of train by using semaphore system. After that, the Nott's engineer decided to implement it on the main road and side roads to control the train that would pass through the main and branch railway lines which can be used during the day and night time by using two colours, that are red and green.

In 1908, the words of “Stop” and “Go” were added on the backgrounds of red and green colour respectively. The kerosene lamp was used as the background lamps during the night time enable night traveler to notice the signboard clearly. This traffic light was controlled by an officer and he or she may blow the whistle as a signal to alert traveler for the change of sign of traffic sign.

In 1912, the word “Stop” and “Go” traffic light was painted in red and white respectively which operated and manned by a police woman. This traffic control device was placed on the top of the tower in Paris (Sessions,1971). On the same year, the first that traffic light use electric to operate was invented and established by a policeman in Salt Lake City, Utah, name Lester Wire. He used red and green colour as well on that traffic light.

After to two years, the design of the traffic light was change in which the buzzer was added on the traffic light as a warning for colour changes. It has two colours, that are red and green with a buzzer that proposed by James Hoge. This design enables the fire station, police or ambulance to control the signals when emergency. The interconnected traffic light was introduced two years after the three-coloured traffic light was introduced.

In 1920, the first four-way, three-coloured traffic light was invented. The colours used were red, amber and green. The adding of the amber colour was because of the police officer could not change the colours of lights at the same time at different junction. This amber colour was previously used on the railroad. This traffic system was proposed by a police officer who name William Potts in Detroit City.

In 1952, computerized control of traffic light was proposed. As computer started to evolve, the traffic light control system also improved well become more reliable, easier to operated and more convenient to be used. In 1990s, the countdown timer on traffic light was introduced which enable the pedestrians to determine the time for them to cross the road. Figure 2.1 below shows the history and evolution of the traffic light.