UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Electronics and Computer Engineering

SELF ROUTING TRAFFIC LIGHT FOR TRAFFIC LIGHT CONTROLLER USING PRIORITY METHOD BASED ON VOLUME OF VEHICLES

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A thesis submitted
in fulfillment of the requirements for the degree of Master of Science
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DECLARATION

I declare that this thesis entitle “Self Routing Traffic Light for Traffic Light Controller using Priority Method based on Volume of Vehicles” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ....

Name : Tan Swee Tiang

Date : 10 August 2015

APPROVAL

I hereby declare that I have read this dissertation/report and in my opinion this dissertation/report is sufficient in terms of scope and quality as a partial fulfillment of Master of Science in Electronic Engineering.

Signature : ……………………………………………………...

Supervisor Name : Prof. Dr. Muhammad Ghazie Bin Ismail

Date : 11 August 2015

DEDICATION

Specially..

To my beloved parents and brother

To my dear supervisor and not forgetting to all friends

For their

Love, Sacrifice, Encouragements, and Best Wishes

ABSTRACT

Traffic congestion is defined as the volume of vehicles at the traffic junction which is higher than the available road capacity. However, with traffic light system installed, traffic congestion still happens especially during peak hours. This thesis proposes a new joint algorithm for traffic light system to manage and control the traffic flow at the traffic junction in conjunction with a proposed new sensing method. The aim is to improve the efficiency of conventional traffic light system in terms of reduction of the waiting and travelling times of road users. Normally, there are two methods used to control the conventional traffic light system which are sequencing and sensor demand methods. In the sequencing method, the traffic light system is designed to operate based on a preprogrammed sequence without consideration of real time behavior. In the sensor demand method, it is based on real time sensor detection where loop sensors are placed under certain road junctions. In order to increase and enhance the efficiency and accuracy of real time traffic flow, this thesis proposes a novel implementation of sensing method called Self-Routing Traffic Light (SRTL) which incorporates a self-algorithm program as a practical solution to reduce traffic congestion. SRTL is capable of counting the total number of vehicles entering a certain junction and exiting from the same junction on a real time basis. Based on the use of dual sensors at each road junction, the vehicles are detected by triggering the programmable logic controller to manage and control the traffic light indicators according to real traffic demand. This research uses data at a cross traffic junction in Perak between Jalan Taiping and Kuala Sepatang with the primary data provided by Jabatan Kerja Raya, JKR Larut Matang & Selama, Taiping. With the primary data provided, Simulation of Urban Mobility (SUMO) is used to create traffic simulation for different types of situation. The performance of STRL is compared with conventional sequencing and sensor demand methods. Based on the results of the simulation using SUMO, SRTL show better performance in terms of reducing waiting and travelling time of road users at the traffic junction during peak hours by 35.28% (waiting time) and 24.59% (travelling time) compared to the sensor demand method and an improvement compared to the sequencing method of 46.01% (waiting time) and 29.18% (travelling time). For off peak hours, SRTL also show better performance, 55.57% (waiting time) and 30.25% (travelling time) compared to the sensor demand method and an improvement compared to the sequencing method of 59.43% (waiting time) and 32.89% (travelling time). In conclusion, SRTL provides and ensures the smoothness of traffic flow especially during peak hours by reducing significantly the waiting and travelling times of vehicles at the traffic junction.

ABSTRAK

Kesesakan lalu lintas ditakrifkan sebagai jumlah kenderaan di persimpangan trafik lebih tinggi daripada kapasiti jalan raya yang sedia ada. Walau bagaimanapun, dengan pemasangan sistem kawalan lampu isyarat (SKLI), namun kesesakan tetap berlaku terutamanya pada waktu puncak. Tesis ini mencadangkan algoritma yang baru untuk SKLI bagi mengurus dan mengawal aliran trafik di persimpangan trafik sempena dengan kaedah penderiaan baru yang dicadangkan. Tujuannya adalah untuk meningkatkan kecekapan sistem konvensional lampu isyarat dari segi pengurangan masa menunggu di persimpangan trafik dan masa perjalanan pengguna jalan raya. Biasanya, terdapat dua kaedah yang digunnakan untuk mengawal SKLI konvensional iaitu kaedah aliran berturusan dan permintaan deria. Dalam kaedah aliran beturusan, sistem kawalan lampu isyarat direka bentuk untuk beropesi berdasarkan urutan yang diprogramkan tanpa pertimbangan tingkah laku masa nyata. Dalam kaedah permintaan deria, ia berdasarkan pengesanan deria yang gelung dibawah jalan raya persimpangan trafik dengan pertimbangakn laku masa nyata. Dalam usaha bagi meningkatkan kecekapan dan ketepatan aliran trafik, tesis ini mencadangkan pelaksanaan kaedah baru, bernama "Self-Routing Traffic Light (SRTL)" yang menggabungkan program algoritma-diri sebagai penyelesaian praktikal untuk mengurangkan kesesakan lalu lintas. SRTL mampu mengira jumlah kenderaan memasuki and keluar dari persimpang trafik berdasarkan masa yang nyata. Berdasarkan penggunaan dwi deria pada setiap persimpangan jalan, kenderaan dapat dikesan dengan mencetuskan pengawal logic boleh atur cara untuk mengurus dan mangawal penunjuk lampu isyarat mengikut permintaan trafik sebenar. Kajian ini menggunakan data di suatu persimpangan lampu isyarat yang terletak di Perak andtara Jalan Taiping dan Kuala Sepatang dengan data utama yang disediakan oleh Jabatan Kerja Raya, JKR Larut Matang & Selama, Taiping. Dengan data utama yang diberikan oleh JKR, Simulasi Bandar Mobiliti (SUMO) digunakan untuk membuat simulasi trafik bagi pelbagai jenis keadaan. Prestasi bagi SRTL dapat dibandingkan dengan SKLI konvensional keadah aliran berturusan dan permintaan deria. Berdasarkan keputusan simulasi (SUMO), SRTL menunjukkan prestasi yang lebih baik dari segi pengurangkan masa menunggu di persimpangan jalan dan masa perjalanan pengguna jalan raya pada waktu puncak dengan bertambah baik sebanyak 35.28% (masa menunggu) dan 24.59% (masa perjalanan) berbanding dengan keadah permintaan deria dan peningkatan sebanyak 46.01% (masa menunggu) dan 29.18% (masa perjalanan) berbanding dengan keadah aliran berterusan. Bagi masa bukan waktu puncak, SRTL juga menunjukkan prestasi yang baik iaitu 55.57% (masa menunggu) dan 30.25% (masa perjalanan) berbanding dengan kaedah permintaan deria dan 59.43% (masa menunggu) dan 32.89% (masam perjalanan) berbanding dengan kaedah aliran berterusan. Kesimpulannya, SRTL menyediakan dan memastikan kelancaran aliran trafik terutamanya pada waktu puncak dengan mengurangkan masa menunggu di persimpangan dan masa perjalanan yang diambil oleh pengguna jalan raya.

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LIST OF ABBREVIATIONS

TLS	Traffic Light System
TJS	Traffic Junction Simpang
SUMO	Simulation of Urban Mobility
PLC	Programmable Logic Controller
VIPs	Video Imaging Processors
SM	Sequencing Method
SDM	Sensor Demand Method
RE	Red light at East lane
AE	Amber light at East lane
GE	Green light at East lane
RS	Red light at South lane
AS	Amber light at South lane
GS	Green light at South lane
RW	Red light at West lane
AW	Amber light at West lane
GW	Green light at West lane
RN	Red light at North lane
AN	Amber light at North lane
GN	Green light at North lane
ES1	Sensor 1 at East Lane
ES2	Sensor 2 at East Lane
ES3	Sensor 3 at East Lane
SS1	Sensor 1 at South Lane
SS2	Sensor 2 at South Lane
SS3	Sensor 3 at South Lane
WS1	Sensor 1 at West Lane
WS2	Sensor 2 at West Lane
WS3	Sensor 3 at West Lane

NS1	Sensor 1 at North Lane
NS2	Sensor 2 at North Lane
NS3	Sensor 3 at North Lane
P1	Phase 1
P2	Phase 2
P3	Phase 3
P4	Phase 4
P5	Phase 5
ZAIK	Centre for Applied Informatics
IDM	Intelligent Driver Model
OSM	Open Street Map
XML	Extensible Markup Language
O-D	Origin - Destination
SRTL	Self Routing Traffic Light
JKR	Jabatan Kerja Raya
DCP1	Traffic volume from Kuala Sepatang to Traffic Light Junction
DCP2	Traffic volume from Jalan Persekutuan 1 to Traffic Light Junction
DCP3	Traffic volume from Jalan Taiping to Traffic Light Junction
DCP4	Traffic volume from Changkat Jering to Traffic Light Junction
PCU	Passenger car units
adj S	Adjustable saturation flow

LIST OF SYMBOLS

T	Time (second)
L_n	Distance between the first and the last traffic light junction
n	Number of vehicle
x_n	Position of n^{th} vehicle
$x_{(n-1)}$	Position of $(n-1)^{th}$ vehicle
$L(n-1)$	Length of $(n-1)^{th}$ vehicle
v_n	Speed of n^{th} vehicle
v_{n-1}	speed of $(n-1)^{th}$ vehicle
τ	driver's reaction time (s)
S	Saturation flow
q	Actual flow
p.c.u./hr	passenger car units per hour
W	Width (meter)
S_{adj}	Adjustable saturation flow
Fg	Correction factor (effect gradient of traffic junction)
Ft	Correction factor (turning radius of traffic junction)
Y	Y-value
L	Total lost time per cycle (second)
a	Amber time (second)
A	Acceleration of vehicle (m/s^2)
V	Speed of vehicle (m/s)
Co	Optimum cycle time
C	Total effective green time
g_n	Effective green time
G_n	Actual green time
K_n	Controller setting time
I	Inter-green time

R	Driver action time
RC	Reserve capacity

LIST OF PUBLICATIONS

NO	TITLE
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