

A REAL TIME TRAFFIC SIGNAL CONTROL SYSTEM

A dissertation submitted to the
Department of Electrical Engineering, University of Moratuwa
in partial fulfillment of the requirements for the
degree of Master of Science

LIBRARY
UNIVERSITY OF MORATUWA, SRI LANKA
MORATUWA.

by

JAYAKODY ARACHCHIGE NIMANTHI NISHANI
KUMUDU JAYAKODY

621.3 "08"
621.3 (043)

Supervised by: Dr. Lanka Udawatta and Dr. Sisil Kumarawadu,

Department of Electrical Engineering
University of Moratuwa, Sri Lanka



91207

91207

DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

UOM Verified Signature

...
25.01.2008

We endorse the declaration by the candidate.

UOM Verified Signature

...Dr. Lanka Udawatta

UOM Verified Signature

...Dr. Sisil Kumarawadu

CONTENTS

Declaration	ii
Abstract	vi
Dedication	vii
Acknowledgement	viii
List of Figures	ix
List of Tables	x
Chapter 1 Introduction	1
1.1 Background	1
1.2 Motivation	3
1.3 Literature Review	3
1.4 Contributions of the Research	5
1.5 Organization of the Report	5
Chapter 2 Available Adaptive Traffic Control Systems	6
2.1 Introduction	6
2.2 Major Methodologies	6
2.3 Split Cycle Offset Optimization Technique	6
2.4 Sydney Coordinated Adaptive Traffic System	9
2.5 Real time Hierarchical Optimized Distributed & Effective System	11
2.6 OPAC – Optimized Policies for Adaptive Control	15
Chapter 3 Decentralized Intelligent control Model	18
3.1 Introduction	18
3.2 Detection in Adaptive Control	18
3.2.1 Function of Detection	18
3.2.2 Detection Methods	19

3.2.3 Inductive Loop Detectors	20
3.3 Influence Detection	21
3.3.1 Structure of the Intelligent Control	21
3.3.2 Formulating the Influence Function for Traffic Signal Control	22
Chapter 4 Fuzzy Control Strategy Development	25
4.1 Introduction	25
4.2 Fuzzy Inference System	25
4.2.1 Fuzzy Basics	25
4.2.2 Fuzzification	26
4.2.3 Rule Base	30
4.2.4 Determination of the Single Output	33
4.3 Control Strategy	34
4.3.1 System Architecture	34
4.3.2 Decentralized Approach	35
4.3.3 Prediction Method	36
4.3.4 Control Mechanism	37
Chapter 5 Simulation and Results	41
5.1 Introduction	41
5.2 Simulation Model Development	41
5.2.1 Simulink Basics	41
5.2.2 Traffic Simulation Model of an Intersection	42
5.2.3 Simulation Results	44
5.3 Comparison with existing Fixed time Traffic Control System	46
5.3.1 Delay Calculation	46
5.3.2 Delay Calculation for the Approach A	47

5.3.3 Delay Calculation for the Approach B	49
5.3.4 Delay Calculation for the Approach C	51
5.3.5 Delay Calculation for the Approach D	53
Chapter 6 Conclusions and Future work	56
6.1 Conclusions	56
6.2 Future Work	56
References	58

Abstract

Traffic congestion problem in Colombo city is getting worse since traditional traffic control system could not fulfill the need. Since the existing system is a fixed time fixed cycle control system, it cannot fit with dynamic traffic environment.

In this research, a decentralized control strategy to control a traffic network grid is presented. Single controller is to control traffic signals of all approaches at one intersection and each approach green time is given by its separate Fuzzy Inference System. Vehicle arrival data are to be collected by lane detectors. Inductive Loop Detectors are proposed for this purpose. Herein, a methodology is developed to decide green time of each approach based on the arrival data by the Fuzzy Inference System and the Cycle time. Influence to the particular intersection is identified and is factorized as an input to the Fuzzy Inference System. Later, the green time is decided by the FIS. Results for this mechanism are shown for one intersection on a simulated environment modeled by Matlab.

Calculations have been done based on the real data obtained for fifteen occasions. Results for three sets of data from both existing fixed time system and the intelligent model have been compared based on the calculations done for the total vehicle delay time, expected at the passing the particular intersection. It shows 51.6% of minimized total vehicle seconds delay by the intelligent traffic control model over the fixed time control system.

To my parents

Acknowledgement

This is to pay my warm gratitude to the Department of Electrical Engineering, University of Moratuwa, Sri Lanka for giving me the opportunity to read for the M.Sc in Industrial Automation and to do this research during the period of October 2005 to January 2008.

I would like to extend my warm thanks with respect to my research supervisors Dr. Lanka Udawatta and Dr. Sisil Kumarawadu, who have given endless support and guidance while I was doing the research and following the program. Their breadth of knowledge and the advices given me at the presentations made me highly impressed to do the research in depth and to develop myself by enriching academic, research oriented and professional maturity. Their countless advices and the guidance were invaluable.

I would also like to thank Professor Ranjith Perera, the Head of the Department. He has given me support and encouragement, and his advice and feedback about my research at presentations have greatly enhanced and strengthened the study. I thank him for all the time and energy he has paid for my work.

I also wish to extend thanks to my friends and colleagues who were invaluable in completing this study, and to the management of Electro-Serv (pvt) ltd who has given me the support by releasing me from the duty to follow this program.

I am indebted to my parents and to my brother Suranga Jayakody for the guidance they have given to me. I recall their constant support, encouragement, love and guidance given me every time.

Finally, I would like to share my research experience with all of you.

Nimanthi Jayakody

University of Moratuwa, Sri Lanka

January 2008

List of Figures

Figure	Page
3.1 Block diagram of the Inductive Loop Detector	20
3.2 Part of the traffic network	22
3.3 Intersection A	23
4.1 Trapezoidal membership function for the input Influence	27
4.2 Triangular membership function for the output Split	28
4.3 Variation of Split Vs. Influence	29
4.4 Graphical representation of rule evaluation	31
4.5 Block diagram of the control system	35
4.6 Master Slave control model	36
4.7 Flow chart for proposed adaptive control mechanism	39
5.1 Traffic simulation model developed by Matlab	43
5.2 Arrivals at an intersection over the cycle time	47

List of Tables

Table	Page
4.1 Membership Values of the Input Influence	27
4.2 Membership Values of the Output Split	28
5.1 Detector Counts at Approach Counters	44
5.2 Influences calculated for the detector data	44
5.3 Splits determined by the Fuzzy Inference Systems	45
5.4 Delay Calculation for the Intelligent Model at Split A	48
5.5 Delay Calculation for the Fixed time Control Model at Split A	49
5.6 Delay Calculation for the Intelligent Model at Split B	50
5.7 Delay Calculation for the Fixed time Control Model at Split B	50
5.8 Delay Calculation for the Intelligent Model at Split C	52
5.9 Delay Calculation for the Fixed time Control Model at Split C	52
5.10 Delay Calculation for the Intelligent Model at Split D	54
5.11 Delay Calculation for the Fixed time Control Model at Split D	54
5.12 Improvement obtained by the Intelligent Control Model	55