Improve And Extension Traffic Light At Intersections

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Abstract. In this paper, the development of intelligent system makes the Decision-making extension is possibility in order to extend the time of green color and improve the timing of the adoption of the density of vehicles in real time at intersections using fuzzy logic and genetic algorithm. Traffic control is the synchronization of time in each of the stages in order to reduce downtime, delay and the increase in total production of vehicles and the development of efficient control in real time. We use fuzzy logic for their ability to adapt with traffic conditions. However, complex and non-linear processes and their ability take decisions with incomplete information by quickly and effectively way. For reaching to the optimal performance of the junctions we use genetic algorithm Search to find the best version to choose.

Keywords: Traffic light, phase sequences, Genetic algorithm**,** Fuzzy logic.

1 INTRODUCTION

In a conventional traffic light controller [16][20][12] has cycle times, which are not optimal and fixed .Traffic control methods include, fixed-time control, area static control and area dynamic control [4][18]. Traffic light controller is unable to solve the congestion in the intersection because there are empty lanes of vehicles at the intersection of roads while the other lanes are filled by them according to the rush hours and direction. By developing on traffic lights they can be able to overcome these obstacles and interaction with the surrounding environment. We will use the fuzzy logic [3][16][5][6] and genetic algorithms[1][2][8] technology to ensure smooth flow of traffic and overcome the shortcomings, deficit and increase of vehicle flows and decrease traffic delays under traffic conditions. To make optimal decisions we use processing techniques like wireless sensor network to know incoming and outgoing links (lanes) the controller utilize the information which receives from these sensors [12]. the main idea in this paper is to solute congestion intersections , reduce travel time and fuel consumption so that leading to reduce pollution and help people and save them by using Intelligent Transportation Systems (ITS)[15][17]. Congestion of traffic has many variables and they are time, day, season, weather and unpredictable situations such as accidents, special events or constructional activities. Intelligent Transportation Systems (ITS) applications in traffic signal control system to develop systems it reduce congestion and operational costs, provide alternate routes to travellers, enhances productivity and increase the capacity of infrastructure.

2 INTERSECTION

Avoidance of Collision by a concept of stop vehicles front lanes through Traffic light management at an intersection and it is hard challenge and complex. In this paper the intersections consist of the phases [13] and the cellular automata (CA) [1]. Driving rules of vehicles depend on using (CA) and how to use (CA). Each link (lane) is divided into a number of cells and has a unique ID number. A size of the road-cell is 16 pixels and each

vehicle occupies two cells (32 pixels), where the vehicle can occupy the road-cell or not that means it will be empty [1]. We use cellular automata algorithm (CAA) in this paper because it allows us the first reason represent significant events during congestion such as traffic standstill, resume motion, return to standstill again, and so on. The other reason we can identify a vehicle's basic attributes that includes medium speed, maximum speed, vehicle location, desired speed and current acceleration. Traffic light can be divided into two types and they are red and green colour through calculation the green splits and cycle lengths. It depends on real-time of traffic data in road networks. Phase is a set of lanes in traffic its job is exit vehicle from the intersection it is presented by drawing the traffic flow [5] of the green light it is shown in Figure 1, they are eight phases and all of them is called a one cycle. The length of a one cycle is determined by the length of many phases (Φi, i = 1,…., N) that completes the one cycle through the intersection[3][20].

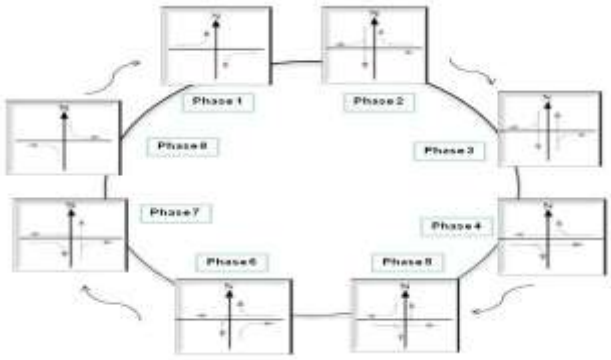


Figure 1. The one cycle contains 8-phases.

Traffic light controller has two types in each cycle (all phases) they are: 1) fixed-time (FX) and 2) Real-time [7]. Fix time (FX) is predetermined in all length of phases (one cycle), by using statistical data in last year's. Real-time (RT) or dynamic approach is used in a length of cycle it depends on the traffic condition or emergency. An advantage of Real-time is an exploitation of real time and the modification. Phases can adapt according to traffic conditions. Green light indicates to an active phase and its period can gradually extend when there is congestion that means when vehicles arrive and each of them has Time of an arrival. The extension of time is limited, maximum 205 seconds. And red light is the end of the current phase and a beginning of the next phase. when vehicles reach to intersections they store information about themself and they are ID number, performance, size, arrival time, arrival velocity, type of turn, arrival lane, etc[9].Fuzzy in traffic lights controller consists of three modelling 1) the Green Phase module and, 2) the Next Phase Module, 3) the Decision Module [13].

3 THE GREEN PHASE MODULE

nowadays we are using (CA) and rules of driving , in order to observe conditions of flow of traffic of the green phase only by knowing inputs of the number of vehicles, through the local detectors (detectors are within the lane itself) ,remote detectors (detectors are from neighbor lanes).

3.1 Fuzzy logic systems

We discuss the implementation of control system of intelligent traffic lights by using technology of fuzzy logic which has the capability to mimic the intelligence of human that means it is as thinking as humans, for controlling traffic lights, analysis, ability to take decision in an environment that it lacks the information and easy and very suitable for non-linear processes such as density, cost, waiting time, etc [11]. Fuzzy logic allows the manipulation of linguistic data (Large, Medium and Small) and inaccurate, as a useful tool in the design of signal timing. A fuzzy system element as it is shown in Figure 2[14].

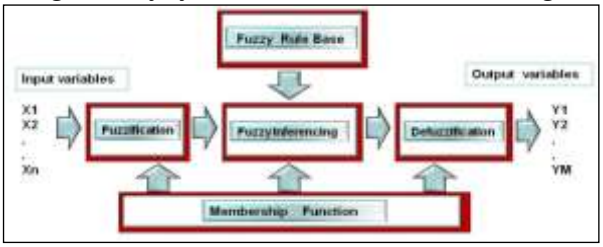


Figure 2. Elements of Fuzzy logic System.

3.1.1 Input and Output of Membership

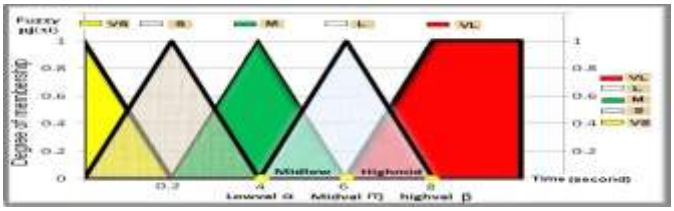
In this paper, function of Membership is analysis variable of fuzzy for two inputs and one output as it is shown: 1) Variable of Input AVi is the numbers of the vehicles when they arrive at the crossroad (Arrival).2) Variable of Input QGi is the number of the queue of vehicles (Queue). 3) Variable of Output is the Extension of Time in the current green phase, it is symbolize by (ΔT) [10].

3.1.2 Functions of the membership

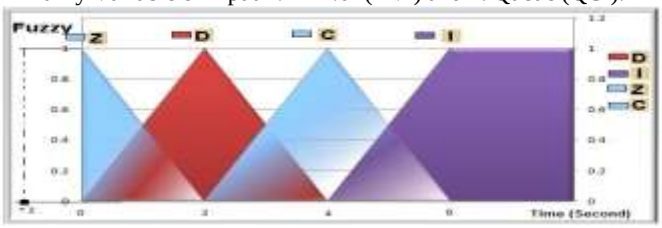
The graphical representation of the linguistic variables is presented as it is shown in Figure 3. we can see the Degree of membership of fuzzy variables on y-axis and the universe of discourse it is also called the reference super set on x-axis (Time second) . Fuzzy Variable of Output which is existed in x-axis it is called the universe of discourse is the length of time to extend it (seconds). linguistic values are divided into different fuzzy subsets: 1)AVi = {VS, S, M, L, VL}.2) QGi= {VS, S, M, L, VL}.3) ΔT= {D, C, I}. VS is Very Small, S is Small, M is Medium, L is Large, VL is Very Large, D is Decrease, C is Constant, I is Increase. i refers to the sequence number of the signal current phase.

3.1.3 The Basic Rules of Fuzzy

the linguistic control strategy that is decided by "if-then-else" statement .The basic function of The Basic Rules of Fuzzy is representation the expert of knowledge in a form of IF-THEN a structure of the rules combine AND/OR operators. We have 25 fuzzy rules, IF the number of vehicles which are waiting in line or queuing (Q) is medium AND the number of vehicles which arrive or arrival (A) is small THEN the allocated time for the green light (T) decreases Some of them are shown in Table 1.



Fuzzy Variable of Input 1: Arrival (AVi) and 2: Queue (QGi).



Fuzzy Variable of Output: Extension Time (ΔT).

Figure 3. Graphical representation of Functions of the membership of the fuzzy logic controller.

TABLE I

FUZZY VARIABLES OF ARRIVAL, QUEUE AND EXTENSION OF THE TRAFFIC LIGHT CONTROL.

QUEUE / ARRIVE	VS	S	M	L	VL
VS	D	D	D	D	C
S	D	D	D	C	C
M	D	D	C	C	I
L	D	C	C	I	I
VL	C	C	I	I	I

3.1.4 Inference Engine

Inference Engine divides into two classes: the first class is an assignment of the Inference and the second class is mechanism of action Inference. An assignment of the Inference, it reduces time of the total delay and waiting of vehicles as well as to avoid traffic congestion and synchronization of the local traffic controller with its neighbors. The green lights will be extended and the next phase is continued with notice the density of the vehicles at any junction. The mechanism of action Inference, the fuzzy inference evaluates the stored rules in the basic rules of fuzzy and then sending it to Defuzzification. its job is process of input functions of Membership (AVi, QGi) to convert (retranslate) values the fuzzy output (ΔT) to become real crisp values.

3.1 Unit of Extension

The green lights will be extended and the next phase is continued with considering the density of the cars at any of the intersection, through Moving vehicles. Moving vehicles consists of detectors (sensors, camera, cellular automata (CA), etc) which they can activate a change in the length of phase. Each road in the junction has a detector for vehicle that detects of the presence of vehicles at each of the junction. Moving vehicles use two parameters [13]. Initial Interval: a phase takes the green light (starts green single) that is applied in fuzzy logic for controlling on traffic light, and making it to begin from 5 seconds. Unit of Extension : After the Initial Interval had finished, the green color will extend if it detects the urgent need to expansion , in this paper Unit of Extension means 40 seconds, the green color mustn't exceed 205 seconds that means five times of Unit of Extension with initial interval in order to achieve the justice. Then Decision Module will stop operation of extension when it reaches to 205 seconds (five times) or detects that there isn't any vehicle at intersection.

4 THE GENETIC ALGORITHM

The Genetic algorithm (GA) is executed to obtain the best possible solution and steps of algorithm are:

0 start: Create population of chromosomes

1 Fitness: Evaluate Fitness F(X) of each chromosome in the Population

2 New populations:

0 selection based on F(x)

1 Recombination: Cross-over chromosomes

2 Mutation: Mutate chromosomes

3 Reject or accept new one

3 Replace: Replace old with new population: the new Generation.

4 Test: Test problem criteria.

5 Loop: Continue step 1-4 until criteria is satisfied.

4.1 Computes the fitness function

The genetic algorithms discard any solutions with a weak fitness value and accept any good fitness value, where Fitness is quality of solution; the value that is assigned to an individual (Chromosomes) is based on how far or close from the solution. The Greater fitness value is the best solution therefore, is chosen.

4.1.1 The algorithm calculates the green times (GTV).

$$GTV = AVi * Time \quad (1).$$

Where AVi is the quantity of the vehicles which arrive at the crossroad (Arrival).

4.1.2 *The algorithm calculates the length of queue for vehicles (Queue, Qgi).*

$$Qgi = Vp1 + Vp2 + Vp3 + Vp4 \quad (2).$$

$$Qgi = Qgi * (V_{AVG}) \quad (3).$$

Where VPi counts the number of vehicles in every phase when traffic light becomes red. V_{AVG} is the average of arrival vehicles at intersection through red color.

4.1.3 A Performance of indexes

A fitness function (F) consists of linear combination of a performance of indexes in all of the four lanes.

$$F = P.I.1 + P.I.2 + P.I.3 + P.I.4. \quad (4).$$

Performance Index (P.Ii) depends on capacity of the road and its priority.

4.1.4 Important Vehicles

Important vehicles which have the priority such as ambulance, fire-fighter, and police. We will give vehicles a weight if it is necessary in order to support the road with green color, avoid delay, justice and give the security.

$$P.I_i = W_i * Qgi/GT_i \quad i=1, 2, 3, 4. \quad (5).$$

Wi is a weight which is given to road i. GTi is sum Green minimum time with green extension time ΔT.

4.2 Initialize of population

Each chromosome means one Cycle and it contains four genes. The location of each gene determines the phase. One gen (phase) consists four alleles, 1) gen is green time (GT), 2) gens (phases) are red time (RT) mean Queue (Qgi) and the other three gen weight (important vehicles). Every chromosome is a string of bits 0 or 1 after that we change the time from seconds to Binary code and then to Gray code. As it is shown in Figure 6.

		Phase 1 (Gen)				Phase 2 (Gen)				Allele
		GTV	Qg2	Qg3	Qg4	Qg1	GTV	Qg3	Qg4	Fitness Function
Chromosome 1	Dec Secod	5	3	7	9	8	45	20	13	5.225463867
	Binary	101	11	111	1001	1000	101101	10100	1101	
	Gray	111	10	100	1101	1100	111011	11110	1011	
Chromosome 2	Dec Secod	165	9	11	4	4	5	6	2	2.909219265
	Binary	10100101	1001	1011	100	100	101	110	10	
	Gray	11110111	1101	1110	110	110	111	101	11	

Figure 6. Building the chromosome in Intersection.

4.3 The best solution for individuals

It means when the traffic light become green for all the four roads time of green colour will be extended more times on original (fixed) time and execution in the emulator (the Decision Module).

5 RESULTS

For testing our traffic control system, we compare results fuzzy systems (FS) and genetic algorithms (GA) control with fixed time control system (static control). We did this experiment on 1000 vehicles in intersection it is shown in table III.

TABLE III
COMPARISON BETWEEN REAL TIME & FIXED TIME SYSTEM

phase	time	FX	RT
1	8:00	120	260
2	8:02	120	380
3	8:04	120	125
4	8:06	120	170
	Sum car	480	935
phase	time	FX	RT
1	8:08	120	45
2	8:10	120	85
3	8:12	120	125
4	8:14	120	125
	Sum car	960	1315

6 CONCLUSIONS

This paper shows performance of improvement and it is compared with fixed time cycle. Enhancing of the capacity of roads and traffic flow in the development of intelligent systems in real time. The concepts of genetics are translated into a search algorithm to reaching the best fitness (copies) namely Search to find the best version to choose. fuzzy systems (FS) and genetic algorithms (GA) optimize traffic light timings in real time where provide a set of

extension of optimum green time in the phases ,reduce average of waiting time vehicle , improve average of speed vehicle , reduce congestion and operational costs, provide alternate roads for travellers and enhance productivity. A length of cycle (all phase) depends on conditions of the traffic or emergency that means vehicles which have the priority such as Ambulance, fire fighter, and Police.

References

Ashfaq H. Farooqi, Ali Munir and A. Rauf Baig. (2009).THE: traffic light simulator and optimization using Genetic Algorithm.

Ayad Mashaan Turky, Mohd Sharifuddin Ahmad and Mohd Zaliman Mohd Yusoff. (2009). The Use of Genetic Algorithm for Traffic Light and Pedestrian Crossing Control.

B.Madhavan Nair, J. Cai (2007). A fuzzy Logic Controller for Isolated Signalized Intersection with Traffic Abnormality Considered.

Christina Diakaki, Markos Papageorgiou, Kostas Aboudolas. (2002). A multivariable regulator approach to traffic responsive networkwide signal control.

Ehsan Azimirad, Naser Pariz, and M. Bagher Naghibi Sistani. (2010).A Novel Fuzzy Model and Control of Single Intersection at Urban Traffic Network.

Girija H Kulkarni, Ms. Poorva G Waingankar.(2007).Fuzzy Logic Based Traffic Light Controller.

I.N.Askerzade (Askerbeyli), Mustafa Mahmood.(2010).Control the Extension Time of Traffic Light in Single Junction by Using Fuzzy Logic.

Javier Sánchez, Manuel Galán, and Enrique Rubio.(2007).Applying a Traffic Lights Evolutionary Optimization Technique to a Real Case: "Las Ramblas" Area in Santa Cruz de Tenerife.

Kurt Dresner and Peter Stone.(2005).Multiagent Traffic Management: An Improved Intersection Control Mechanism.

Lin Zhang,Honglong Li, Ph.D,Panos D. Prevedouros, Ph.D.(2004).Signal Control for Oversaturated Intersections Using Fuzzy Logic.

Madhavi Arora and Dr. V. K. Banga.(2012).Intelligent Traffic Light Control System using Morphological Edge Detection and Fuzzy Logic.

Malik Tubaishat, Yi Shang and Hongchi Shi.(2007).Adaptive Traffic Light Control with Wireless Sensor Networks.

Marzuki Khalid, See Chin Liang and Rubiyah Yusof .(2004).Control of a Complex Traffic Junction using Fuzzy Inference.

Michael Negnevitsky.(2005).Artificial Intelligence A Guide to Intelligent Systems .(2nd Edition) .

Pinson, Suzanne; Balbo, Flavien.(2010).Using intelligent agents for Transportation Regulation Support System Design. Article accepté pour publication ou publié.

Sandeep Mehan.(2011).Introduction of Traffic Light Controller with Fuzzy Control System.

Sangheon Pack,Humphrey Rutagemwa, Xuemin Shen, Jon Mark,Kunwoo Park.(2007).Efficient Data Access Algorithms for ITS-based Networks with Multi-Hop Wireless Links.

Tsin Hing Heung, Tin Kin Ho, Member, IEEE, and Yu Fai Fung, Member, IEEE.(2005).Coordinated Road-Junction Traffic Control by Dynamic Programming.

Yi-Sheng Huang. (2006).Design of Traffic Light Control Systems Using Statecharts.