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RESEARCH ARTICLE

ADVANCE TRAFFIC CONTROL AND PLANNING.

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Abstract

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Traffic control can be regarded as a multi agent application in which car-agents and traffic-light-agents need to coordinate with each other to optimize the traffic flow and to avoid congestions. It is important to know the road traffic density real time especially in mega cities for signal control and effective traffic management. Traffic lights play an important role in the traffic management. The existing traffic lights follow the predetermined sequence. So these lights are called static traffic lights. These traffic lights are not capable to count the number of vehicles and the priority of the vehicles on intersection point. As a result some vehicles have to wait even there is no traffic on the other side. The vehicles like Ambulance and Fire Brigade are also stuck in traffic and waste their valuable time. In this paper, we propose an adaptive traffic light control algorithm that adjusts both the sequence and length of traffic lights in accordance with the real time traffic detected. Our algorithm considers a number of traffic factors such as traffic volume, waiting time, vehicle density, etc. and system also provides quality of service to Emergency vehicles.

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Introduction:-

This paper presents an automatic road traffic management systems that manage road traffic with the goal of improving traffic safety, optimizing the speed of the flow of traffic, and minimizing the energy consumption of vehicles running on the roads. Most existing work use a fixed sequence for traffic lights control, and take minimum average waiting time and number of vehicle stops as objectives. Most of them use the sensor to calculate current volume of traffic but this approach has the limitation that these techniques based on counting of the vehicles and treats a emergency vehicles as the ordinary vehicles means no priority to ambulance, fire brigade or V.I.P vehicles. With this system, we can consider the priority of different type of vehicles and also consider the density of traffic on the roads by installing RF reader on the road intersections. Radio frequency identification is a technique that uses the radio waves to identify the object uniquely. Section {I} represents the method a model problem and some notation and traffic control algorithm to detect the traffic condition, and then determine green light sequence and the green light length , section {II} represents the performance of our algorithm through simulation and implementation and section {III} represents provides approach to information regarding the priority of the vehicle and type of the vehicle with the help of VIN based on RFID Technique. Radio frequency identification is a technique that uses the radio waves to identify the object uniquely. RFID is a technique that is widely used in the various application areas like medical science, commerce, security, Electronic toll collection system, access control etc. There are three main components of RFID: RFID tag, RF Reader and Database. Various types of tags are available but we can mainly

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divide them into two categories: passive tags and active tags. The passive tags don't contain any internal power source. There are three parts of the tag: antenna, semiconductor chip and some form of encapsulation. The life of the passive tag is very long. The reader sends electromagnetic waves that produce current in the tag's antenna. In response antenna reflects the information stored in it. The active tags contain a battery as an internal power source used to operate microchip's circuitry and to broadcast the information to the reader. The range and cost of these tags is more as compare to passive tags . We have three kinds of tags which work on the three different frequency ranges: low – frequency, high-frequency and ultra high frequency. The Low frequency tags works on frequency lies between 30 ~ 300 KHZ and High Frequency and Ultra High Frequency Tag works on the frequency range lie 3 ~ 30 MHZ and 300 ~ 3 GHZ respectively

Problem Modeling and Notations:-

How to respond to a dynamically changing traffic environment adaptively to improve controlling efficiency. the efficiency includes maximum intersection throughput (the number of vehicles passing through the intersection), and minimum vehicle's average waiting time. the efficiency includes maximum intersection throughput (the number of vehicles passing through the intersection), and minimum vehicle's average waiting time. has two sensor nodes, one is installed at the intersection and the other is with a given distance, called *Sensor Distance*, from the intersection.

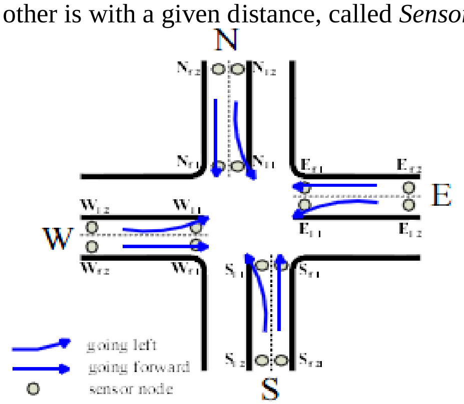


Fig. 1. Isolated Intersection

Subject to traffic safety rules, there exists a maximum of twelve different possible cases of green lights, in Fig. 2. Therefore, in face of dynamically changing traffic environment, the problem is transformed to decide which case should obtain green light next and how long it should last for.

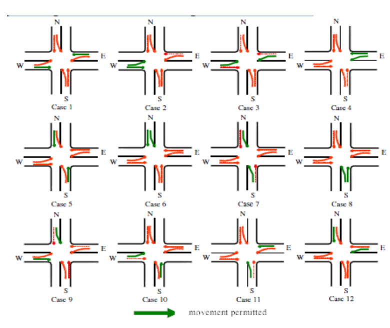


Fig. 2:- Twelve possible configurations of green lights

To formulate the problem, we use the following notations, and assume that all vehicles run at a constant speed *speed* and all the vehicles are in the same type:

$I = \{$north, south, east, west$\}$.

$J = \{$forward, left$\}$.

$R = \{1,2,3,...,8\}$.

$C = \{1,2,3,...,12\}$.

TP: total throughput.

AV GWT: average waiting time.

T: total time period.
DP(*k, t*): number of vehicles passing through the intersection at case *k* at time *t*, $k \in C$.
WT(*k, t*): sum of vehicles' waiting time at case *k* at time *t*, $k \in C$.
RM(*k, t*): number of vehicles at case *k* at time *t*, $k \in C$.
*Xy*1: sensors installed at the intersection in lane *y* at direction *X*, $X \in I$, $y \in J$.
*Xy*2: sensors installed with distance *Sensor Distance* from intersection in lane *y* at direction *X*, $X \in I$, $y \in J$.
Efficiency:

$$Max\ TP = Max\ \frac{\sum_{t=1}^{T} \sum_{k \in C} DP(k,t)}{T}$$

$$Min\ AVGWT = Min\ \frac{\sum_{t=1}^{T} \sum_{k \in C} WT(k,t)}{\sum_{t=1}^{T} \sum_{k \in C} RM(k,t)}$$

Equation 1 calculates the maximum number of vehicles passing through the intersection within a unit of time (*TP*), Equation 2 calculates the minimum vehicle's average waiting time (*AV GWT*) during time period *T*.

Proposed Algorithm:-

Traffic light control algorithm based on the above established model. The algorithm contains three steps: vehicle detection, green light sequence determination and light length determination. Vehicle detection detects and calculates traffic information in real-time. Green light sequence determination uses the traffic information to determine the next green light to the case in the most need. Light length determination determines how long the green light will last for. At the beginning, we set a control cycle *Tcontrol* first, which is defined as an upper bound of light length. This value of *Tcontrol* is based on expert knowledge.

Vehicle Detection:-

The first step is to detect arrival and departure rate of vehicles in each lane, and then collect relevant data, with sensor nodes installed in each lane of the intersection, as illustrated in Fig. 1. Sensor nodes detect the number of vehicles in each lane and each vehicle's ID and type. *Xy*1 is responsible to detect vehicles at the intersection, *Xy*2 is responsible to detect vehicles from the intersection with distance *Sensor Distance* mentioned. *Sensor Distance* is equal to *Tcontrol* × *speed* so that *Xy*1 will get the information of the vehicles which will reach the intersection after *Tcontrol* time in advance through the communication between *Xy*1 and *Xy*2. Using these detected data, the arrival rate and departure rate in each lane real-time can be determined. In a lane having green light, both arrival and departure rates are calculated in real-time. In a lane having red light has the departure rate of zero and the arrival rate reflects how many vehicles are waiting in the lane. Because each vehicle has a length *Lvehicle*, we divide lane length *Llane* into *m* intervals with the same length *Linterval* equal to *Llane m* , shown as *D*1,*D*2, ...,*Dm*. *Di* is demonstrated as interval [*di*−1, *di*]; *di* is defined as the distance to the intersection, which equal to *i*×*Linterval*. *RM*(*Di, t*), *AR*(*Di, t*), *DP*(*Di, t*) are defined as number of vehicles in, arriving in and departing from *Di* at time *t*, respectively. The arrival rate in *Di* at time *t* is equal to the departure rate in *Di*+1 at time *t* − 1, and then *RM*(*Di, t*) can be calculated(in equation 3 and equation 4). After that, *G*(*Di*) can be determined (in equation 5), which is defined as the density of traffic flow in interval *Di*, and then the density of traffic flow in the lane*V DDF*(*D*1,*D*2, ...,*Dm*) can be demonstrated in equation 6.

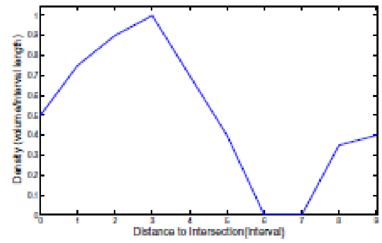
$$AR(D_i,t)=DP(D_{i+1},t-1)\} \quad (3)$$

$$RM(D_i,t)=max\{RM(D_i,t-1)+AR(D_i,t)-DP(D_i,t),0\} \quad (4)$$

$$G(D_i)=\frac{RM(D_i,t)}{L_{interval}} \quad (5)$$

$$VDDF(D_1,D_2,\ldots,D_m)=f(G(D_1),G(D_2),\ldots,G(D_m)) \quad (6)$$

This is a nonlinear function, a random function example is shown in Fig. 3. Different interval has different traffic flow density, that is different number of vehicles. At some intervals, there exists a sub-interval without any vehicle in, and its length is larger than *Lvehicle*. Here, we define this sub-interval as a *blank*. In order to check blank accurately, *Linterval* should be equal to 2.5×*Lvehicle*. Then, if there exists a *G*(*Di*), whose value is lower than 0.4 and higher than 0.2, we can decide that there is a blank in *Di* and the blank length *L*(*blank*) is equal to *Lvehicle*. If there exists a *G*(*i*), whose value is lower than 0.2, we can decide that there is a blank in *G*(*Di*) and *L*(*blank*) is equal to 2×*Lvehicle*.



Green Light Sequence Determination:-

The second step is to make a decision to determine green light sequence, using the traffic data real-time. In order to make this decision, we define *GLD*(*k*, *t*) to indicate the case *k*'s green light demand at time *t*, so that the case which has the most urgent demand should get the green light following. Since our objectives are to maximize the throughput and minimize the average waiting time, number of vehicles in each lane detected, their corresponding waiting time, the blank circumstance are influential factors. To guarantee that each case would not wait too long, hunger level as well affect the green light sequence determination decision-making.

Furthermore, special circumstance and effect from the adjacent intersections can play a role, too. Equation 7 demonstrates all the factors of *GLD*(*k*, *t*).

$$GLD(k,t)=a_1\times TV(k,t)+a_2\times WT(k,t)+a_3\times HL(k,t)$$
$$+a_4\times BC(k,t)+a_5\times SC(k,t)+a_6\times Neibor(k,t) \qquad (7)$$

Here, *TV* (*k*, *t*), *WT*(*k*, *t*), *HL*(*k*, *t*), *BC*(*k*, *t*), *SC*(*k*, *t*), *Neibor*(*k*, *t*) are defined as the weight of traffic volume, average waiting time, hunger level, blank circumstance, special circumstance and influence from neighboring intersections of case *k* at time *t*, respectively, *ai* are defined as the coefficient of these parameters to demonstrate their priorities, *i* =1, 2, 3, 4, 5, 6. In our problem, since the distance between two intersections is longer than *SensorDistance*, *Neibor*(*k*, *t*) can be ignored in this problem. Therefore, we discuss the 4 main factors as follows.

Factor 1) Traffic Volume:-

After *V DDF*(*d*,*RM*(*t*)) calculation, we can calculate the weight of traffic volume of each case. To calculate *TV* (*k*, *t*), we need to obtain *TraV ol*(*i*, *t*) first, which is defined as the total number of vehicles in the lane *i*, from time *t* to following *T control* time. *FV* (*i*, *t*) is defined as number of vehicles which would reach the intersection at time *t* in the lane *i*, *i* ∈ *R*. Equation 8 shows *TraV ol*(*i*, *t*) in lane *i* with the green light at time *t*, and equation 9 shows *TraV ol*(*i*, *t*) in lane *i* with the red light at time *t*. So, traffic

volume in case *k* can be obtained (in equation 10), *u*,*v* are two lanes of case *k*. Then, the traffic volume weight can be calculated (in equation 11). Higher *TV* brings more influence in decision-making.

$$TraVol(i,t)=RM(i,t)+\sum_{j=1}^{T_{control}}(FV(i,t+j)-DP(i,t+j))+\Sigma L(blank) \qquad (8)$$

$$TraVol(i,t)=RM(i,t)+\sum_{j=1}^{T_{control}}FV(i,t+j) \qquad (9)$$

$$TraVol(k,t)=TraVol(u,t)+TraVol(v,t) \qquad (10)$$

$$TV(k,t)=\frac{TraVol(k,t)}{\sum_{k\in C}TraVol(k,t)} \qquad (11)$$

Factor 2) Waiting time:-

To calculate *WT*(*k*, *t*), we need to obtain *AV GTwait*(*i*, *t*) first, which is defined as average waiting time in lane *i*, from time *t* to following *Tcontrol* time. Equation 12 shows *AV GTwait*(*i*, *t*) in lane *i* with the green light at time *t*, and equation 13 shows *AV GTwait*(*i*, *t*) in lane *i* with the red light at time *t*. So, average waiting time in case *k* can be obtained (in equation 14), *u*,*v* are two lanes which of case *k*. Then, average waiting time weight can be calculated (in equation 15). Higher *WT* brings more influence in decision-making

$$AVGT_{wait}(i,t)=0 \quad (12)$$

$$AVGT_{wait}(i,t)=\frac{RM(i,t)\times T_{control}+\sum_{j=1}^{T_{control}} FV(i,t+j)\times(T_{control}-j)}{TraVol(i,t)} \quad (13)$$

$$AVGT_{wait}(k,t)=\frac{(AVGT_{wait}(u,t)+AVGT_{wait}(v,t))}{2} \quad (14)$$

$$WT(k,t)=\frac{AVGT_{wait}(k,t)}{\sum_{k\in C} AVGT_{wait}(k,t)} \quad (15)$$

Factor 3) Hunger Level:-

The hunger level *HL*(*k*, *t*) is defined to guarantee the fairness, it can be determined by times of green light of case *k*, which is represented by *N*(*k*, *t*), $k \in C$, in equation 16. The more times the case got green lights before, the lower hunger level it gets currently; the fewer times the case got green lights before, the higher hunger level it gets currently.

$$HL(k,t)=1-\frac{N(k,t)}{\sum_{k\in C} N(k,t)} \quad (16)$$

Factor 4) Blank Circumstance:-

Blank plays a rather important role to calculate *GLD*(*k*, *t*). We try to minimize frequency of the circumstance in which there is a blank at the intersection with the green light for the certain lane. In order to maximize the throughput and minimize average waiting time, we calculate how many blanks

there are in each lane, and the length of each blank.

Within a *T*(*blank*) time, if a sensor node cannot detect a vehicle passing through, we decide there is a blank of length *L*(*blank*).

$$L(blank) = T(blank) \times speed$$

Blank detection indicates three possible circumstances: every case has blank, or some cases have blank, or none of them has a blank. Different circumstances have different solutions. When every case has at least one blank, we would like to give green light with high priority to the case in which the first detected blank has the farthest distance to the intersection. In this way, green light would be provided to let more vehicles leave. When some cases have blank, we would decide to give red light for these cases next directly. When none of them have blank, we treats them as the same priority.

Vehicle Priority Algorithm:-

The total vehicles are divided into 4 categories: First system category includes Ambulance, Fire Brigade vehicles and V.I.P vehicles. These vehicles have the highest priority. The second category includes the buses and school & college buses. These buses need to reach their destination on time so these vehicles also need a fast service. Third category includes the car, motor cycles and scooters and fourth category include the Heavy vehicles. Day time priority of 3rd category is high as compare to 4th category but during night hours the priority of the heavy vehicles high. Each intersection on the road has 4 traffic lights as shown in the figure 1. Each lane has its own RFID reader that stores the vehicles passing through it with time stamp. On the basis of the time stamp, we find the violators. For this purpose we store the duration of the green light. So the vehicles coming on the corresponding light are allowed to move in any direction. During this time reader corresponding to red light stores the vehicles passing through the lane.

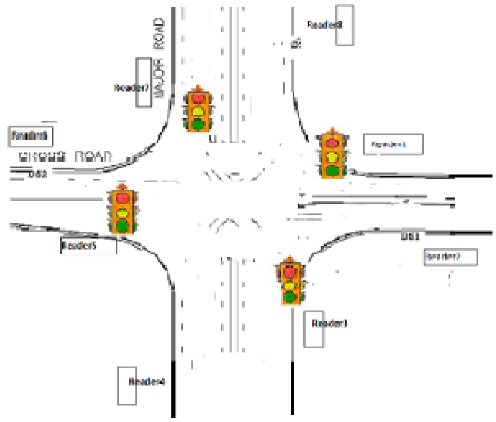


Fig. 4:- Structure of the Intersection & placement of the reader

Intelligent Traffic Light Controller: Each city has multiple intersections as shown in the figure 2. Two lights are called linked Lights that are placed on opposite sides of the road that join two intersections. The RFID reader stores the records of all the vehicles that passed through the road. The Traffic light controller follows the same round robin sequence of the lights. But if an Emergency vehicle is detected at any traffic light then controller leave the round robin schedule and generate the green signal for the ambulance. The other task of the controller is to calculate the time of green signal that is based on the number of vehicle. To solve the problem of Starvation a time limit is defined. If this limit exceeds then that light gets its turn.

The flow chart given below represents the flow of the algorithm. In which after receiving the message from linked lights controller consider the factors like traffic density of the road, priority of the vehicles and queue length and starvation factor to decide the term of the lightto display green signal. The flow chart given below not only works according to the number of vehicles near the traffic light but also solve the problem of starvation that can be arisen. Here the basic purpose of the algorithm is to calculate the green time duration and also provide the quality of the service to the Emergency vehicles like ambulance, Fire brigade and VIP vehicles so that they can reach at their destination as early as possible and reduce the time wasted at the Red Light.

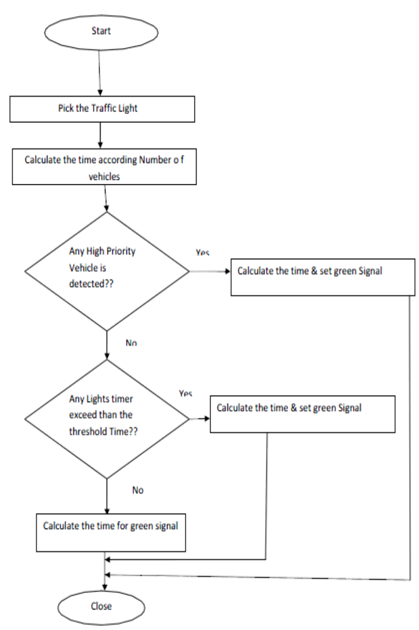


Fig. 5:- Flow Chart Model For Vehicle Priority approach

Conclusion:-

Using the proposed adaptive traffic light control algorithm, comparing it with fixed-time traffic control (FTC) and actuated traffic control (ATC), which are based on the same random arrival rate of each lane, *Tcontrol* , *speed*, *Lvehicle* and *Llane*. We set The objective of ATC refereed is to minimize the average waiting time, which is popular in existing ATC algorithm. We define *volume to-capacity* to indicate the busy degree of each lane. Here, *capacity* is defined as how many vehicles can be in the lane at the same time, equals to *Llane* *Lvehicle*

Therefore, *volume-to capacity* is equal to *TraV ol* capacity

The comparison items include throughput-to-volume and average waiting time. The intersection throughput values were calculated using the total number of vehicles departing the intersection per unit of time, and expressed as vehicles per second. Throughput-to-volume is defined as the percentage of passing vehicles in total traffic volume. The comparison items include throughput-to-volume and average waiting time. The intersection throughput values were calculated using the total number of vehicles departing the intersection per unit of time, and expressed as vehicles per second. Throughput-to-volume is defined as the percentage of passing vehicles in total traffic volume.

The work also considers not only the priority of the vehicles but also the density of the vehicles on the road and controls the traffic light sequence efficiently and more accurately and the accuracy of the RFID is more than Camera’s so it also improves the performance of traffic light Violation Detection System.

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References:-

1. Traffic Light Control in Wireless Sensor Network-based Intelligent Transportation System Binbin Zhou∗, Jiannong Cao∗, Xiaoqin Zeng§ and Hejun Department of Computing, The Hong Kong Polytechnic University, Hong Kong §Department of Computer Science and Technology, Hohai University, China †Department of Computer Science, Sun Yat- sen University, China
2. Urban Tra_c Control with Co-Fields Marco Camurri, Marco Mamei, and Franco Zambonell Dipartimento di Scienze e Metodi dell'Ingegneria, University of Modena and Reggio Emilia Via Allegri 13, 42100 Reggio Emilia, Italy
3. Automatic Traffic Density Estimation And Vehicle Classification For Traffic Surveillance Systems Using Neural Networks Celil Ozkurt And Fatih Camci Computer Engineering Department, Fatih University Istanbul, Turkey.
4. History based Traffic Control Gabriel Balan ,George Mason University Fairfax, VA (USA) Sean Luke , George Mason University Fairfax, VA (USA)