Wireless Traffic Signal Light using Fuzzy Rules

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Abstract:

In this paper, we wish to construct a optimal traffic cycle using wire remote control. if police vehicle or ambulance suddenly enter the traffic intersection, it will increase the traffic accident. In this paper, wireless traffic light use the radio traffic control signal and research about the hardware manufacture to check special detectors on urgency vehicles may safety and rapidly enter traffic intersection.

Also, this paper present a traffic signal control conditions that analyzes different traffic intersection flows in cases of saturated flows, where the real traffic volume demand is large and the capacity constraints of bottlenecks have significant effects on the flow patterns. Through computer simulation this wireless traffic light has been proven to be much more safety and efficient than fixed traffic signal light which does not considering emergency vehicles for safety escort.

Keywords: Principle of vehicle detecting, Coordination of traffic cycle, Wireless traffic light

1. Introduction

In this paper, wireless traffic light use the radio traffic control signal and research about the hardware manufacture to check special detectors on urgency vehicles may safety and rapidly enter traffic intersection.

Also This paper is proposes a optimal green time to analyzes traffic network flows in cases of saturated flows. If the throughput of bottlenecks limit the downstream flow flows and in some cases might limit the ability of the network to serve all the green demand. Another important feature of saturated networks is the effect of the queue spillback on travel times in um stream links. The more important thing is overflows into the bottlenecks result in apparent violations of the outflow rates into bottlenecks might be smaller than the inflows. Now days, the traffic congestion has increased steadily in urban network.

Moreover, if there are car accident and under construction work of telephoned, it is very difficult to calculate optimal green time. Because these roads are already to occupied with many cars and it is not easy to enter the vehicles in the road . So, in this paper, traffic control for coordination of traffic signal considering safety or switch off the green time are proposed a avoid traffic congestion, car accident, and informing the emergency passing vehicle considering safety.

In this paper, we wish to construct a optimal traffic cycle using wire remote control. If police vehicle or ambulance suddenly enter the traffic intersection, it will increase the traffic accident. In this paper, wireless traffic light use the radio traffic control signal and research about the hardware manufacture to check special detectors on urgency vehicles may safety and rapidly enter traffic intersection. Wireless traffic light system can switch on and switch off the traffic cycle using special detector when emergency vehicle is come up to the road or come over the road.

The traffic signal control system of the traffic congestion length is also described by a number of lanes , length of vehicle size and length of traffic intersection. Three traffic signal control parameters are adaptively controlled so as to minimize a vehicle waiting time and increase a vehicle speed when suddenly emergency vehicle comes in. This paper is organized as follows: Section 2 We briefly explain the problem of conventional traffic light. Section 3 presents the basic principle of vehicle and different vehicle analog signature using loop detector and estimating vehicle length. Section 4 will explain coordination of traffic cycle simulation. Finally, Section 5 will give conclusions.

2. Capacity of traffic intersection

Based on traffic volume balance at each signalized intersection, the traffic congestion mechanism can be described quantitatively.

The capacity at each signalized intersection is evaluated summing up each lane capacity as follows. where are the possibility of number of left turn cars, straight forward cars, saturation degree of traffic intersection. The traffic capacity at each signalized intersection can be rewritten as follows. Where I, j, k denote the number of lanes, length of vehicle length and length of traffic intersection.

The three most important characteristics of traffic are flow, speed, and concentration. Before attempting to model these characteristics, it is essential to definitions are related to the methods of measurement, as well as to the methods of averaging the measurements.

Traditionally, the traffic engineer has used volume or flow as one of the primary measures of traffic condition or state. This has been because flow is the easiest of all characteristics to obtain.

An optimum cycle length formula was developed by webster for pretimed application. This formula, yields the cycle length that will produce minimum total vehicle delay. A second formula was developed for similar cycle length calculations for actuated applications. These are expressed as follows.

The traffic volume balance is held at each signalized intersection of the traffic network for a certain sampling period. It can be described by the following equation.

$C_c(green) = G_{rtc}(car)+G_{rti}(car) - G_{rto}(car)$

where:

$G_{rtc}(car)$: Excess incoming traffic cars

$G_{rti}(car)$: Incoming traffic cars

$G_{rto}(car)$: Outgoing traffic cars

In order to determine number of vehicles for straight, it must get number of right turn and straight. Because many roads are used same line as a right turn and straight. If there are so many vehicles in the line, we can not know how many vehicle go to straight or right turn. Therefore to determine optimal green time, it must predict the number of straight turn not a turn right.

$C_c(green)=C_{xc}(in)*R_{tn}(exp\_in)+S_{tr}(exp\_in)$

$C_{rt}(green)=N_l* W_L* C_{xl}(in, out)$

where :

$C_{xc}(in)$: Excess incoming traffic cars

$R_{tn}(exp\_in)$:expected cars for right turn

$S_{tr}(exp\_in)$: expected cars for straight

The capacity at each signalized intersection is evaluated summing up each lane capacity as follows. If capacity of upper traffic intersection is bigger than capacity of lower traffic intersection, it will be alright to go vehicles for green time. But, if If upper capacity of traffic intersection is bigger than capacity of lower traffic intersection, it will be alright to go vehicles for green time. Moreover to prevent spiilbak, it must check the capacity of intersection.

X_{cap}(cars, length, lanes)upper > X_{cap}(cars, length, lanes)lower

In this paper the traffic signal control system of the traffic congestion length is to considered 1 ~ 3 coordinated intersections as follows.

for 2 lanes of the traffic intersection,

$$J_i(car) = \sum_i (S_{tr}(car) + R_{tn}(car))$$

for 4 lanes of the traffic intersection,

$$J_i(car) = \sum_i \sum_j (S_{tr}(car) + R_{tn}(car))$$

for 6 lanes of the traffic intersection,

$$J_i(car) = \sum_i \sum_j \sum_k (S_{tr}(car) + R_{tn}(car))$$

The above formula may be utilized to select the cycle length at a given isolated intersection. The equations yield cycle length

Depending on the capacity of traffic intersection, the red clearance interval is determined by one of the following expressions.

$$r = \frac{W+L}{V}, \ or$$

$$r = \frac{P}{V}, \ or$$

$$r = \frac{P+L}{V}, \ or$$

where

r=length of red clearance interval, to the nearest 0.1sec, W=width of intersection, in feet, measured from the near-side stop line to the far edge of the conflicting traffic lane along the actual vehicle path, P=width of intersection, in feet, measured from the near-side stop line to the far side of the farthest conflicting pedestrian crosswalk along the actual vehicle path, L=length of vehicle, recommended as 20 ft, and V=speed of the vehicle through the intersection, in ft/sec.

Generally, for volume conditions that approach capacity, the lane utilization factor is not applied in the analysis. It is applied, the results can be considered to prevent spiiback.

$$s = s_0 N f_w f_{HV} f_g f_P f_{bb} f_a f_{RT} f_{LT}$$

where:

s=saturation flow rate for lane group, in vphg
s0=ideal saturation flow rate per lane, usually 1,800 pcul
N=number of lanes in lane group
f_w=adjustment factor for lane width
f_{HV}=adjustment factor for heavy vehicles
f_g=adjustment factor for grade
f_p=adjustment factor for adjacent parking lane and activity
f_{bb}=adjustment factor for local buses stopping
f_a=adjustment factor for area type
f_{RT}=adjustment factor for right turns
f_{LT}=adjustment factor for left turns

Once the adjustments have been made to volume and to saturation flow, the capacity of each lane group being analyzed is computed as follows.

$$c_i = s_i \times g/C_i$$

c_i=capacity of lane group i, in vph
s_i=saturation flow rate for lane group i, in vph
(g/C_i)=green/cycle ratio for lane gropu i

$$d = 0.38C\frac{[1-g/C]^2}{[1-(g/C)(X)]} + 173\,X^2$$

$$\times[(X-1)+\sqrt{X-1^2+(16X/c)}]$$

where

d=average stopped delay per vehicle, in sec/veh
C=cycle length, in sec
g/C=green ratio for the lane group
X=v/c ratio of the lane group
c=capacity of the lane group

3. Principle of vehicle detecting

The conventional loop detector installed on roads today detect a change in inductance from the presence of a vehicle. The loop sensitivity, SL, of an inductive loop is defined as Eq. (1).

$$SL = 100 * \frac{LNV - Lv}{LNV} = 100 * \frac{\triangle L}{L}$$

where

LNv = Inductance with no vehicle
Lv = Inductance with vehicle

Vehicle detector systems sense a decrease in inductance during the passage or presence of a vehicle in the zone of detection of the sensor loop. Thus, when a vehicle passes over the loop or stops within the loop, the inductance of the loop decreases.

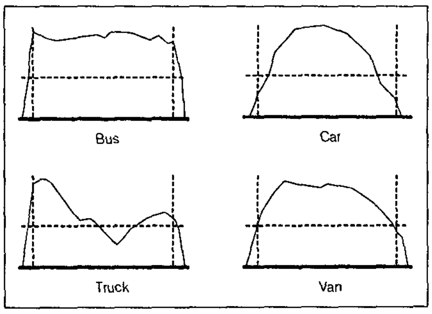

Fig 1. principle of vehicle detecting

In Fig 1 shows Sensitivity for four classifications of analog vehicle signature have specific values, when they pass the single loop detector(1.8M *1.8 M). But, it is not the same passing vehicle speed, passing vehicle weight, and passing area of loop detector when lower traffic intersection of passing vehicles passes over the loop detector. Therefore, it is not easy to classify 4 kinds of passenger car units.

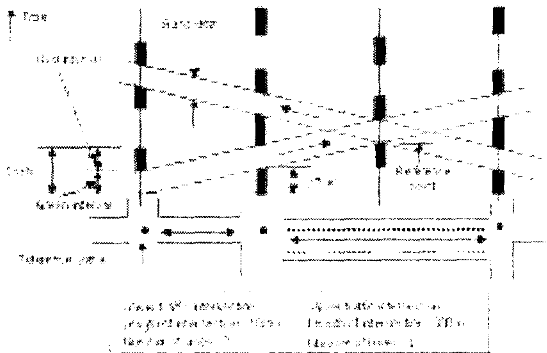

Fig 2. Optimal green time depending on lower and upper traffic intersection

If there are car accident and under construction work of telephoned, it is very difficult to calculate optimal green time. Because these roads are already to occupied with many cars and it is not easy to enter the vehicles in the road .

So, in this paper, traffic control for coordination of traffic signal considering safety or switch off the green time are proposed a avoid traffic congestion, car accident, and informing the emergency passing vehicle considering safety as shown in fig 2.

4. Coordination of traffic cycle simulation

A knowledge-based traffic expert system that if police vehicle or ambulance suddenly enter the traffic intersection, it will increase the traffic accident. In this paper, wireless traffic light use the radio traffic control signal and research about the hardware manufacture to check special detectors on urgency vehicles may safety and rapidly enter traffic intersection.

The concept of knowledge in the knowledge-based society is different from the one in the past. The knowledge-based society demands active knowledge, alive and dynamic, rather than stagnant. That is, knowledge is not considered to be something made by and obtained from others but something created according to the individual's needs and through trial and error. Such a change in the concept of knowledge differentiates the image of a man in the knowledge-based society from the image of man in industrial society.

4. Design of optimal fuzzy traffic cycle

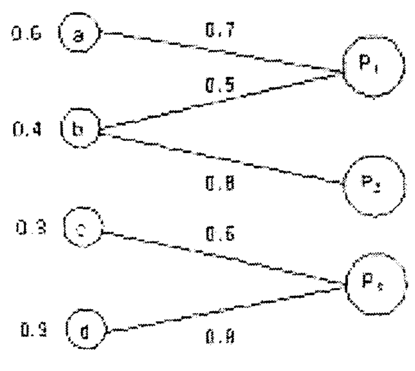

Fig. 3 Fuzzy conversion factor for length of traffic intersection

Let's think about how many cars are in the upper traffic intersection at rush hour.

At this time, let's assume that high saturation degree of upper traffic intersection conditions of a, b ,c ,d are 0.6, 0.4, 0.3, 0.9.
Low saturation degree of lower traffic intersection conditions are P_1, P_2, P_3.

In other words, there are so many cars in the upper traffic intersection but, there are a few cars in the lower traffic intersection.
Let's inferences the degree of saturation when estimating of passing vehicles start from upper traffic intersection and entering to the lower traffic intersection.
The numbers above in the line are lanes and length of traffic intersection.
Capacity of traffic intersection is very closely related with lanes of width of traffic intersection.
The important thing is to prevent spillback and estimate how many vehicles can enter the upper traffic intersection.

If lower traffic intersections and upper traffic intersections consist of equal 4 lanes and 100 meter for length of traffic intersection.
It must extend the optimal green time when there are so many vehicles in the traffic road. But, it must reduce the optimal traffic cycle when there are a few vehicles on the traffic road or capacity of passing vehicles for upper traffic intersection is smaller than capacity of lower traffic intersection.
in order to prevent the spillback and optimal traffic cycle we must consider width and length of traffic intersection.

In this paper, we will introduce about fuzzy extension set of different traffic intersection

The following shows examples of calculation for the membership of B'.
For b_1,

$$Min[\ \mu_A(a_1),\ \ \mu_R(a_1,\ b_1)] = [0.4, 0.8] = 0.4$$

$$Min[\ \mu_A(a_3),\ \ \mu_R(a_3,\ b_1)] = [0.9, 0.3] = 0.3$$

$$Max[0.4, 0.3] = 0.4 \Rightarrow \mu_{B'}(b_1) = 0.4$$

For b_2,

$$Min[\ \mu_A(a_2),\ \ \mu_R(a_2,\ b_2)] = [0.5, 0.2] = 0.2$$

$$Min[\ \mu_A(a_4),\ \ \mu_R(a_4,\ b_2)] = [0.6, 0.7] = 0.6$$

$$Max[0.2, 0.6] = 0.6 \Rightarrow \mu_{B'}(b_1) = 0.6$$

For b_3,

$$Max\ Min[\ \mu_A(a_4),\ \ \mu_R(a_4,\ b_3)] = Max\ Min[0.6, 0.4] = 0.4 \Rightarrow \mu_{B'}(b_3) = 0.4$$

So fuzzy set B' obtained by fuzzy set A and fuzzy relation R is,

$B' = [(b_1,\ 0.4),\ (b_2,\ 0.6),\ (b_3,\ 0.4)]$

Extension of fuzzy set and fuzzy relation is also possible among the several relations and sets. That is, the fuzziness in fuzzy set A can be propagated through more than one relations and sets.
Figure 3 Fuzzy set A can make a fuzzy set B′ in crisp set B by fuzzy relation $R_1 \subseteq A \times B$, and B′ again can make a fuzzy set C′ from fuzzy relation $R_2 \subseteq B \times C$.

$$A = [(a_1,\ 0.8),\ (a_2,\ 0.3)]$$
$$B = [b_1,\ b_2,\ b_3]$$
$$C = [c_1,\ c_2,\ c_3]$$

$M_{R_1} =$

	b_1	b_2	b_3
a_1	0.3	1.0	0.0
a_2	0.8	0.0	0.0

$M_{R_2} =$

	c_1	c_2	c_3
b_1	0.7	0.4	1.0
b_2	0.2	0.0	0.8
b_3	0.0	0.3	0.9

By fuzzy set A and fuzzy relation R1, we get the following B'.

$B' = [(b_1,\ 0.3),\ (b_2,\ 0.8),\ (b_3,\ 0.0)]$

Again by B' and R_2, we get C'

$C' = [(c_1,\ 0.3),\ (c_2,\ 0.3),\ (c_3,\ 0.8)]$

The original fuzziness in the set A was propagated to C' through B, C, R_1, and R_2

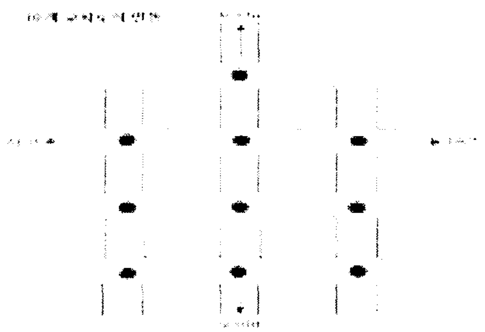

Fig 4 Optimal traffic cycle of 10 Traffic intersection

Figure 4 shows a block diagram of an optimal traffic cycle light for 10 traffic intersection using fuzzy neural network and it can reduce vehicle waiting time and to determine optimal green time, adapting to any different type of traffic intersection.

```
int graphdrive=DETECT,graphmode;
    int n_c,s_c,e_c,w_c;
    int paval;
    int ncar[3],scar[3],ecar[3],wcar[3];
    int pcar[3];
    float ntime,stime,etime,wtime;
    float ptime;
    float ppp;
    int naval=0,saval=0,eaval=0,waval=0;
    int nfval=0,sfval=0,efval=0,wfval=0;
    int goflag;
    int ntl,stl,etl,wtl;
    nrandom=YES,srandom=YES,erandom=YES;
     randomize();
   for(i=0;i<3;i++)
   {
         ncar[i]=0;
         scar[i]=0;
         ecar[i]=0;
         wcar[i]=0;
         pcar[i]=0;
    }
    goflag=NORTH;
    ntl=GREENLIGHT;
    stl=REDLIGHT;
    etl=REDLIGHT;
    wtl=REDLIGHT;
    setcolor(LIGHTBLUE);
    outtextxy(140,80,"North");
    nabuf[0][0]=1;
    nabuf[0][1]=NSCENTER-10;

    nabuf[0][2]=UP+20;
    naval=1;
    paval=0;
    pcar[1]=1;

    while(!kbhit())
    {
         if(nrandom==YES)
         if(n_c<3)
         {
              nfval++;
              switch(n_c)
              {
                   case 0:        /*small car*/
                   {
                        ncar[0]++;
                        break;
                   }
                   case 1:        /* medium car*/
                   {
                        ncar[1]++;
                        break;
                   }
                   case 2:        /* large car*/
                   {
                        ncar[2]++;
                        break;
                   }
              }/* check for traffic ocndition */
       if((pass1+pass2)>140) {
                weight=random(5000)+25000;
                outtextxy(480,90,"       High    Capacity
."); }
                else if((pass1+pass2)>130) {
                        weight=random(5000)+22500;
                   outtextxy(480,90,"LOW speed "); }
                else if((pass1+pass2)>120) {
                        weight=random(5000)+17500;
                outtextxy(480,90," Middle Capacity
                                                "); }
                else if((pass1+pass2)>100) {
                        weight=random(5000)+12500;
                        outtextxy(480,90,"    Highl
                                        Speed "); }
                else if((pass1+pass2)>80) {
                        weight=random(5000)+7500;
                        outtextxy(480,90,"    Middle
                                Capacity "); }
                else {
```

```
                    weight=random(8000);
    outtextxy(480,90," Low speed
                                         "); }
    sprintf(buffer3,"%d",weight);
    outtextxy(550,75,buffer3);
```

Table 1. Comparison with A.I. traffic light depending on capacity of traffic intersection considering emergency vehicle

Switch on	Traffic condition								Passing car			Waiting time	
3 Roads	width of road			Length of road			Speed	Capacity	Big	Med	small	R.F. Light	T.O.D (Sec).
ABC	3	4	8	130	155	370	slow	High	5	4	7	52	60
CDE	4	4	6	170	140	390	med	High	4	9	8	55	60
ABC	4	6	8	190	320	250	slow	Med	2	0	4	48	60
EFG	8	4	6	250	190	140	G	High	2	3	13	51	60
ABC	4	6	8	150	190	120	B	Low	1	1	6	42	60
CDE	8	6	8	190	170	260	E	Low	3	2	5	39	60
ABC	4	4	6	250	230	280	A	Med	1	2	9	47	60
CDE	4	6	4	190	190	320	E	High	9	8	11	53	60

5. Conclusion

Under relative light traffic conditions in linear corridor systems, it is usual to try and coordinate sets of signals to produce a switch on condition. This means that traffic passing through one set of signals meets subsequent signal at green.

In this paper, wireless traffic light use the radio traffic control signal and research about the hardware manufacture to check special detectors on urgency vehicles may safety and rapidly enter traffic intersection.

Also, this paper present a traffic signal control conditions that analyzes different traffic intersection flows in cases of saturated flows, where the real traffic volume demand is large and the capacity constraints of bottlenecks have significant effects on the flow patterns. Through computer simulation this wireless traffic light has been proven to be much more safety and efficient than fixed traffic signal light which does not considering emergency vehicles for safety escort.

No matter how well the electric traffic light has been systematized, it cannot properly function during a department stores sudden sale period, holidays or traffic over runs at 130%.

Thus, in this paper with the help of the Fuzzy Traffic Sense Network it allows the smooth run of traffic by repairing the state of traffic at 10 different intersections every 5 minutes and creating the minimum period of green signal based upon the amount of traffic.

Yet, the most efficient way is to control 10 different intersections with one traffic tower. Thus calculating the compensation variable of different road variables such as one-way streets and merging road conditions.

According to the simulation, over 25 to 38 % of traffic waiting time is reduced. Also this system analyzes one week of proposed traffic situations and describes the different intersections and provides information on local businesses such as gas stations and restaurants.

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