Controlling Time of Traffic Lights Automatically and Adaptively

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ABSTRACT

Controlling of traffic lights at road intersection will be optimum, if the adjustment is appropriate to level of vehicles queue. The densest queue of vehicles requires green time longer than less dense queue of vehicles. A new algorithm referred to Webster method is proposed to count the green, red, and humber time at traffic light automatically and adaptively, by using to predict number of vehicles from previous research. The algorithm that was resulted by composite between Radial Basis Function Network (RBFN) methods with K-Means cluster was used to predict number of vehicles. The resulting of simulation shows that system could predict number of vehicles in real time by total error 0,053977.

Webster method is generally used to calculate green, red, and humber time, but it is constant, while level of dense of vehicles queue is not constant. This paper uses Webster method to calculate time of traffic lights, and uses actual vehicles flow that is predicted by composite as main parameter to count green time. The humber time is determined by speed of vehicles and distance between stopping line with target line. The speed is obtained by implementation of XOR and subtraction method into speed algorithm. So, green and humber time is always change appropriate with levels of vehicles density.

Effectiveness of new algorithm and system is simulated by software. The system can determine maximum green time if the condition of vehicles flow is dense, and determine minimum green time if the condition of vehicles flow is quiet.

Keywords: RBFN, predict number of vehicles, adaptively, automatically, controlling traffic light.

INTRODUCTION

Generally, controlling time traffic light is manual, while traffic of vehicles every phase is not constant, so the manual system is not effective. This case is causing many researchers have done many researches to overcome effectiveness of traffic light system. Gong research has added CAMSHIFT algorithm to the system tracking of traffic light [1]. Wan research has made a framework for a dynamic and automatic traffic light control expert system combined with a simulation model, which is composed of six submodels coded in Arena to help analyze the traffic problem [5]. Chung has discussed a vision-based traffic light detection system at intersection [3]. Chen has done research the Eco-Sign system is a traffic light control system for minimizing greenhouse gases emitted by idling vehicles at intersections [2]. Yoyok has created structure and algorithm to predict number of vehicles at traffic light intersection by using composite between RBF Networks and K-Means Cluster method [6].

This paper explain about new algorithm how to implement prediction of vehicles number (result of research in 2010) to control time of traffic light in automatically and adaptively. This is only review at glance about prediction of vehicles number, there were three main

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processes: learning, examination, and clustering process. First, image of every vehicle (big vehicle, light vehicle, motorcycle, and vehicle without engine) was processed by using image processing; the result was floating point numeral. The floating point numeral was used as data input to process RBF Networks function, the result was weight. The examination process was done in real time, start from capturing vehicles flow at intersection road until comparing weight with learning process, and the finally it was done clustering to group every vehicle, and to predict number of vehicles.

Webster method is adopted to determine green, red, and humber time. The number of vehicles was converted into passenger car equivalent (pce),

WEBSTER METHOD AS CONTROLLING TRAFFIC LIGHTS INTERSECTION

Webster method is often used for calculating traffic lights time at intersection road manually based on constant planning time. One of important factors for counting traffic lights time is saturated flow near intersection. Saturated flow is maximum flow which can pass intersection from one direction without disturbance. This method is used to determine how long time green, red, and humber at intersection traffic light. Webster method gives provision base on observation result and calculation that saturated flow for road width as follows:

Table 1. Vehicle Saturated Flow in (passanger cars)/ hour

Road Width (m)	3,05	3,35	3,65	3,95	4,25	4,60	4,90	5,20
Saturated Flow (pc/h)	1850	1875	1900	1950	2075	2250	2475	2700

If the road width is more than 5.2 m, so saturated flow = L x 525 (pp/h).

Especially a good intersection road (free view, and so on), saturated flow is added by 20%, and bad intersection road (uphill road, unfree view, and so on), saturated flow is substracted by 15%.

- Ratio norm flow against saturated flow is y = Q/S
- The worth of congestion is stated as phase ratio, FR = Σymax

S = saturated flow (pc/h) obtained from table

Q = real flow (pc/h) obtained from observation

The factor which is needed to calculate maximum period is lost time (t_{lost}), that is time full cycle when there is no vehicle. This is done not only all time of red and red/red/humber, but also part of preparing time to move (starting-up) and preparation stops (tailing-off) for each color change lamp [4]. The lost time is counted by formulation:

$$Lt = 2n + R \quad (1)$$

by, n = number of phase (such as simple intersection (NW, EW = 2 phases)

R = time for all red and time for red/red/humber (2+3 = 5 second)

Lt = defined by total green time substracted by 1 second per green.

Observation laboratory in London, optimum period (C_o) is given:

$$C_o = \frac{1.5(L_t+5)}{(1-FR)} \quad (2)$$

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Time green is defined:

$$g_i = \frac{y_i(C_o - L_t)}{FR} - 1 \quad (3)$$

This is range of cycle time:

Table 2. Cycle Time

Setting Type	*Feasible cycle time (sec)*
Two phase of setting	40 – 80
Three phase of setting	50 – 100
Four phase of setting	80 - 130

Source: MKJI (1997)

Finally, actual green time:

$$ga = g + k - Lt \quad (4)$$

by:

ga = actual green time (second)

g = cycle green time (second)

k = humber time (generally, use 3 second)

Lt = lost time

Co = cycle time (second)

q = actual vehicle flow (pc/h)

S = saturated flow (pc/h)

PREDICT NUMBER OF VEHICLES BY USING RADIAL BASIS FUNCTIN NETWORK (RBFN) AND K-MEANS CLUSTER

The RBFN model which is examined in the research is a unsupervised manner, by using weight value that have been resulted in the learning process, and then it is used to calculate the value of output function RBFN (F_{out}). This model use data input which is got from capturing vehicles image in real time. Several of examining process steps such as: image processing, preparing data input, hidden layer activated are as same as learning process. The examination process has several of steps, such as; image processing, preparing data input, hidden layer activated by using Gauss function figure (1) follows:

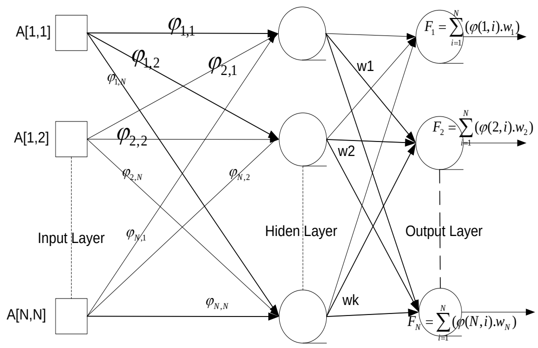

Figure 1. Neural Network Structure of RBFN with N output

Calculating of Fout values from weight which have been resulted learning process and data input in real time as writen on equation (5),

$$F(x) = \sum_{i=1}^{k} \varphi(\left\| x - \bar{x}_i \right\| . w_i) \qquad (5)$$

Then F_{out} data are grouped by using K-Means cluster, the following is flowchart of K-Means clustering in figure (2):

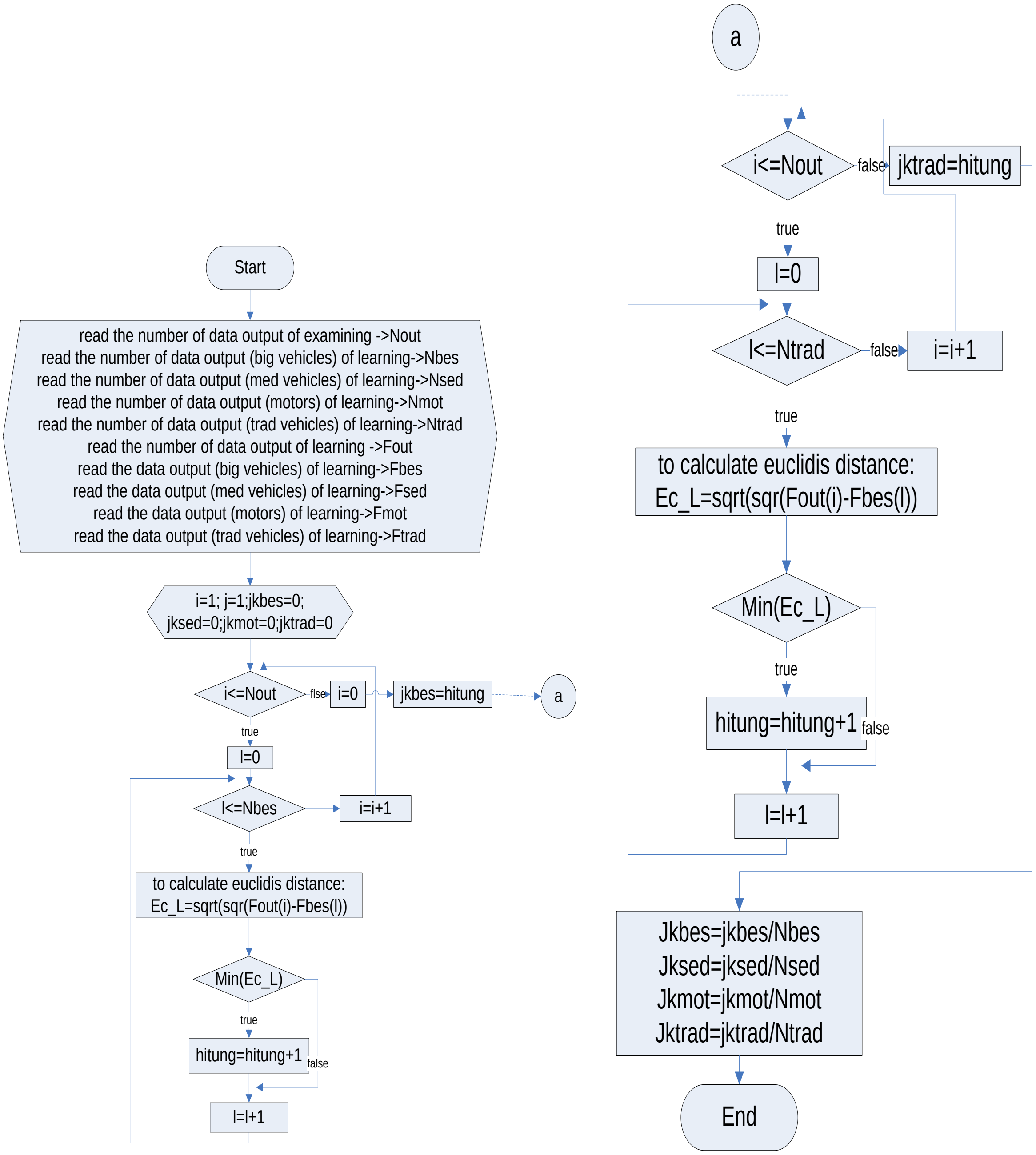

Figure 2. K-Means Clustering process, and the number of vehicles calculating

NEW ALGORITHM FOR CALCULATING GREEN, RED, AND HUMBER TIME AT TRAFFIC LIGHTS

In the previous research was resulted vehicles number prediction which was grouped in 5 categories scilicet,

- Heavy vehicle (such as bus, truck, dump truck,…)
- Light vehicle (station weagon, sedan, van,…)
- Motorcycle
- Vehicle without engine

The unit of prediction will be converted into passenger car equivalent (pce). In equation (1), (2), (3), and (4) can be known that some variable have change worth appropriate with actual condition in real time. Lost time as humber time is obtained from distance between stopping line with target line is divided by speed of vehicles. The speed is obtained by implementation of XOR and subtraction method into speed algorithm. So, green and humber time is always change appropriate with levels of vehicles density, figure (3) is flowchart of green time in nst phase:

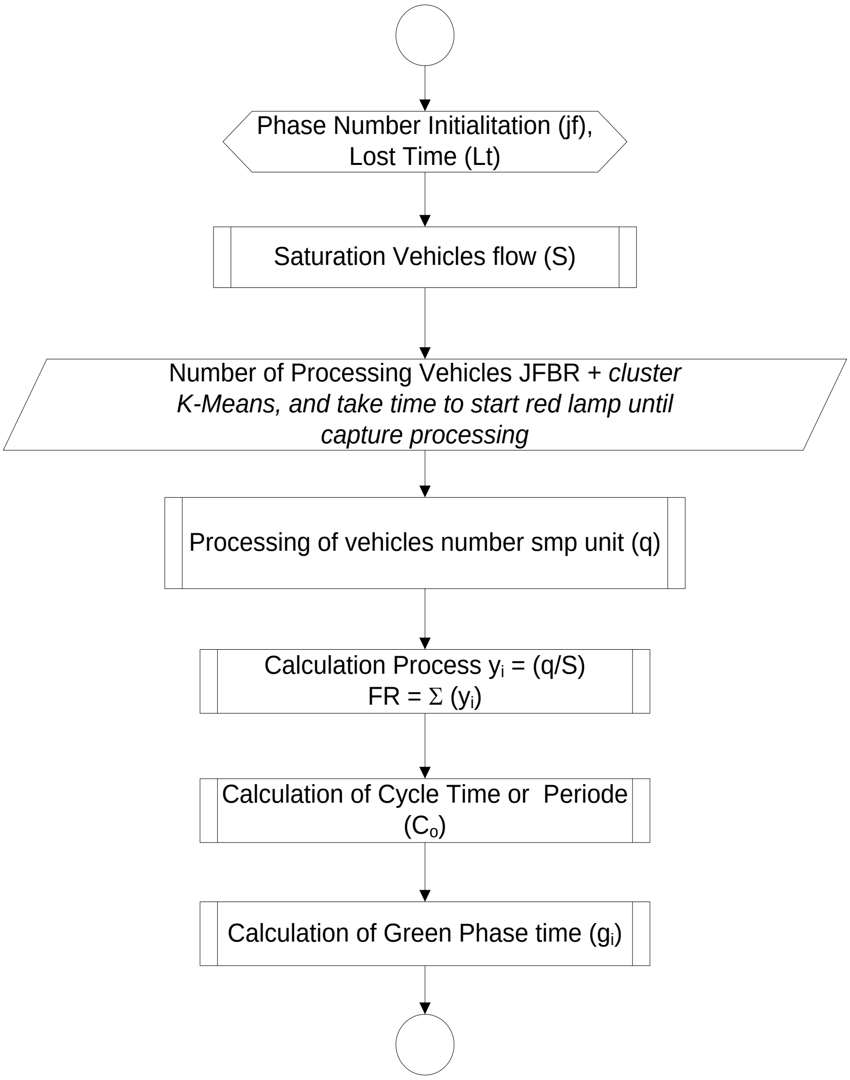

Figure 3. Flowchart of green time in nst phase

In the figure (3) shows that many parameters is determined in real time, so green time will be obtained in real time is appropriate with vehicles flow. The green time is obtained in real time that is appropriate with vehicles flow condition is called controlling time of traffics light automatically and adaptively. Figure (4) is algoritm of system in traffic light,

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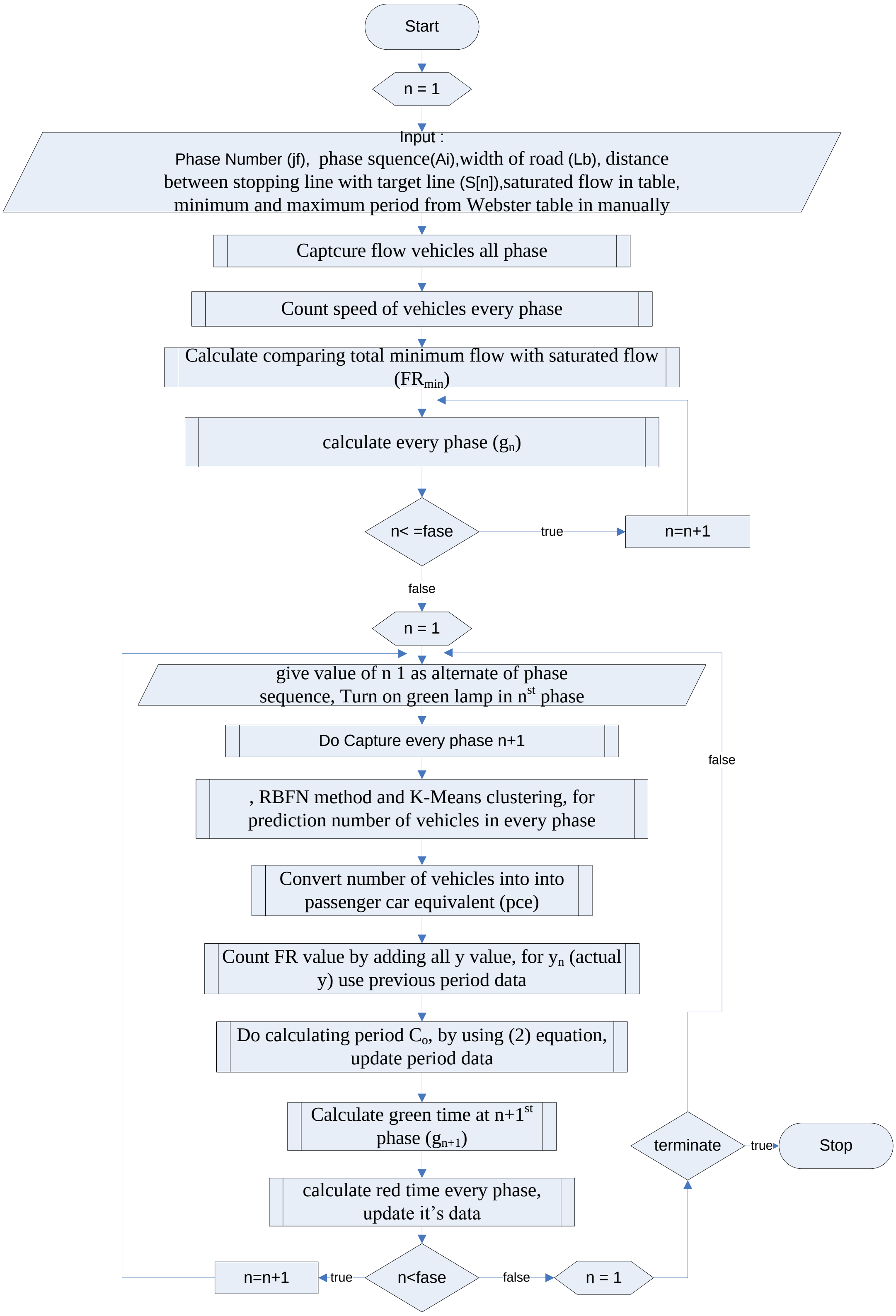

Figure 4. Flowchart of Traffic light Conttrolling System in automatically and adaptively

Figure (4) can be explained as follows:

1. Enter worth of phase number, phase squence, width of road, distance between stopping line with target line, saturated flow in table, minimum and maximum period from Webster table in manually.

2. Captcure flow vehicles all phase
3. Count speed of vehicles every phase, by using image processing, and then calculate time which is needed from stopping line until target line every phase. This time is lost time as humber time and overlapping red-green time. Calculate comparing total minimum flow with saturated flow (FR_{min}), and then comparing minimum flow every phase (y_{in}) and take the largest value from every phase.
4. From data 1 - 3 is used to calculate every phase (g_n)
5. Turn on lamp in one period
6. If pass one period, give value of n 1 as alternate of phase sequence
7. Turn on green lamp in n^{st} phase and red lamp for other phase.
8. Capture vehicles flow for all phase
9. Do image processing, RBFN method and K-Means clustering, for prediction number of vehicles in every phase. Count time start red turning on until capturing time in all phase except n^{st} phase. Convert number of vehicles into into passenger car equivalent (pce). Count vehicle flow in passenger car unit per second (q).
10. Do to compare between vehicles flow actual and saturated (q/S) in all phase except n^{st} phase, take the largest value in every phase (y). Count FR value by adding all y value, for y_n (actual y) use previous period data.
11. Do calculating period C_o, by using (2) equation, update period data.
12. Calculate green time at $n+1^{st}$ phase (g_{n+1}), by using (3) equation, and calculate red time every phase, update it's data.
13. What is n<=jf, if true so n=n+1, and then repeat number 7, if false n=1, what will be terminated the system, if true so Ending, and if false go to number 7

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