INTELLIGENT TRAFFIC CONTROL SYSTEM USING DENSITY BASED ESTIMATION ALGORITHMS

[1]SWESWEWIN, [2]WUTYIWIN, [3]MEMEKO

[1,2,3]Mechatronic Engineering Department, Mandalay Technological University, The Republic of Union of Myanmar
E-mail: [1]sswinn22@gmail.com,[2]wutyiwin@gmail.com, [3]myatthinzarkoycc@gmail.com.

Abstract - The traffic congestion is a daily occurrence problem throughout the world. This intelligent traffic control system (ITCS) intends to work more effectively the traffic control for the four-way intersection. This system is a vehicle-actuated signal type control system such that traffic cycle time can be varied and related to the actual demands by traffic. The traffic video file at a station in Mandalay is utilized for the experimental test and traffic density area on the road is used as the input data for controller of the system. The density areas on both directions of the analyzed road are calculated by using contour, moment and area-based calculation image processing algorithms. Depending on sum of the amount of density area on both directions, three types of traffic cycle times are determined such as 30 sec, 45 sec and 60 secs. This research is desired to improve the system by reducing waste of time based on traffic density area.

Keywords - Contour, Moment, Area-Based Calculation Algorithm, Traffic Cycle Time, Density Based Traffic Control System.

I. INTRODUCTION

The traffic congestion has worsened due to the rapid increase of vehicles and insufficient roads to accommodate them. This problem was attempted to solve by many researchers with different ways. The magnetic loop detection system was also utilized by burring in the ground of the road. Some of the current traffic technique involves the infra-red and radar sensors to count and analyze the traffic queen. Conventional signaling systems use timing circuitry that they turn to red and green by depending on the time, also create problems during the peak hours due to regarding traffic estimation. Intelligent systems have been developed that these systems can estimate the traffic density.

The vision based intelligent traffic management system is a robust framework that manages the on-road traffic flow in real time by estimating traffic density near traffic signals. This system used a simple algorithm to calculate the number of vehicles at various signals on a road to efficiently manage the traffic by controlling signals to avoid congestion and traffic jam [1]. The traffic density estimation and vehicle classification are useful and effective for traffic management systems. The real time video traffic video file was utilized for traffic surveillance system using neural network method [2]. The image captured in the traffic signal is processed and converted into grayscale image then its threshold is calculated based on which the contour has been drawn in order to calculate the number of vehicles present in the image. [3].

The system detects vehicles through images instead of using electronic sensors embedded in the pavement. A camera was installed alongside the traffic light. It captured image sequences. Setting image of an empty road as reference image, the captured images are sequentially matched using image matching. The Prewitt edge detection operator has been carried out and according to percentage of matching traffic light durations can be controlled [4]. A smart traffic controller was implemented using the real-time image processing. The sequence of the camera was analyzed using the different edge detection algorithms and object counting methods. It has been customized to be used in the future to control the traffic light sign by giving each sign sufficient time, depending on the number of cars on each direction [5].

Traffic congestion at many intersections in Mandalay needs to be an efficient traffic control system due to increases in numbers of vehicles. The traffic density areas on both directions of a lane are calculated on the basis of acquired vision through video cameras. The traffic cycle time is determined according to the amount of that areas. The fixed-time signal system was also used when the errors occur in the density-based control system.

II. INTELLIGENT TRAFFIC CONTROL SYSTEM

This traffic control is optimized to an intelligent system by using image processing algorithms. The sequence of this system is shown in **Fig.1**.The main street is defined as the priority lane for the four-way intersection. The traffic cycle time is determined according to the amount of sum of density areas for both directions at that lane. There are three types of traffic density area depending on the result of experimental test. After area-based system is activated, the image sequence of next lane is prepared to analyze for processing while the green time is on the previous lane.

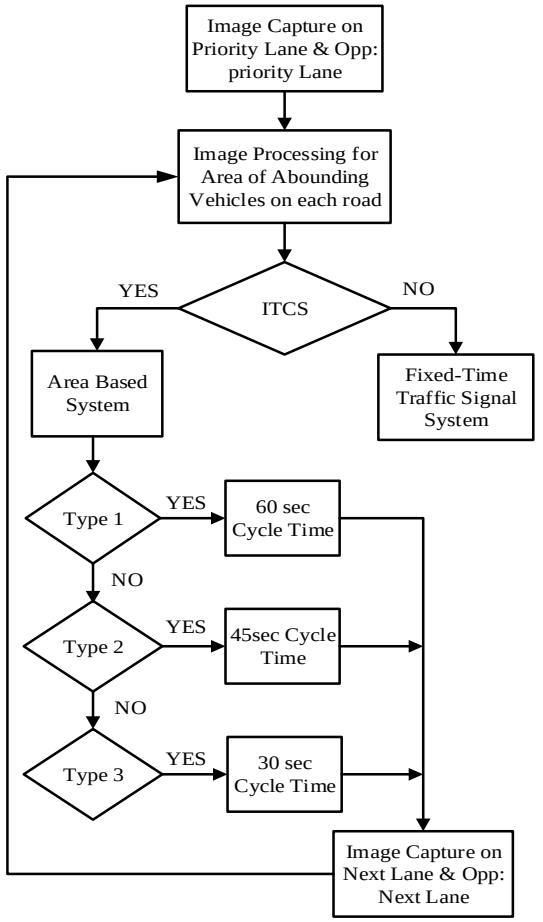


Fig.1. Flowchart of Intelligent Traffic Control System (ITCS)

III. TRAFFIC DENSITY AREA CALCULATION FOR ITCS

The processing steps are shown in **Fig.2**. Firstly, the images of video camera from both opposite directions of the priority lane are captured. And then, background image is subtracted to get the foreground objects by using image subtraction. Secondly, morphological operation and thresholding help to detect the vehicles area on the lane clearly. Thirdly, the contour, moment and area estimation algorithms can be applied to calculate the area of vehicles bounded on this lane.

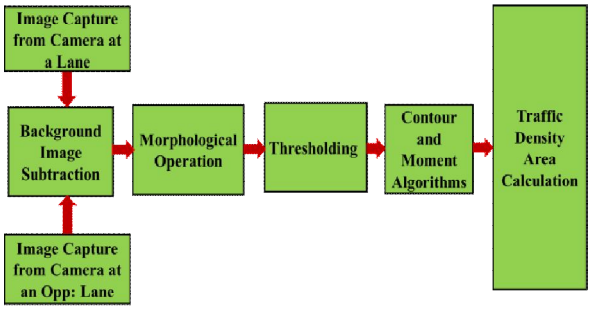


Fig.2. Image Processing Algorithms for ITCS

3.1. Contour Moment and Area

Contours are the simple curve to join all the continuous points (along the boundary) [6]. Simple image properties derived via raw moments such as area or sum of grey level.

M_{00} and centroid:

$\{\bar{x},\bar{y}\}=\{M_{10}/M_{00}, M_{01}/M_{00}\}$ (1)

The raw moment:

$M_{ij} = \sum_x \sum_y x^i y^j I(x,y)$ (2)

Where, M_{ij} is defined as a sum over all of the pixels in the object, in which the value of the pixel at point x, yis multiplied by the factor $x^i y^j$.

It means that area of object can calculate as the 0^{th} order moment for the binary images [7].

3.2 Traffic Density Area at Peak Hour

Image processing-based traffic density area calculation is implemented by using OpenCV framework. In this research, the traffic video file at a station in Mandalay is used. Traffic density area of peak hour is experimented for determining the traffic cycle time. The amount of traffic density area is calculated according to the contour area of the vehicles abounded on the lane. The contour area is measured by the pixel numbers. This image is captured on the analyzed lane by using the image processing techniques and shown in **Fig.3**.



Fig.3. Captured Image at a Lane

After applying the image processing, the result of density area is calculated and it is about $4.08967x10^5$ pixels of contour area of vehicles. This result is shown in **Fig.4.**



Fig.4. Contoured Image with Area

IV. AREA BASED TRAFFIC CYCLE TIME

The traffic cycle time is considered according to the status on both directions of a lane. Therefore, the total sum of pixel numbers for both opposite directions of a lane determines type of traffic cycle time.

Based on the previous experimental results at rush hour for passing time (green time), the maximum traffic cycle time is defined as 60 seconds[6]. In this research, the traffic cycle times are divided into three types such as 60 seconds, 45 seconds and 30 seconds respectively. This is shown in **Table 1**.

If the total sum of amount of density areas is between $8x10^5$ and $7x10^5$ pixels, the cycle time is 45 seconds. The traffic cycle time can be determined 30 seconds when the traffic density area is about $7x10^5$ pixels and less than.

Table 1: Area Based Traffic Cycle Time

Types	Area Comparison (pixels)	Traffic Cycle Time (sec)
1	$(A_{Lane} + A_{opp:L}) \geq 8x10^5$	60
2	$8x10^5 > (A_{Lane} + A_{opp:L}) \geq 7x10^5$	45
3	$7x10^5 > (A_{Lane} + A_{opp:L}) \geq 0$	30

According to the traffic light time of a four-way intersection in Mandalay, the traffic lights are defined as the following. The yellow light time is commonly set about 3 seconds at many intersections in Mandalay.

The green time of priority lane is mainly considered. In the maximum cycle time of 60 seconds, the green time is taken as 39 seconds for the priority lane. The green time is lasted for 29 seconds of that lane at 45 seconds cycle time. For 30 seconds cycle time, the green time of 14 seconds is determined for vehicles on the lane respectively.

The traffic light timing diagrams for three types of cycle time are also described in **Fig.5., Fig.6.** and **Fig.7.**

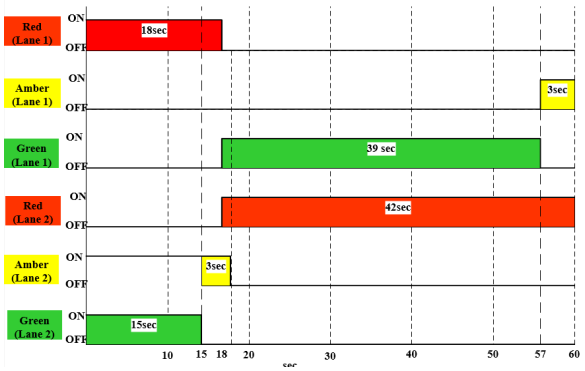


Fig.5. Traffic Light Timing Diagram (60 sec)

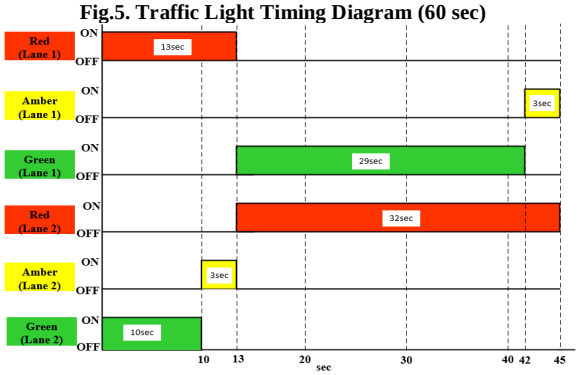


Fig.6. Traffic Light Timing Diagram (45 sec)

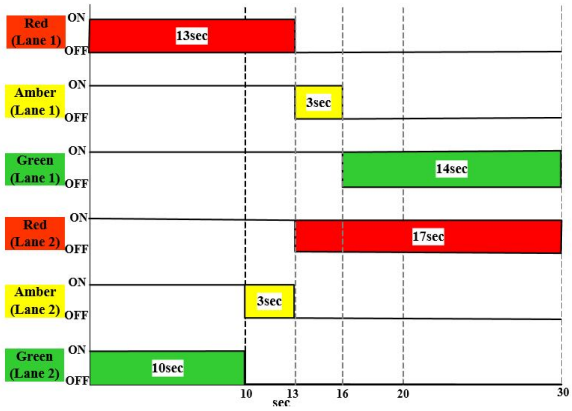


Fig.7. Traffic Light Timing Diagram (30sec)

V. EXPERIMENTAL RESULTS

The traffic density area of a four-way intersection is tested for determining the cycle time of the intelligent traffic control system. Firstly, the priority lane is calculated to define the cycle time for vehicles passing (green time). And then, the traffic cycle time of next lane would be calculated for the traffic control sequence. The density area calculation for the next lane is carried out when the yellow time mode is on at the priority lane.

5.1. Test for Priority Lane

Images are captured firstly from the opposite directions of a priority lane. The image of one direction of that lane is shown in **Fig.8.** and its opposite direction is shown in **Fig.9.**



Fig.8. Captured Image of a Priority Lane



Fig.9. Captured Image of Opposite Direction at a Priority Lane

By applying the image processing algorithms, the contour area of vehicles on both directions are

calculated. Contoured results for each image are shown in **Fig.10.**and**Fig.11.**

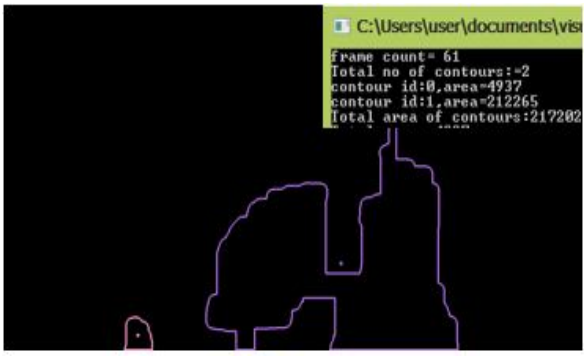


Fig.10. Contoured Image of a priority Lane



Fig.11. Contoured Image with Area for Opposite Direction at Priority Lane

By combining the amount of traffic density areas on both directions of the priority lane, the traffic cycle time of the priority lane is determined.

The amount of density area for one direction at the priority lane is about 217202pixels. In the next direction at that lane, 338075 pixels of the area is calculated. Total density area for the priority lane is about $5.55277x10^5$ pixels. Therefore, the traffic cycle time will be 30 seconds because this limit is in Type 3.

5.2. Test for Next Lane

After applying the traffic sequence on the priority lane, the images of the next lane were analyzed for determining the cycle time. These images would beprocessed when the passing time is turned on the priority lane. They are shown in **Fig.12.**and **Fig.13.**



Fig.12.Captured Image at Next Lane



Fig.13. Captured Image of Opposite Direction at Next Lane

Contoured results for each direction of the next lane are also shown in **Fig.14** and **Fig.15.**

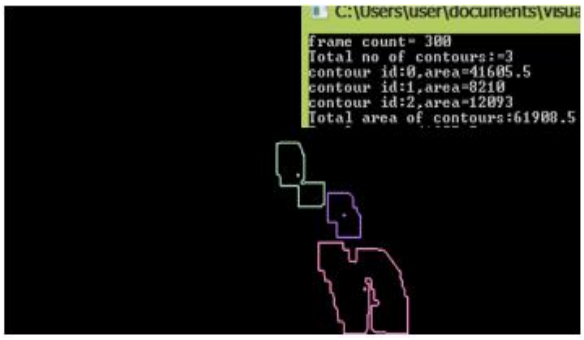


Fig. 14. Contoured Image with Area



Fig. 15. Contoured Image with Area for Opposite Direction at NextLane

The amount of density area for one direction at the next is about 61908.5pixels. In the next direction at that lane, 70665 pixels of the area is calculated. Total traffic density area for the next lane is about $1.325735x10^5$ pixels. Therefore, the traffic cycle time for the next lane also will be 30 seconds.

The traffic control sequence will be activated firstly at the priority lane with duration cycle time is about 30 seconds based on the traffic density area on both direction of that lane. And then, the cycle time about 30 seconds for the next lane will also be applied for this control system. This traffic control system is being density area based. The experimental results are implemented by using image processing with the help of Opencv.

CONCLUSION

This traffic control system is based on the vision sensor and utilized with image processing techniques.This systemis intelligent and work well due to base on the traffic demand on the road. Itis also carried out for saving time of the vehicles at the road in the city. And it is more reducing the waiting time without vehicles on the road. As a result, this vision based intelligent traffic control system can be available that the congestion problems will be effectively reduced at peak hours on the road than other convectional system. The fixed-time signal system is also used for the emergency case. Therefore, this intelligent traffic control system can be useful more than conventional methods in the real world.

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REFERENCES

[1] Akoum, A.H., "Automatic Traffic Using Image Processing", Journal of Software Engineering and Applications, 10, 765-776,2017.

[2] CelilOzkurt and FatihCamci, "Automatic Traffic Density Estimation and Vehicle Classification for Traffic Surveillance System using Neural Networks, Computer Engineering Department, Fatih University, Vol. 14, No. 3, pp. 187-196, 2009.

[3] K.Vidhya and A.Bazila Banu, "Density Based Traffic Signal System", International Conference on Innovations in Engineering and Technology, K.L.N. College of Engineering, On 21st& 22nd March, 2014.

[4] Pallavi Choudekar, Sayanti Banerjee and M.K.Muju," Implementation of Image Processing in Real Time Traffic Light Control", Ajay Kumar Garg Engineering College, Department of mechanical engineering Ghaziabad, UP ,India, 978-1-4244-8679-3/11/$26.00 ©2011 IEEE

[5] M.H.M, "Vision Based Intelligent Traffic Management System", COMSATS Institute of Information Technology, 978-0-7695-4625-4/11 © 2011 IEEE.

[6] htpps://docs.opencv.org,OpenCV Contour Features.

[7] Leonidas Kotoulas, Student Member, IEEE, and Ioannis Andreadis, "Accurate Calculation of Image Moments", IEEE Transactions on Image Processing, Vol. 16, No. 8, August 2007.

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