ISSN- 2394-5125 VOL 10, ISSUE 01, 2022

Density-based Traffic Light Controlling System using Morphological Operators and Fuzzy Logic

Dr. B. Subba Reddy[1], A. Deeksha[2], Ch. Soujanya[2], G. Sai Sree[2]

[1]Professor & HOD, [2]UG Student, [1,2]Department of Information Technology

[1,2]Malla Reddy Engineering College for Women (UGC-Autonomous), Maisammaguda, Secunderabad, Telangana, India

Abstract

There is a need for the development of advanced smart traffic controlling schemes due to the enhancement in urban traffic congestion. Currently, there are some traffic controlling methods based on timers or controlled by humans. However, due to these systems there must be wastage of power in the night times and early morning hours. To address this issue, this paper introduces a novel and real time traffic light controlling system with digital image processing, in which the morphological operators are utilized with contrast enhancement and fuzzy logic systems. The proposed traffic control system offers an enhanced improvement in response time, automation, reliability and overall efficiency over the conventional systems.

Keywords: digital images, traffic controlling, histogram equalization, morphological operators and statistical parameters.

1. INTRODUCTION

As the population of modern cities is increasing day by day due to which vehicular travel is increasing which lead to congestion problem. Traffic congestion has been causing many critical problems and challenges in the major and most populated cities. Due to this traffic congestion, there is more waste of time. The steady increase in the number of automobiles on the road has amplified the importance of managing traffic flow efficiently to optimize utilization of existing road capacity. High fuel cost and environmental concerns also provide important incentives for minimizing traffic delays. So, there is a need of proper control of traffic signal timing sequence. Various sensors have been employed to estimate traffic parameters for updating traffic information. Previously different techniques had been proposed, such as infra-red-light sensor, induction loop etc. to acquire traffic date which had their fair share of demerits. In recent years, image processing has shown promising outcomes in acquiring real time traffic information using CCTV footage installed along the traffic light. Different approaches have been proposed to glean traffic data. Some of them count the total number of pixels [1], some of the work calculate number of vehicles [2-4]. These methods have shown promising results in collecting traffic data. However, calculating the number of vehicles may give false results if the intravehicular spacing is very small (two vehicles close to each other may be counted as one) and it may not count rickshaw or auto-rickshaw as vehicles which are the quotidian means of traffic especially in South-Asian countries. And counting the number of pixels has disadvantage of counting insubstantial materials as vehicles such as footpath or pedestrians. Some of the works have proposed to allocate time based solely on the density of traffic. But this may be disadvantageous for those who are in lanes that have less frequency of traffic. Edge detection technique is imperative to extract the required traffic information from the CCTV footage. It can be used to isolate the required information from rest of the image. There are several edge detection techniques available. They have distinct characteristics in terms of noise reduction, detection sensitivity, accuracy etc.

ISSN- 2394-5125 VOL 10, ISSUE 01, 2022

2. RELATED WORK

There are many researchers who worked on traffic light controlling systems and many papers have been presented in the literature from the past few years. The author in [5], presented a novel image processing algorithm, which assigns a qualitative description to a traffic scene, and this has been utilized to control the traffic lights. They considered two cases to analyze the traffic, fist one is the percentage of the road that occupied by vehicles and second is number of moving and idle vehicles in those. Pallavi et. al in [6] presented an image processing-based traffic light controlling system, which functions based on edge detection methodology. Prewitt operator has been utilized to detect the edges of vehicles presented on the road then after according to the matching percentage durations of traffic lights has modified. Chandrasekhar et. al. proposed a traffic control system that utilizes digital image processing techniques instead of electronic sensors [7], this has decreased the traffic congestion and avoided the time being wasted by a green light on an empty road. It was also more reliable in estimating vehicle presence because it uses actual traffic images. It visualizes the practicality, so it functions much better than those systems that rely on the detection of the vehicles' metal content. Author in [8] proposed a comparative analysis of several edge detection operators utilized in controlling traffic. They also discussed the restrictions of conventional traffic controlling schemes. Omkar et. al. presented a remedy for preventing heavy traffic congestion in [9], this worked based on the area occupied by the vehicles instead of number of vehicles present on the road. A smart traffic controlling using image processing has been presented in [10] which operates based on the density of traffic present on the road. Recently, an image processing technique-based traffic light controlling scheme is presented in [11].

3. PROPOSED SYSTEM

This section describes the proposed traffic light controlling scheme which utilizes morphological operations and fuzzy logic controller. Our model measures the traffic density on the road and according to the traffic density measurements, it decides the cyclic time of the traffic light signals. This also overcomes the problem of expensive sensors because in this technique a high-quality camera has been used for intelligent traffic light control.

A. Morphological Operator based Implementation.

Figure 1 shows the proposed system model.

Algorithm: Traffic light controlling using morphological operators

Step 1: Select and read a reference image without any traffic

Step 2: Select and read a traffic image

Step 3: Convert both reference and traffic images into gray scale

Step 4: Enhance the contrast of images by applying histogram equalization

Step 5: Apply morphological operations i.e., dilation and erosion to the reference and traffic images

Step 6: Now, subtract the dilated and eroded images to get the difference image

Step 7: Calculate the statistical parameters such as mean, variance and standard deviation

Step 8: Finally, find out the matching percentage for traffic controlling

Traffic lights can be controlled based on percentage of image matching.

- Green light will glow for 90 seconds if the percentage of matching is between 0 to 10%.
- Green light will glow for 60 seconds if the percentage of matching is between 10 to 50%.
- Green light will glow for 30 seconds if the percentage of matching is between 50 to 70%.
- Green light will glow for 20 seconds if the percentage of matching is between 70 to 90%.
- If the matching is between 90 to 100% - red light is on for 60 seconds

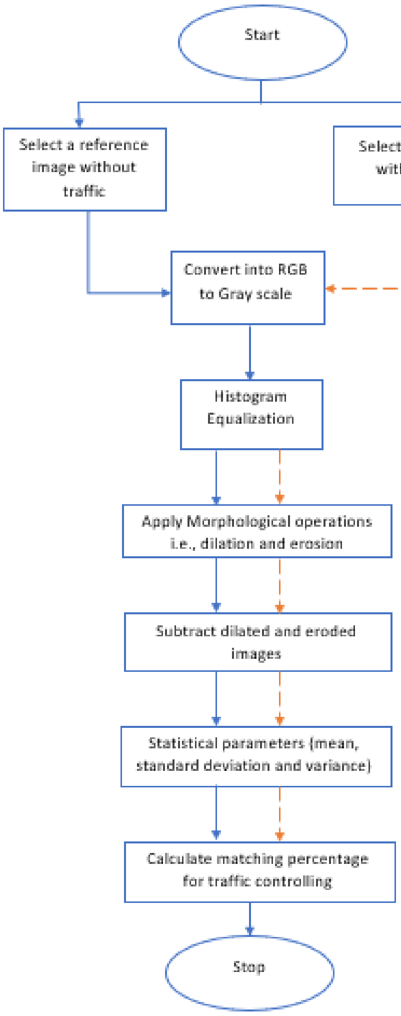


Fig. 1 Flow chart of proposed traffic controlling system with image processing.

B. Fuzzy Logic based Implementation.

This section briefly discussed fuzzy logic controlling for traffic light monitoring. Fuzzy is a set Fuzzy logic technology has the capability of mimicking human intelligence for controlling the traffic flow. It allows the implementation of real-life rules like the way in which humans would think. Fuzzy logic traffic lights control is an alternative to conventional traffic lights control which can be used for a wider array of traffic patterns at an intersection. A fuzzy logic-controlled traffic light uses sensors that count cars instead of proximity sensors which only indicate the presence of cars. As the traffic distributions fluctuate, the fuzzy controller can change the signal light accordingly.

ISSN- 2394-5125 VOL 10, ISSUE 01, 2022

1) Design consideration:

1. Traffic from north, south, east, west, from north to west, south to east, west to south and east to north is allowed.
2. Right turns are considered.
3. Two fuzzy inputs are used: the weight of the traffic on the arrival side (Arrival) and the weight of traffic on the queuing side (Queue). If the north and south side is green then this would be the arrival side while the west and east side would be considered as the queuing side, and vice-versa.
4. Signal time is already predefined in the controller based on average traffic condition; extension of the green light is done over already determined time.

Thus, based on the current traffic conditions the fuzzy rules can be formulated so that the output of the fuzzy controller will extend or not the current green light time. If there is no extension of the current green time, the state of the traffic lights will immediately change to another state, allowing the traffic from the alternate phase to flow [4].

2) Input and Output Membership Functions and fuzzy rule base:

For the traffic lights control, there are four membership functions for each of the input and three membership functions for output fuzzy variable of the system. Figure 3 shows the fuzzy variables of Arrival, Queue and Extension of the system control.

4. RESULTS AND DISCUSSION

This section describes the simulated results of the proposed traffic control scheme. Reference image is demonstrated in figure 2 and all the test images are displayed in figure 3 respectively. dilated and eroded images obtained from morphological operators are disclosed in figure 4. Figure 5 shows that the contrast enhanced traffic scene image and difference images of reference and traffic scene images. Figure 6 shows that the green light for 20sec after calculation matching percentage.

Fig. 2 Reference image

Fig. 3 different traffic images used for testing.

ISSN- 2394-5125 VOL 10, ISSUE 01, 2022

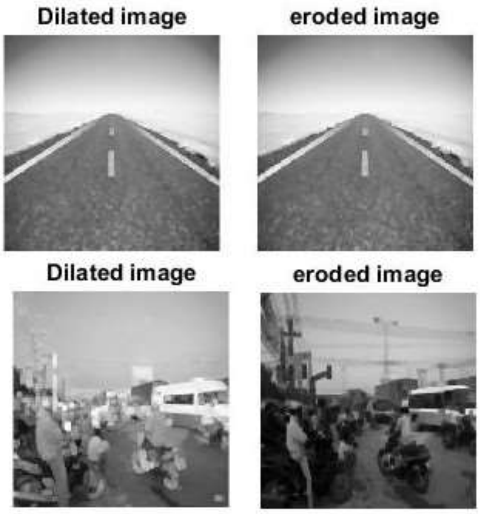


Fig. 4 Dilated and eroded images of reference and traffic

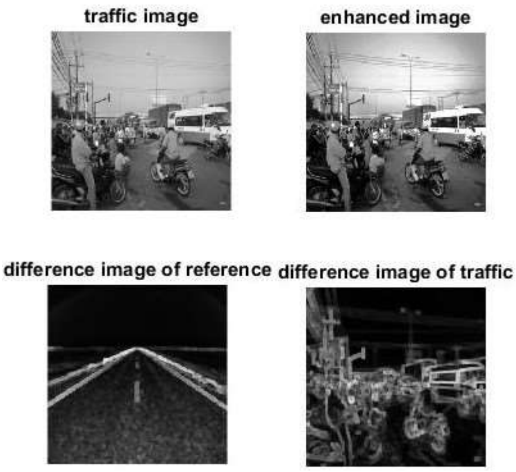


Fig. 5 Traffic image contrast enhanced image, difference images of reference and traffic

Fig. 6 message box of 20sec green light

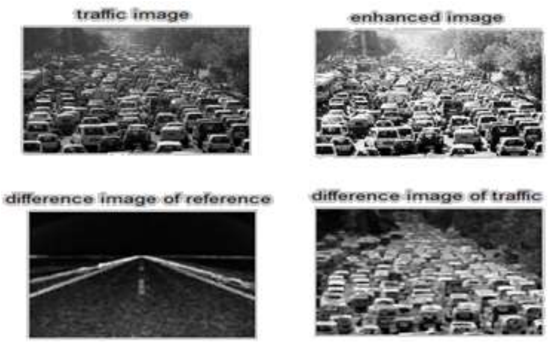


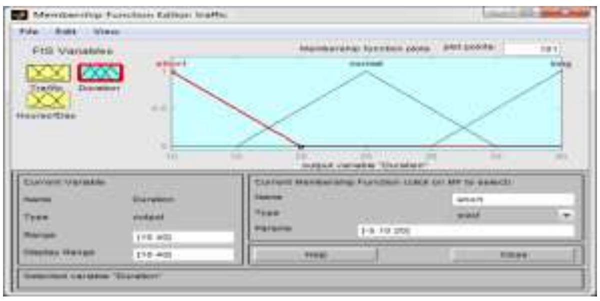
Fig. 7 Traffic image contrast enhanced image, difference images of reference and traffic

ISSN- 2394-5125 VOL 10, ISSUE 01, 2022

Fig. 8 Dilated and eroded images of reference and traffic.

Figure 7 shows that output obtained from the proposed morphological operators of another sample of traffic scene image which has more traffic in it.

Fig. 9 message box of 90 sec green light



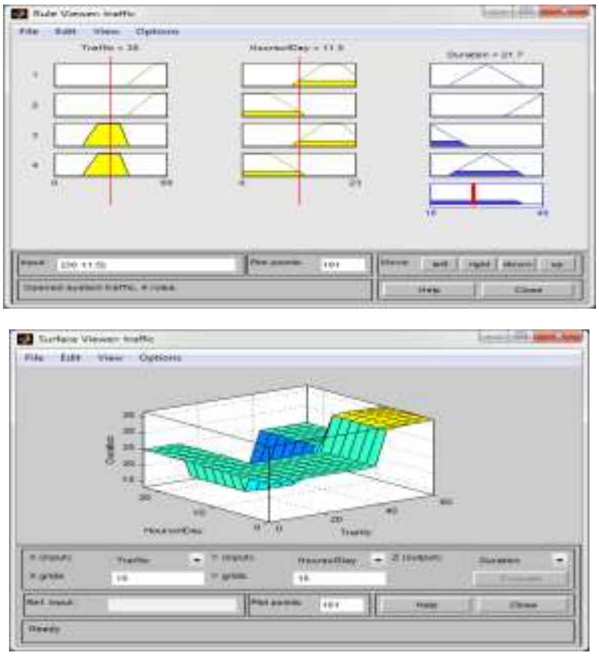


Fig. 10 Traffic control system using fuzzy logic controlling.

Dilated and eroded images of reference and traffic scene images in figure 8. Figure 9 shows the message box of 90 sec green light, which is more time compared to previous sample traffic scene in which we have a smaller number of vehicles. This shows that the proposed traffic controlling is well suited for smart traffic controlling systems. Figure 10 discloses the FLC-based rules, membership functions and the final traffic light controlling.

5. CONCLUSIONS

In this, we have discussed two techniques for traffic light control. Firstly, we have discussed histogram equalization and morphological method for real time traffic control and then fuzzy logic controlling. If we compare two methods we find that fuzzy logic is simple to implement than morphology method because morphology method is very lengthy procedure, even because it is edge detection method it does not perform well during night time, edges of certain vehicles will not able detect due to dark at night time, but fuzzy logic only counts the number of vehicles not deal with edges, it gives more accurate results, if we see cost factor then morphological method is less costly than fuzzy because morphology method only needs high quality camera not sensors which is less costlier. The fuzzy logic allows the implementation of real-life rules like the way in which humans would think, so no doubt fuzzy logic gives better result. It also deals with the number of vehicles due to which it gives better results, but morphology method depends upon the density of traffic due to which it gives approximate result. Hence, both methods had their own importance in real time environment. This work may extend to find new methods for better results during night time using morphology technique so that cost and good results make the system worthier.

REFERENCES

[1] Md. Munir Hasan, Gobinda Saha, Aminul Hoque and Md. Badruddoja Majumder, "Smart Traffic Control System with Application of Image Processing Techniques," in 3rd International Conference on Informatics, Electronics & Vision, Dhaka, May 2014.

[2] Vismay Pandit, Jinesh Doshi, Dhruv Mehta, Ashay Mhatre and Abhilash Janardhan, "Smart Traffic Control System Using Image Processing", International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Vol. 3, Issue 1, January – February 2014.

ISSN- 2394-5125 VOL 10, ISSUE 01, 2022

[3] M. Sweet, “Traffic Congestion’s Economic Impacts: Evidence from US Metropolitan Regions,” Urban Studies, Vol. 51, No. 10, pp. 2088–2110, Oct. 2013.
[4] T. Semertzidis, K. Dimitropoulos, A. Koutsia and N. Grammalidis, “Video sensor network for real-time traffic monitoring and surveillance”, The Institution of Engineering and Technology, Volume 4, Issue 2, June 2010, pp. 103 – 112.
[5] G.T. Shrivakshan and Dr.C. Chandrasekar, “A Comparison of various Edge Detection Techniques used in Image Processing”, International Journal of Computer Science Issues, Vol. 9, Issue 5, No. 1, September 2012.
[6] Pallavi Choudekar, Sayantu Banerjee and M K Muju, “Implementation of image processing in real time traffic light control”, 3rd International Conference on Electronics Computer Technology, Kanyakumari, India, pp. 94-98, 2011.
[7] Chandrasekhar. M, Saikrishna. C, Chakradhar. B, Phaneendra Kumar. P & Sasanka. C, “Traffic Control Using Digital Image Processing”, International Journal of Advanced Electrical and Electronics Engineering, Vol. 2, No, 5, pp. 96-102, 2013.
[8] Kavya P Walad and Jyothi Shetty, “Traffic Light Control System Using Image Processing”, International Journal of Innovative Research in Computer and Communication Engineering, Vol. 2, No. 5, pp. 288-293, 2014.
[9] Omkar Ramdas Gaikwad, Anil Vishwasrao, Prof. Kanchan Pujari and Tejas Talathi, “Image Processing Based Traffic Light Control”, International Journal of Science, Engineering and Technology Research, Vol. 3, No. 4, pp. 1010-1014, April 2014.
[10] Prashant Jadhav, Pratiksha Kelkar, Kunal Patil and Snehal Thorat, “Smart Traffic Control System Using Image Processing”, International Research Journal of Engineering and Technology, Vol. 3, No. 3, pp. 1207-1211, 2016.
[11] K Senthilkumar, Vijayan Ellappan and A R Arun, “Traffic analysis and control using image processing”, IOP Conf. Ser.: Mater. Sci. Eng. 263, 2017.