Real Time Traffic Light Controlling System Using Morphological Operators and Fuzzy Logic

B Hari Krishna1*, P Santosh Kumar Patra2, and Ganapuram Kalpana3
1Department of Electronics and Communication Engineering, St. Martin’s Engineering College, Secunderabad, India
2Department of Computer Science and Engineering, St. Martin's Engineering College, Secunderabad, India
3Department of Electronics and Communication Engineering, CMR Engineering College, Hyderabad, India
Email: *harikrishna07@gmail.com

Abstract: There is a need for 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 human. However, due to these systems there must be wastage of power in the night times and early morning hours. In order to address this issue, this paper introduces a novel and Traffic light management scheme in real-time with digital image recognition using contrast improvement and fluctuating logic systems for morphological operators. The proposed traffic control system provides an upgrade over traditional systems in terms of time of response, automation, stability and overall performance.

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

1. Introduction
Owing to growing numbers of people in modern towns day by day, car traffic is contributing to congestion. Traffic congestion in large and most populous cities has caused numerous severe issues and challenges. There is more loss of time due to this traffic congestion. The constant growth in the number of cars on the road has increased the value of effective traffic control to maximise the use of available road space. High fuel prices and environmental issues are both significant stimulus to minimise traffic disruptions. Therefore, the traffic signal timing sequence needs to be managed correctly. Several sensors for traffic alerts have been used to predict traffic parameters. Different methods and so on, have previously been proposed for acquisition of traffic dates. The photographs have shown positive results in the retrieval of knowledge about video on the traffic signal. Various methods of gleaning traffic data are proposed. Any of them have absolute pixel numbers [1], while some work measure vehicle numbers [2]. The findings in the collection of traffic data have been promising. However, if the intra vehicle spacing is very small (two near cars can be counted as one) and the measurement of number of vehicles, false results can occur. Moreover, it is disadvantageous to list the number of pixels when measuring in substant objects such as roads or foot paths [3]. Any of the work recommended allocating time only depending on traffic density. But for those on tracks with less traffic frequency this may be disadvantageous. The technique of edge detection is important to obtain the appropriate CCTV traffic information [4]. The requisite details may be separated from the
Several techniques are available for edge detection. They have distinct features as regards noise control, attention to tracking, exactness, etc.

2. Related Work
There are many researchers, who worked on traffic light controlling system and many papers have been presented in the literature from the past few years. A new algorithm for image processing, which gives a quality defined traffic scene and is used to monitor light systems, has been proposed in [5] by the author. The first is the amount that cars occupy and the second is the number of vehicles in which they are driving and stationary introduced in [6] a traffic light control scheme focused on image processing that is focused on the technique of bottom line detection. 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. And Chandrasekhar and. al. suggested to use the traffic management system using digital imagery instead of automated sensors [7], which reduced the traffic congestion and prevented spending time on an empty road with green light. It was much more dependent on actual traffic photographs to determine the presence of a car. The functionality is visualised, so it operates much more efficiently than structures that rely on the metal content of vehicles. Author in [8] proposed a comparative analysis of several edge detection operators utilized in controlling of traffic. They also discussed the restrictions of conventional traffic controlling schemes. A solution in [9] that was focused on the area is inhabited by vehicles. In [10], an intelligent traffic controller was shown that operates on the basis of road traffic density. Recently, a traffic light control device based on picture analysis is introduced in [11].

3. Proposed System Model
This section describes the proposed traffic light controlling scheme which utilizes morphological operations and fuzzy logic controller. Our model measures traffic congestion and determines the synchronous period of the road traffic signals based on measures of average speeds. This also overcomes issue of costly sensors, as a quality camera is used in this technique for smart traffic light control.

3.1. Morphological Operator Based Implementation

**Algorithm: Traffic light controlling using morphological operators**

1. Select and read a reference image without any traffic
2. Select and read a traffic image
3. Convert both reference and traffic images into gray scale
4. Enhance the contrast of images by applying histogram equalization
5. Apply morphological operations i.e., dilation and erosion to the reference and traffic images
6. Now, subtract the dilated and eroded images to get the difference image
7. Calculate the mean, variance and standard deviation statistical parameters
8. Finally, find out the matching percentage for traffic controlling

Amples can be monitored on the basis of the image matching percentage.
- If the Ratio of matching is between 0 and 10 percent, green light can glow for 90 seconds.
- If the Ratio of matching is between 10 and 50 percent, green light can glow for 60 seconds
- If the Ratio of matching is between 50 and 70 percent, green light can glow for 30 seconds
- If the Ratio of matching is between 70 and 90 percent, green light can glow for 20 seconds
- If the matching Ratio is between 90 to 100% - red light is on for 60 seconds

Figure 1 shows the proposed system model of encoding plans for traffic control using image processing.
3.2. Fuzzy Logic Based Implementation

This section briefly discussed fuzzy logic controlling for traffic light monitoring. Fuzzy is a fixed logic technology Fuzzy has the potential to simulate human intelligence for traffic control. It enables real-life rules such as human thinking to be implemented. Fuzzy traffic control is a choice for traditional traffic control lights, which can be used at an intersection for a broader range of traffic conditions [12]. A fluorescent logically operated traffic light uses sensors that only show the location of vehicles rather than sensors of proximity. The flow control will adjust the signal light accordingly, as the traffic distributions fluctuate [13].

3.3. Design Consideration

a) Traffic is allowed to travel from south, north, west and east, from south to east, from north to north and from west to south.

b) Assumed there are right turns.

c) Couple of fuzzy inputs were utilized: The traffic weight is on the side of arrival which is just cited as Arrival and the traffic weight on the side of queuing is referred as Queue. For eg, if there's a green light for the north and south, that’s the arrival side while the west and east side are called Queue and vice versa [14].
d) Depending upon the aggregate time duration, there is specified time in FLC. Further, enhancement of green light can be done by just overwriting existed one [15]. Therefore, as mentioned above, all the rules are derived based on present traffic scenario thus the FLC outcome will upgrade or not the present green light. The mode of the lights will be changed robotically in another mode where no green time improvement is available [16].

3.4. Input And Output Membership Functions And Fuzzy Rule Base
There are four input membership functions for the management of traffic lights and three system output fluctuating membership functions. Figure 3 indicates the fluctuating variables of device control entry, queue and extension.

4. Results
This portion mentions the findings of the proposed traffic control scheme in Figure 2 displays the reference image, and all test images are seen in Figure 3, respectively. Detailed and eroded images obtained from morphological operators is 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 shown that the green light for 20sec after calculation matching percentage.
Figure 5: Traffic image contrast enhanced image, difference images of reference and traffic

Figure 6: Message box of 20sec green light

Figure 7: Traffic image contrast enhanced image, difference 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.

Figure 8: Dilated and eroded images of reference and traffic
Figure 9: Message box of 90 sec green light

Figure 10: Traffic control system using fuzzy logic controlling
Dilated and eroded images of reference and traffic scene images in Figure 8. Figure 9 shown that the message box of 90 sec green light, which is more time compared to previous sample traffic scene in which we have lesser number of vehicles. Figure 10 shows the fuzzy modelling of traffic control system. This shows that the proposed traffic controlling is well suited for smart traffic controlling systems.

5. Conclusion
This article discussed couple of smart traffic controlling approaches based on Morphological operations and fuzzy logic controlling. Primarily, morphological and histogram equalized approach is utilized for implementing a traffic light controlling. Later, it is also implemented FLC for the same. Both of them are having their own significance since FLC performs better in night time and when there are no lighting conditions. The other one executed better performance in case of good lighting environment. Hence, both methods had their own importance in real time environment. In future, this approach can be extended by implementing innovative morphological operations with some night vision cameras which produce high definition image even in case of non-uniform lighting conditions.

References
[1] Hartanti, Dian, Rosida Nur Aziza, and Puji Catur Siswipraptini. "Optimization of smart traffic lights to prevent traffic congestion using fuzzy logic." TELKOMNIKA Telecommunication Computing Electronics and Control 17, no. 1 (2019): 320-327.
[2] Javaid, Sabeen, Ali Sufian, Saima Pervaiz, and Mehak Tanveer. "Smart traffic management system using Internet of Things." In 2018 20th International Conference on Advanced Communication Technology (ICACT), pp. 393-398. IEEE, 2018.
[3] Sweet, Matthias. "Traffic congestion’s economic impacts: Evidence from US metropolitan regions." Urban Studies 51, no. 10 (2014): 2088-2110.
[4] Patriot, Teguh, Andyka Kusuma, and Nahry Nahry. "Analysis of Speed Limiting Using Speed Cameras: Case Study in Indonesian Toll Road.".
[5] Siswipraptini, Puji Catur, Rosida Nur Aziza, Iriansyah Sangadji, and Indrianto Indrianto. "The design of a smart home controller based on ADALINE." TELKOMNIKA 18, no. 4 (2020): 2177-2185.
[6] Merrad, Walid, Abderrezak Rachedi, Krishna Busawon, and Richard Binns. "A survey on smart traffic network control and optimization." In 2016 International Conference Multidisciplinary Engineering Design Optimization (MEDO), pp. 1-6. IEEE, 2016.
[7] Alhafidh, B. M., and W. Allen. "Smart homes based on smart cities design patterns." Internet of Things and Big Data Analysis: Recent Trends and Analysis. United Scholar (2016).
[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] Ganapathy, Kirupa, V. Vaidehi, and Dhiyapoorani. "Sensor based efficient decision making framework for remote healthcare." Journal of Ambient Intelligence and Smart Environments 7, no. 4 (2015): 461-481.
[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.
[12] Shahada SA, Hreiji SM, Atudu SI, Shamsudheen S., “Multilayer Neural Network Based Fall Alert System Using IOT,” International Journal of MC Square Scientific Research, 11(4), 1-5, 2019.
[13] Ahmad, Rashid, and Do-Hyeun Kim. "A collaboration based context prediction in smart office." Journal of Ambient Intelligence and Smart Environments 7, no. 6 (2015): 805-815.
[14] Vijayabaskar V., Rajendran V. and E.Logashanmugam, “Study of Different Denoising Methods for Underwater Acoustic Signal”, Journal of Marine Science and Technology, Vol. 23, No. 4, pp. 414-419, 2015.

[15] Hartanti, Dian, BayuPratama, and Muhammad FachroziYetriva. "AplikasiSistem Monitoring PengontrolanPenggunaanPeralatanElektronik." JREC (Journal of Electrical and Electronics) 7, no. 1 (2019): 1-10.

[16] Wen, Yu-Ju, Alan Liu, and Wei-Wei Huang. "A study on constructing dynamic context models for smart homes." In 2013 CACS International Automatic Control Conference (CACS), pp. 103-108. IEEE, 2013.