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# Application of Morphological Method of Edge Detection and fuzzy logic technique for Traffic light control

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## Abstract

Traffic is the major problem which every country faces because of the increase in number of vehicles throughout the world, particularly in large urban areas. Therefore the need arises for simulating and optimizing traffic control algorithms to better accommodate this increasing demand.One of the ways to overcome traffic problems in large cities is through the development of an intelligent traffic control system which is based on the measurement of traffic density on the road .In this paper we present techniques with which this problem of traffic is solved.We discuss Morphlogical edge detection and fuzzy logic technique to solve this problem and after that we discuss comparison between two techniques to show which technique gives best results

**Keywords**

*Morphological Edge detection,Gamma correction, Fuzzy logic controller.*

## 1. INTRODUCTION

As the population of the 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 wastage 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.

For intelligent traffic light system ,the most common technique is the use of fuzzy logic contoller .Tradionally a fixed time controller is used which has certain disadvantages..They have predefined cyclic time which schedules off-line on a central computer based on average traffic conditions.Due to this there is a wastage of time by a green light for same time on a less congested road as compare to more congested road[2].so to overcome this problem, the

fuzzy based controller and morphological edge detection method which is based on the measurement of the traffic density. In morphological edge detection method which is image based method will detect vehicles through images instead of using electronic sensors
The designed system aims to achieve the following.

- Distinguish the presence and absence of vehicles in road images;
- Signal the traffic light to go red if the road is empty;
- Signal the traffic light to go red if the maximum time for the green light has elapsed even if there are still vehicles present on the road.

In fuzzy contoller ,the fuzzy logic is used.The fuzzy logic technology allows the implementation of real-life rules similar to the way human would think. For example,humans would think in the following way to control traffic situation at a certain junction: "if the traffic is heavier on the north or south lanes and the traffic on the west or east lanes is less, then the traffic lights should stay green longer for the north and south lanes"

# 2. TRAFFIC CONTROL USING IMAGE PROCESSING BASED ON MORPHOLOGICAL EDGE DETECTION

There is technique which is used for the traffic light control based on image processing which measure 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 overcome the problem of expensive sensors because in this technique a high quality camera has been used for intelligent traffic light control[11]

Following are the steps involved :

- Image acquisition ,in which empty road and image with traffic on road is captured ,empty road image is saved as a reference image .
- RGB to gray conversion of both the images
- Image enhancement
- Image matching using Morphological edge detection which matches the edges of the reference image and the image with traffic on road[10].

## 2.1 . Methodology

Part 1 :

- First image of the road is captured, when there is no traffic on the road
- This empty road's image is saved as reference image
- RGB to gray conversion is done on the reference image
- Now gamma correction is done on the reference gray image to achieve image enhancement
- Edge detection of this reference image is done thereafter with the help of morphological edge detection

Part 2:

- Images of the road are captured.
- RGB to gray conversion is done on the sequence of captured images
- Now gamma correction is done on each of the captured gray image to achieve image enhancement
- Now image subtraction is done to remove unwanted effects like shadows and marks on road.
- Edge detection of these real time images of the road is now done .

Part 3:

- After edge detection procedure both reference and real time images are matched and traffic lights can be controlled based on percentage of matching. If the matching is between 0 to 10% - green light is on for 90 seconds. If the matching is between 10 to 50% - green light is on for 60 seconds. If the matching is between 50 to 70% - green light is on for 30 seconds. If the matching is between 70 to 90% - green light is on for 20 seconds. If the matching is between 90 to 100% - red light is on for 60 seconds.

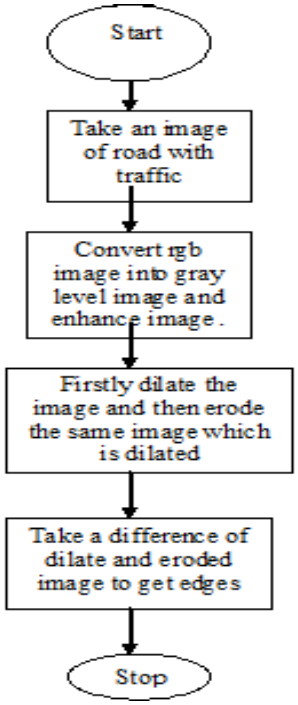



Fig 1:Flow graph for morphological edge detection

In addition to edges that are caused by vehicles there is also extra edges which is caused by undesired factors like damaged road or white marks on the road surface and shadow of trees and buildings.To remove the effect,we differ the edges of background pictures from from the edges of current pictures.

## 2.2. Mathematical Morphology

Mathematical Morphology is one of the most productive areas in image processing .The content of mathematical morphology is based on set theory.A structuring element is a special mask filter that enhances an input images. Following are the main mathematical morphological operators:

- Dilation
- Erosion
- Opening
- Closing

### 2.2.1. Dilation

Dilation is defined as the maximum value in the window. Hence the image after dilation will be brighter or increased in intensity. It also expand the image and mainly used to fill the spaces.

### 2.2.2. Erosion

Erosion is just opposite to dilation. It is defined as the minimum value in the window .The image after dilation will be darker than the original image .It shrinks or thins the image.Erosion process shrinking objects or images by changing pixels with a value of "1" to "0".

### 2.2.3. Opening and closing

Both parameters are formed by using dilation and erosion. In opening, firstly image will be eroded and then it will be followed by dilation.And in case of closing,firstly image will be dilated and then followed by erosion.

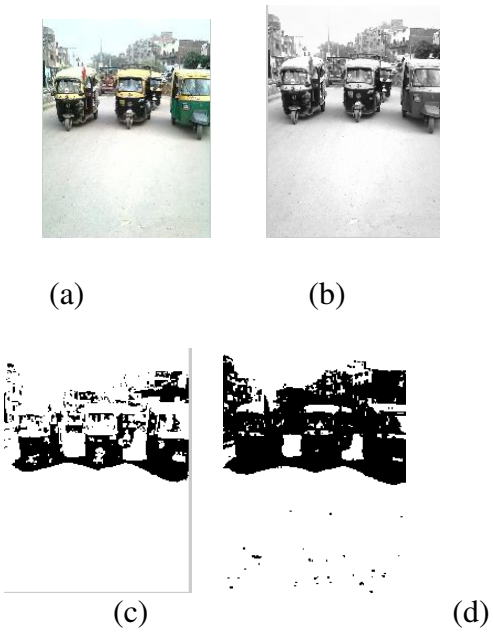



Figure 2 : (a) Original Image (b) Gray level image (c) Dilated image (d) Eroded image

## 2.3. Results using Morphological edge detection method

(a)

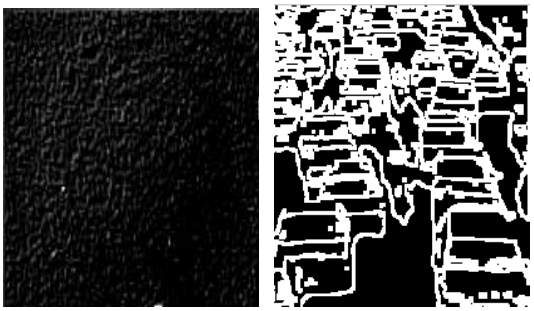
(b)

(c)

(d)

( e )

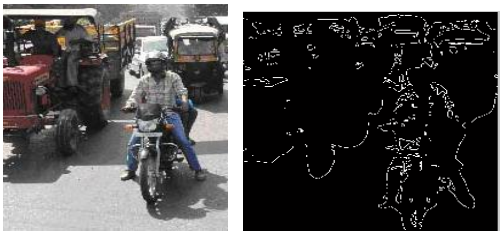
( f)



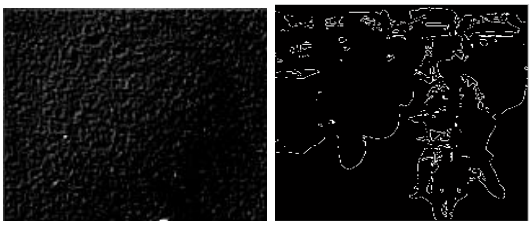
(g)

Figure 3 : (a) Original Image (b) Gray level image (c) Dilated image (d) Eroded image (e) image after taking difference of dilated and eroded image (which is edge detected image) (f) image after background differencing (g) image of empty road which is compared with edge detected image for image matching

(Matching in this in the range of 0 to 10% so green light is for 90 seconds)



(a) (b)



(c)

Fig 4 : (a) original image (b) image after edge detection using similar operation given in flow graph (fig 2) (c) image of empty road which is compared with edge detected image for image matching

(Matching in this in the range of 50 to 70% so green light is for 60 seconds)

# 3. TRAFFIC LIGHT CONTROL USING FUZZY LOGIC

In this paper, the implementation of fuzzy logic controller for the traffic flow control is discussed. Fuzzy logic technology has the capability of mimicking the human intelligence for controlling the traffic flow. It allows the implementation of real-life rules similar to the way in which humans would think[5]. 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

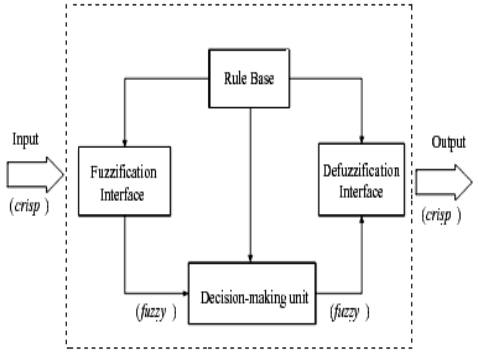



Fig 5: Basic configuration of fuzzy logic system

**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.
5. 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].

### 3.1. 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.

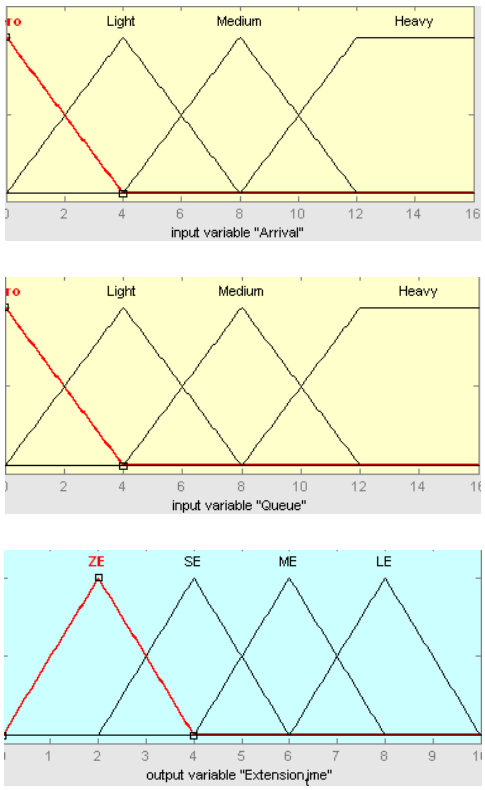



Fig 6 : The membership function for arrival ,queue and extension time respectively

The basic function of the fuzzy rule base is to represent the expert knowledge in a form of IF-THEN rule structure combined with AND/OR operators. For e.g. IF traffic from the north of the city is more AND traffic from the west is less THEN allow movement of traffic from the north side [3,6]. The fuzzy rule base is set of fuzzy rules. It maps the combination of fuzzy inputs (arrival, queuing linguistic variables) to the corresponding fuzzy output.

| Arrival<br>Queue | Z | L | M | H |
|---|---|---|---|---|
| Z | ZE | SE | ME | LE |
| L | ZE | SE | ME | ME |
| M | ZE | ZE | SE | ME |
| H | ZE | ZE | ZE | SE |

Figure 7 : Fuzzy control rules

### 3.2. Inferrence Engine and Defuzzification

Membership functions are used to retranslate the fuzzy output into a crisp value. This method is known as Defuzzification [4]. The fuzzy inference evaluates the control rules stored in the fuzzy rule base. Defuzzification is a process to convert the fuzzy output values of a fuzzy inference to real crisp values. Fist a typical value is computed for each term in the linguistic variable and finally a best compromise is determined by balancing out the results using

different methods like center of sum, center of area, center of area mean of maximum etc. But for this application we use centroid method to process defuzzification of the output variable extension time. This method is mostly used because this method has better performance in terms of continuity, computer complexity and counting.

| No of vehicles at arrival side | No of vehicles at Queue side | Extension time(centroid method) |
|---|---|---|
| 2 | 10 | 2 |
| 5 | 6 | 4 |
| 10 | 4 | 6 |
| 16 | 0 | 8 |

Fig 8 :Table to show different value of extension at different weights at arrival and queue side

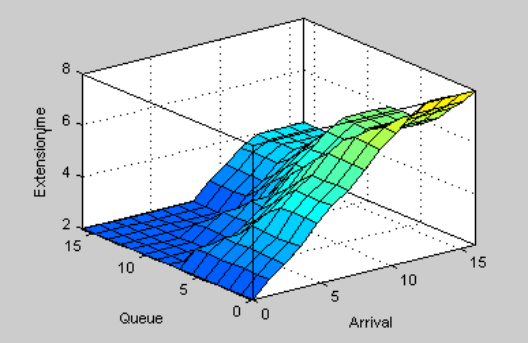



Fig 9: "Queue side" and "Arrival side" vs. Extension Time

As evident from Figure 9, the external time is close to less value when arrival side density is less than the queue side and it goes to long value when arrival side density is more then queue side

# 4. CONCLUSION AND DISCUSSION

Here in this paper we are discussing two techniques for traffic light control .Firstly we discuss morphological method of edge detection for real time traffic control and then fuzzy logic.If we compare two methods we find that fuzzy logic is simple to implement than morphology mehod because morphology method is very lengthy procedure ,even because it is edge detection method it doesnot perform well during night time,edges of certain vehicles will miss due to dark at night time, but fuzzy logic only counts the no 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 qualiy camera not sensors which is less costlier.. The fuzzy logic allows the implementation of real-life rules similar to the way in which humans would think.so no doubt fuzzy logic gives more better

result .It also deal with the no 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.Our future work includes to find new methods for better results during night time using morphology technique so that cost and good results make the system more worthy.

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