

# Fuzzy Inference System for Image Processing

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**Abstract**— Image Processing is one of the important applications of Computer Graphics. Presently applications require kinds of images are source of information for analysis. When image is converted from one form to another as preprocessing scanning etc. some degradations occur at the end hence the edge detection is require for image processing .Edge detection is one of the basic requirement for biometric based human identification system. In this paper we are trying to detect the edges of images by using fuzzy inference system in MATLAB environment without determining threshold value. Only fuzzy inference system is developed and detection of edges is in process. Experimental results are obtained and shown for fuzzy inference system for approx 20 sets of 4 pixel values of fuzzy input set with one output.

**Index Terms**—Fuzzy Inference system, Edge Detection, Image Processing.

## I. INTRODUCTION

Edge detection is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities.

**Edge** - The point at which image brightness changes sharply are typically organized into a set of curve line segments. Edge detection is a fundamental tool in image processing , computer vision particularly in the area of feature detection and feature extraction. The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world.

**Edge Properties** - The edges extracted for 2D images are viewpoint dependent. The viewpoint dependent edges may change as the view point changes, and typically reflect the geometry of the scene such as objects including one another.

We can input the image by using Function  
`"a=imread('1.jpg');"`

`"g1=rgb2gray(a)";`

The work of this paper is concerned with the development of fuzzy logic rules based method which will be able to detect the edges of image. Only fuzzy inference system in MATLAB environment has been developed which gives the output result of the input vector used as membership functions.

## II. LITERATURE SURVEY

Traditionally edges have been loosely defined as pixel intensity discontinuities with in an image[2]. An Edge is not a physical entry ,just like a shadow .It is where the picture ends and wall starts. It is where the vertical and horizontal surfaces of an object meet. It is what happens between a bright window and the darkness of the night [13].

A large number of studies have been published in the field of image edge detection ,which shows its importance in the field of image processing. Many edge detection algorithms are proposed , each of which has its own weaknesses and strength but we cannot say that a particular algorithm is best or not here we are emphasizing few of them. Most of them can be grouped into two categories search based and zero crossing based. Search based method used first derivative expressions such as gradient magnitude and zero cross methods used second order derivative expression computed from the image in order to find edges. Search methods such as 'Robert', 'Sobel', 'Prewitt' have used 2D linear filters to produce vertical and horizontal edges separately to approximate first order derivatives of he image [2]. .All these algorithms are sensitive to noise , to solve these problem the canny edge detector was proposed which combines a smoothing function with zero crossing based method for edge detection.[12] the laplacian edge detection method has used a 2D linear filter to approximate second order derivatives of the pixel value of the image[2]. In another approach by Shannon entropy in which a threshold value is issued to segment and for binarization of the image then can find location and detection of the edges of the image.[14].Edges can be find using fuzzy logic algorithm with different levels of processing and threshold is set from slider control the resultant image from fuzzy is subjected to first and second derivatives to trace the edges of image.[3].Fuzzy based system are fast and provide good accuracy and this system is useful for image classification[4]. Edges can also be detected without determining threshold value[6]. Extended algorithm for edge detection using Shannon entropy is also developed which divide the image pixel into four sub regions all are worked separately for each pixel values[9].All these algorithm are successful for finding edges of the image but a good image edge detector must be able to detect edges of any type of images including noise removal algorithm

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### III. FUZZY LOGIC

#### What is fuzzy logic?

Fuzzy logic is a logical system which is an extension of multivalued logic. In logics system multivalued logic is a propositional calculus in which there are more than two truth values.

There are only two possible values true or false for any proposition but extension to classical two valued logic is an n-valued logic or n greater than two.

#### Why fuzzy logic?

Fuzzy logic is conceptually easy to understand and is flexible and is tolerant of imprecise data. Fuzzy logic is to map an input space to an output space and for doing this a list of if then statements called rules are evaluated in parallel. These Rules are useful because they use variables and adjectives that describes those variables.

### IV. FUZZY INFERENCE SYSTEM

Fuzzy inference system is a method that interprets the values in the input vectors and based on used defined rules, assigns values to the output vector. Using a GUI editors and viewers in the fuzzy logic toolbox, we can build the rules set, define membership functions and analyze the behavior of a fuzzy inference system. The editors and viewers are used to edit and view the membership functions and rules for fuzzy inference system. Complete processing of Fuzzy Inference System is shown in Fig 1.

We can create the fuzzy inference system using GUI tool or command line function.

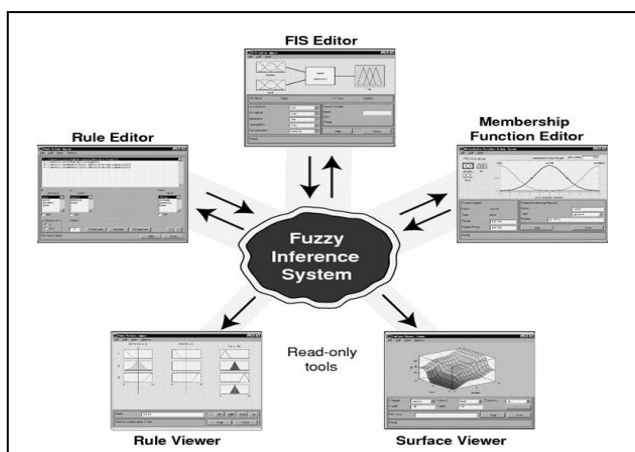


Fig. 1 .Output pixel membership diagram

### V. FUZZY INFERENCE SYSTEM AS A CONTROLLER

Design of fuzzy inference system is of four pixel values as input with one output pixel.

Fuzzy sets – A fuzzy set is a set without a crisp, clearly defined boundary. In this paper we use pixel values of the image as fuzzy set with four input pixel values. We have taken values range from 0 -255 for four input pixel containing white and black color of the image.

Membership Functions – A membership function is a curve that defines how each point in the input space is mapped to a membership values (degree of membership) between 0 and 1.

We have taken two membership function as two fuzzy sets for the input black and white color of the pixel with pi shaped built in membership function range from [0 0 0 255] for black color and range from [0 255 255 255] for white color pixel which is shown in Fig 2.

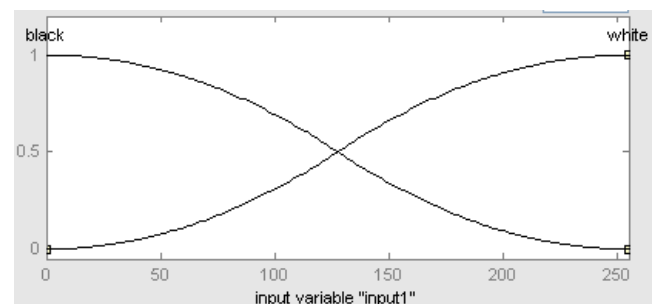


Fig. 2. Input pixel membership diagram

The membership functions for the output black, white and edge of the output pixel with pi shaped built in membership function range from [0 4 8 12] for black color and range from [130 134 138 142] for edge value and range from [243 247 251 255] for white color of the output pixel shown in Fig 3.

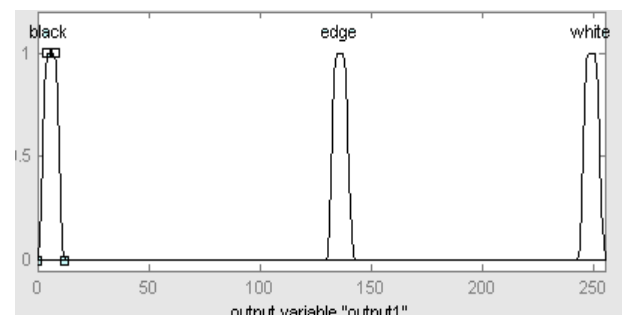


Fig. 3 .Output pixel membership diagram

If Then Rules - Fuzzy sets are the subjects and fuzzy operators are the verbs of fuzzy logic and if then rules are used to formulate the conditional statements that comprise fuzzy logic. A single fuzzy if then rule assumes the form if x is A then y is B, where A and B are linguistic values defined by fuzzy sets on the ranges X and Y. The if part of the rule "x is A" is called "antecedent or premise" while then part of the rule "y is B" is called the "consequent" or "conclusion". In this paper 16 if then rules are set for various conditions that can occur.

### VI. RULE BASED SYSTEM

1. If p1 is black & p2 is black & p3 is black & p4 is black then output is black.

2. If p1 is black & p2 is black & p3 is black & p4 is white then output is edge.
3. If p1 is black & p2 is black & p3 is white & p4 is black then output is edge.
4. If p1 is black & p2 is white & p3 is black & p4 is black then output is edge.
5. If p1 is white & p2 is black & p3 is black & p4 is black then output is edge.
6. If p1 is black & p2 is black & p3 is white & p4 is white then output is edge.
7. If p1 is white & p2 is white & p3 is black & p4 is black then output is edge.
8. If p1 is black & p2 is white & p3 is white & p4 is black then output is edge.
9. If p1 is white & p2 is black & p3 is black & p4 is white then output is edge.
10. If p1 is white & p2 is white & p3 is white & p4 is black then output is edge.
11. If p1 is white & p2 is white & p3 is black & p4 is white then output is edge.
12. If p1 is black & p2 is white & p3 is white & p4 is white then output is edge.
13. If p1 is white & p2 is black & p3 is white & p4 is white then output is edge.
14. If p1 is white & p2 is black & p3 is black & p4 is white then output is edge.
15. If p1 is black & p2 is white & p3 is black & p4 is white then output is edge.
16. If p1 is white & p2 is white & p3 is white & p4 is white then output is black.

Table 1. 3 X 3 window mask for edge pixel

P1	P2	P3
P4	(X,Y)	P6
P7	P8	P9

In this paper we are trying to find the neighbors of the pixel (X,Y) using four connected approach in which directions are changed for practical changes.

We are proposing these four neighbors  $P7=(X-1, Y-1)$ ,

$P4=(X-1, Y)$  and  $P8=(X, Y-1)$  and  $P5=(X, Y)$  of the original or current value of the pixel.

## VII. DEFUZZIFICATION

Defuzzification is a process of producing a quantifiable result in fuzzy logic, for given fuzzy sets and corresponding membership degrees. These will have a number of variables into a fuzzy result. The result is described in terms of membership in fuzzy sets.

There are five methods for defuzzification

1. Centroid Method
2. Bisectors Method
3. Middle of Maximum Method.
4. Smallest of Maximum Method.

5. Largest of Maximum Method.

In this paper for defuzzification we used Centroid method. The input for the defuzzification is a fuzzy set (the aggregate output of fuzzy set) and the output is a single number.

## VIII. EXPERIMENTS

The simulation result for fuzzy inference system for approx 25 input pixel values taken randomly and generated output of the fuzzy inference system after defuzzification.

Reading the fuzzy inference system by using readfis() function in matlab environment.

```
>> b=readfis('edge.fis')
```

Output is generated by using evalfis() function.

```
>> evalfis([250;250;250;250]),b)
```

```
>> b=252.4500
```

Table 2. Output after defuzzification

P4(X-1, Y) Range(0-255)	P5(X,Y) Range(0-255)	P7(X-1, Y-1) Range(0-255)	P8(X, Y-1) Range(0-255)	Output
1	2	3	4	2.5500
25	26	25	130	132.6
4	3	2	1	132.6
125	178	45	103	132.6
31	15	150	240	132.6
3	2	1	4	2.5500
150	170	205	109	132.6
79	8	82	76	132.6
118	171	128	130	132.6
172	175	7	6	132.6
200	200	200	200	252.4500
29	54	157	24	132.6
100	100	100	100	2.5500
1	176	24	203	132.6
1	3	2	4	2.5500
56	57	48	96	132.66
178	180	78	79	132.66
201	179	19	109	132.66
120	130	140	150	132.66
1	4	3	2	2.5500
100	100	100	100	2.5500
250	250	250	250	252.4500
180	50	50	50	132.6000
50	50	50	50	2.5500
120	1	150	150	132.6000

## CONCLUSION

In this paper, we have developed fuzzy inference system with four input pixel containing two fuzzy set and one output pixel

containing three fuzzy sets .Only fuzzy inference system is developed till now and we are working on the edge detection portion for image processing for providing interface between input of the image to the fuzzy set and apply defuzzification of the output generated by fuzzy inference system .Experimental results are displayed in table.

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