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# A NOVEL TECHNIQUE FOR EDGE DETECTION USING FUZZY LOGIC

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## ABSTRACT

Edge detection is an important task in image analysis, and it plays important role in computer vision and medical imaging applications. Fuzzy rule based image processing algorithm has been developed for detecting the edges in the image, based on the changes in the gray values. Gray values of the image are taken as the input of the fuzzy system and a floating mask of 3x3 is applied on the image to detect edge pixel using the predetermined fuzzy rules. In this paper normal edge detection techniques are discussed and evaluated the result images and compared with fuzzy logic approach. The robustness of the proposed method is analyzed, compared and evaluated using the image quality assessment metrics such as the image analysis and the results are presented.

***Keywords: Image, Fuzzy Edge Detection, Gray Values, Pixel, Quality Assessment***

## I.INTRODUCTION

Edge detection is a process of detecting the skeletal structure of an object in image. It plays a vital role in medical applications for detecting defective tissues, biometric system, motion analysis, satellite imaging, etc., The edge detection algorithms are used to detect edges, which are those places in an image that correspond to object boundaries. Edge detection algorithms identify the edge pixels in the image where the intensity changes rapidly. Several approaches have been developed for edge detection. Conventional edge detection methods, such as Sobel, Prewitt, Kirsch and Robert are based on the calculation of the intensity gradient magnitude at each image pixel. In these algorithms, the gradient value is compared with the threshold value and a pixel location is classified as an edge if the value of the gradient is higher than a threshold.

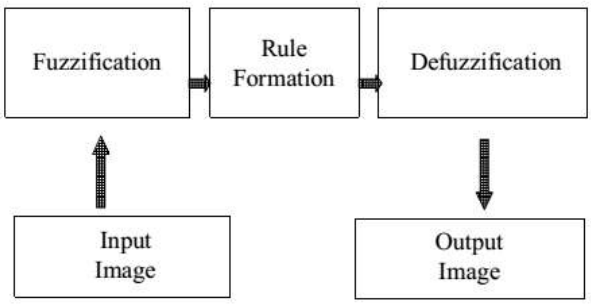



Figure [1.1]: the general structure of fuzzy image processing.

The general structure of fuzzy logic based image processing is shown in fig 1.1. In order to reduce the complexity, the input image acquired is converted to a gray scale form, ranging from 0 to 255 and size is also modified.

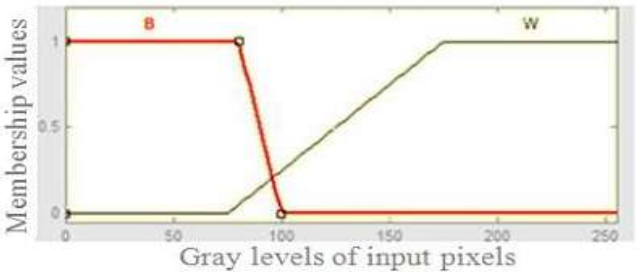
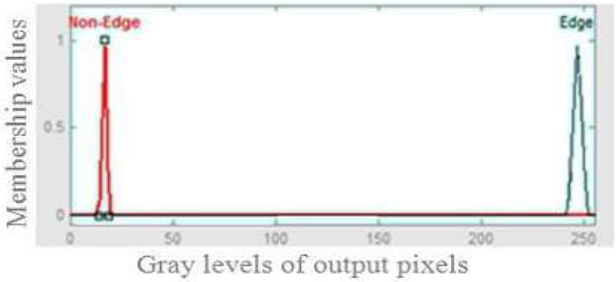



Figure [1.2]: fuzzy sets for the gray values of image




Figure[1.3]: fuzzy sets for edge detection.

## II.EDGE DETECTION TECHNIQUES

### 2.1 Laplacian based Edge Detection

The Laplacian method searches for zero crossings in the second derivative of the image to find edges. An edge has the one-dimensional shape of a ramp and calculating the derivative of the image can highlight its location. Clearly, the derivative shows a maximum located at the center of the edge in the original signal. This method of locating an edge is characteristic of the "gradient filter" family of edge detection filters and includes the Sobel method. A pixel location is declared an edge location if the value of the gradient exceeds some threshold. As mentioned before, edges will have higher pixel intensity values than those surrounding it. So once a threshold is set, you can compare the gradient value to the threshold value and detect an edge whenever the threshold is exceeded. Furthermore, when the first derivative is at a maximum, the second derivative is zero. As a result, another alternative to finding the location of an edge is to locate the zeros in the second derivative.

### 2.3 Sobel operators

The Sobel operator, sometimes called Sobel Filter, is used in image processing and computer vision, particularly within edge detection algorithms, and creates an image which emphasizes edges and transitions.

Sobel Operators are the computation of the partial derivation in gradient may be approximated in digital images. This technique performs 2D spatial gradient measurement on an image and also it emphasizes regions of high spatial frequency that correspond to edges. Typically it is used to find the approximate absolute gradient magnitude at each point in an input gray scale image. In theory at least, the operator consists of a pair of 3 × 3 convolution masks as shown below. One mask is simply the other rotated by 90º.These masks can be separate measurements of the gradient component in each orientation that is Gx and Gy. These can be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient.

## III.FUZZY LOGIC BASED EDGE DETECTION METHOD

### 3.1 Fuzzification

In this phase, the fuzzy sets are created based on the gray scale value of images and membership functions are assigned. The fuzzy set "Black" represents the gray values ranging from 0 to 100 and "White" represents the gray values 80 to 255, which is shown in below figure. Trapezoidal membership function is used for input fuzzy sets the membership value ranges from 0 to 1. The fuzzy set for detecting the edge in the image based on the gray value of the pixel is defined as "Edge" and "Non Edge". The range of gray values for the fuzzy sets "Non-edge and "Edge" are 10 to 20 and 245 to 255 respectively. Triangular membership functions are used for representing these fuzzy sets.

### 3.2 Rule formation

Rule formation is an important step in a fuzzy inference system for image processing applications. In this work, the gray value for each pixel is decided based on the gray level variations of the adjacent, neighbourhood pixels using 3x3 sliding mask as shown in fig .3.1.

| | | |
|---|---|---|
| M1 | M2 | M3 |
| M4 | M5 | M6 |
| M7 | M8 | M9 |

Figure[3.1]:3×3 sliding mask

This sliding mask is moved over the input gray scale image. Depending upon the gray scale value of the eight neighbourhood pixels, which may be either "Black" or "White", the centre pixel (M5) is decided as "Edge" or "Non Edge" using the fuzzy inference rules. These rules are suitable for detecting the edges in the processed image.

### 3.3 Defuzzification

The fuzzy inference rules are fired according to the gray scale values of the adjacent pixels based defuzzification procedure using centroid method is applied to determine the gray scale value of M5 pixel. The value of M5 pixel is modified for each movement of the floating mask.

### 3.4 Algorithm development

The steps involved in the development of fuzzy logic based edge detection are

- Import RGB Image and Convert to Grayscale
- Convert Image to Double-Precision Data

- Obtain Image Gradient
- Define Fuzzy Inference System (FIS) for Edge Detection
- Specify FIS Rules
- Evaluate FIS
- Plot Results

Proposed fuzzy logic based edge detection method is implemented in MATLAB software. The block diagram of the proposed work is shown. Different images were used for testing the performance of the proposed approach and the results are compared with the conventional edge detection methods such as Prewitt, Sobel and Canny methods. The fuzzy based edge detection method detect mainly the pixel that gives knowledge about the edge. It could be noted that the spatial information of proposed method is better than the other methods. Thus the resulting edge based fuzzy image processing seems to be smoother with less robustness.

## IV.CONCLUSION

This paper proposed an improved method for edge detection using fuzzy logic approach. Different images are tested using the proposed method for edge detection and compared with conventional edge detection method. The experimental results showed that fuzzy output contains better detection of edges compared with remaining edge detection techniques, such as laplacian and sobel operators.

## RESULTS

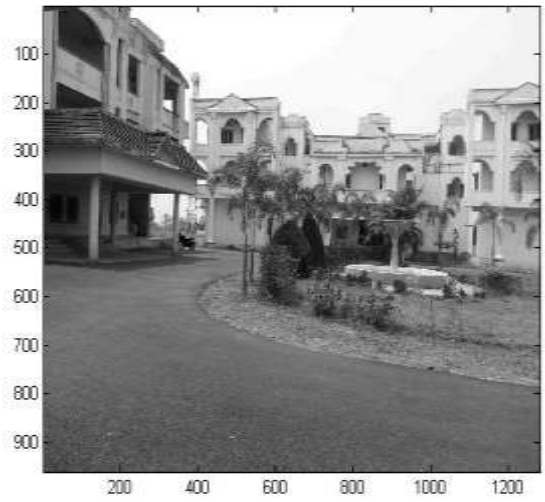
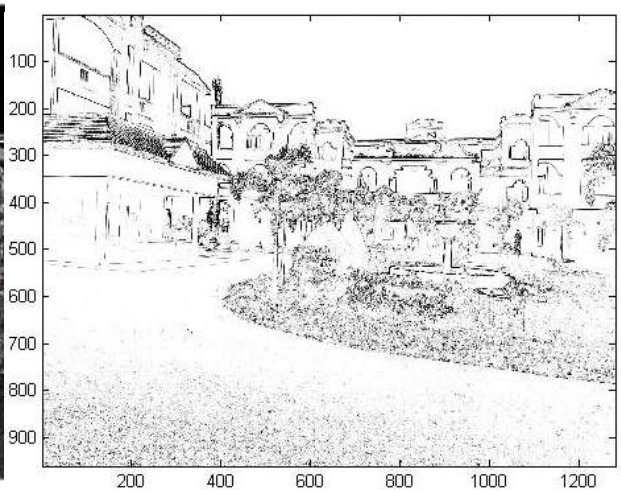



Figure [4.1]: gray scale image

Figure[4.2]: edge detected image by laplacian filter

Figure[4.3]: sobel edge detection




figure[4.4]: edge detection using fuzzy logic

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