ISSN (Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

Volume 3, Special Issue 3, March 2014

2014 International Conference on Innovations in Engineering and Technology (ICIET'14)
On 21st & 22nd March Organized by

K.L.N. College of Engineering, Madurai, Tamil Nadu, India

Performance Evaluation of Canny Edge Detection and Fuzzy Mathematical Morphology in Quality Assessment

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ABSTRACT— In image analysis most commonly used technique is edge detection, probably there are many edge detection techniques are available in the literature of detecting edges .in order to avoid the discontinuities in the image brightness among different regions of an image .we are proposing two edge detection algorithm that are canny edge detection algorithm and fuzzy mathematical morphology based edge detection algorithm and we are evaluating and comparing the performance of these algorithms based on quality assessments. Using same set of images, different image edge detection algorithm can be compared to recognize whether a specific algorithm produces better results.

KEY WORDS —EDGE DETECTION , CANNY EDGE DETECTION ALGORITHM, FUZZY MATHEMATICAL MORPHOLOGY, QUALITY ASSESSMENTS.

I. INTRODUCTION

Image edge detection is the most important area in the field of image processing and edges defines the boundaries between many regions in an image. The process of locating and identifying the discontinuities in the image is also called edge detection. Many edge detectors have been developed to trim down and preserving the inadequate data in an image. Mostly edge detection is based on the first order differential operators and second order differential operators such as Sobel, Prewit, and Robert's operators. these operators are used the gradient approach for detecting edges in specified direction ,so their **performance are degraded.**

Traditional image edge detection are depends on linear methods, now nonlinear methods are being investigated. Mostly edges are identified based on the structural elements and the color and texture and grayscale features [1].

Canny edge detection uses Gaussian filter for to remove noise in an image [2]. It is used to identify the boundary of an object and this method which eliminates the problem of optimization problem [3]. In case of thresholding technique Marr and Hildreth proposed an algorithm based on the zero-crossing in the image [4]. Nonlinear filtering techniques are based on the SUSAN algorithm. It is work well, by making adjacent pixels with brightness to each center pixel values [5].

Existing morphology techniques are based on crisp set theory, but, In recent years fuzzy mathematical morphology is used to extract the image edges [6] in fuzzy domain.

Mathematical morphology is a major non linear edge detection and enhancement technique. It is the mainstream for image processing [6]. Mathematical morphology using fuzzy logic for edge extraction with local and global approaches . A gray scale image is considered as a fuzzy set in the sense that is a fuzzified version binary image. It depends upon the membership function.

Traditional canny edge detection is failed to improve the quality of the image. In this paper, we propose a new approach that performs canny algorithm for edge detection and fuzzy mathematical morphology approach is applied to improve the quality and the quality is measured by using quality assessments. Initially, a Gaussian filter is applied to the input image for to eliminate the noise, because edge

detection is performed on the noise removed image. A unique method is applied by the canny edge detection algorithm. After that expected image edge is tracked and plotted on the image for to get the expected output.

The contribution of the paper is organized as follow in Section II w explain the functionality of the canny edge detection algorithm. In Section III we explain the fuzzy mathematical morphology approach to improve the image quality. In section IV we describe the results and discussion, it is evident how the approach is evident

II CANNY EDGE DETECTION ALGORITHM:

After performing the Gaussian filter, the edges are detected by the canny edge algorithm. Using the gradient kernel approach image gradient magnitude is calculated in horizontal direction

G_x and vertical direction G_y for each pixel. And the direction of the pixel is measured by

$$\theta = \arctan(gy / gx)$$

- After that non maxima suppression is performed in the edge direction for to suppress the magnitude whose gradient values are maximum and it gives the thin edge.
- To detect the edges two threshold values such as the higher threshold value (HIV) and lower threshold value (LTV) are selected from the histogram of the image.
- After that verification is implemented by using these threshold values against each pixels respectively by using Non maxima suppression as given below.
    - The gradient of the pixel is greater than the HIV the sense that pixel is taken as "edge pixel".
    - If the gradient is lie between high and lower threshold value in the sense, that value is also consider as "edge pixel".
    - If the gradient value is lower than the LTV in the sense that is declared as " non edge" pixel.

This lower and higher threshold values are verified by the observation of the experiments. These two threshold values are not only used for to detect large edges it can also find the small edges. Because of some intensity variability this canny edge detection technique have less quality. For to improve the quality of the image, Fuzzy mathematical morphology is applied to the canny edge detected image.

III FUZZY MATHEMATICAL MORPHOLOGY:

The traditional morphological operation is based on crisp set theory. But in the recent year this morphological operations are based on the fuzzy set theory. In case of fuzzy mathematical morphology there are four basic functions: Dilation, Erosion, Opening and closing. Initially we carry the Dilation and Erosion by moving the mask over the image, which has been processed by the means of membership function. Here the structuring element is act as a mask. Let us consider an image X and X' is the image which is processed by the membership function and Y represent the fuzzy structuring element, There are many structuring elements are available based on the application, the shapes of the structuring element may varied. And S is the standard structuring element which has all the elements are 1's in its matrix. This structuring element has standard in size. Seeing the operations of dilation and closing and opening based on erosion operation is not hard. Because there are many different definitions are available in fuzzy mathematical morphology. This operation is very fastest.

$$Erosion: E(X',Y) = \arg\min\{S - | X' - Y'|\} \quad (1)$$
$$Dilation: D(X',Y) = S - E(S - X',Y) \quad (2)$$
$$Opening: O(X',Y) = S - E(S, E(X',Y), B) \quad (3)$$
$$Closing: C(X',Y) = E(S - E(S - X',Y),Y) \quad (4)$$

A. Structuring element

There are many structuring elements based on the application. it is the basic element for morphology. The quantity of the image processing is highly affected by this structuring element because of sharp and width. In case of binary morphology the value of the element is based on 0 or 1, but in fuzzy based mathematical morphology the value is [0, 1] For a normal image 3x3 size structuring element is more essential to get fine result.

Here we are using Omni directional structuring element is used. Here S is a standard structuring element which contain all the element in its matrix are 1's.

1	**1**	**1**
1	**1**	**1**
1	**1**	**1**

(S)

\

0	**1**	**0**
1	**1**	**1**
0	**1**	**0**

(Y)

In this project we use two types of images are used such as (a) ball (b) tobacco leaf If we apply the Canny edge detection to a ball image the quality of the edge detection is somewhat less because of noise and intensity so we given

the fuzzy mathematical morphology like (5), so let us consider A is the result of fuzzy dilation and B is the result of fuzzy erosion.

Let A and B are compared each other for a same image and $K_1$and K_2 are the two maximum values between the corresponding pixel , A and B inside a 3*3 window centered on the pixel (i, j), together with the difference K(i, j) computed on the corresponding pixels (i, j).
In the case of tobacco leaf outmost of the image will not contain any pixel. But it is not a big problem.

$$F(A(i,j),B(i,j)) = \sqrt{K(i,j)\frac{K(i,j)+K1+k2}{3}} \qquad (5)$$

B. Image edge preservation

For to preserve the edges in the fuzzy applied canny image moment preserving algorithm is applied it is used to fix the threshold between [0,1] for this algorithm some steps described as follow.

1) Take a fuzzy image f and divide the image into 4x4 non overlapping blocks of f_j
2) Consider a block f_j, and perform this function.
   - Select a set of moments that contains gray values in pixels f_j.
   - Compute the uniform spectral band based on the variance of the gray level.
   - Create a bitmap of size 4x4 f_j by assigning the pixel value p<t1.
3) Stop the process when all the blocks of f have been processed.

This result will be analyzed based on the quality parameter PSNR.

IV COMPARISON OF RESULTS

In this section we compare the results with canny edge detection algorithm and fuzzy mathematical morphology and analyze the performance this algorithms based on the quality assessment parameter PSNR.

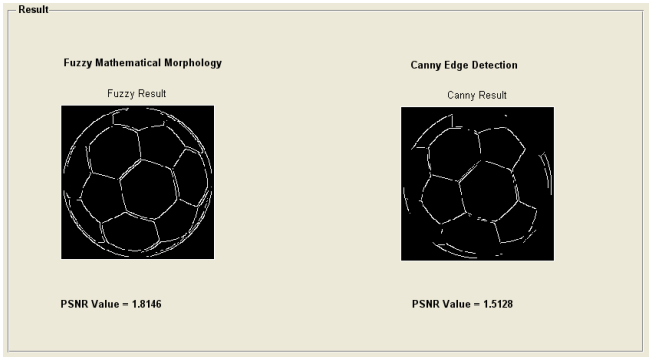

Fig5(a)

Fig5(a) show the result of edge detection of canny followed by fuzzy mathematical morphology. And the improved value for peak signal to noise ratio.

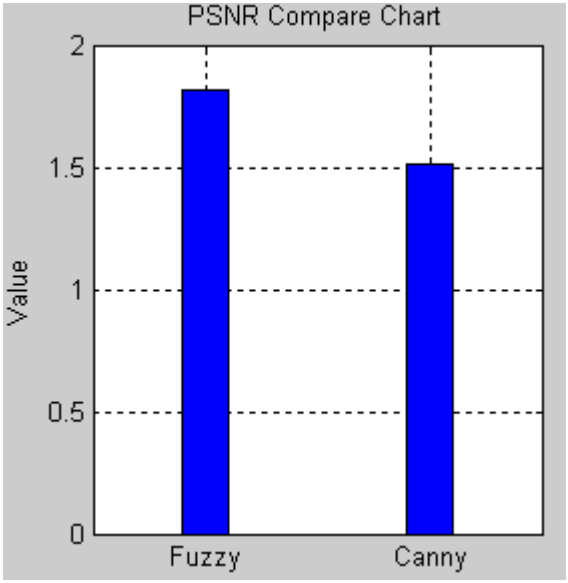

Fig4(b)

Fig4(b) performance evaluation of those algorithm based on erosion.

A. Result for canny edge detection algorithm and fuzzy mathematical morphology for ball image

B Result for canny edge detection algorithm and fuzzy mathematical morphology for tobacco leaf image

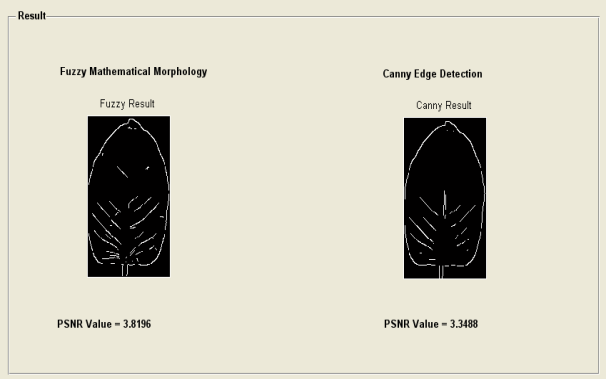

Fig5(c)

Fig5(c) shows the result for tobacco leaf with different PSNR value.

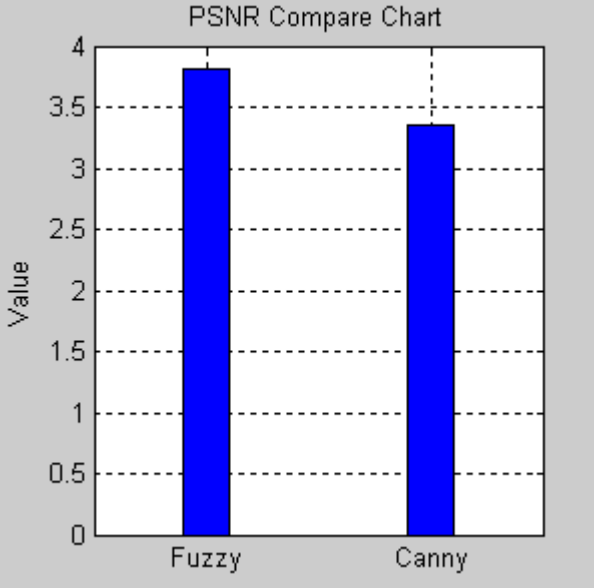

Fig5(d)

Fig5(d) shows the performance of algorithm based on erosion.

C. Results and discussion

In this, those algorithms are applied for many images and fuzzy mathematical morphology gives better results for erosion and opening. It shows the performance of the fuzzy morphology and the PSNR value of this algorithm is high.

The concept of fuzzy mathematical morphology have better efficiency than Canny algorithm. The contribution of this paper gives the performance evaluation of the fuzzy mathematical morphology with the Canny edge detection. For a tobacco leaf and ball image this the fuzzy mathematical morphology gives high effectivity and less threshold

V CONCLUSION

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