Comparative Analysis of Color Edge Detection Techniques Based on Fuzzy Logic

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Abstract: Edge is the important feature of image. The image edges contain rich knowledge which is very important for finding characteristic of image by object recognition. It is the commonly used technique in image processing.This paper shows a fuzzy rule based algorithm that is capable of finding edges effectively from grey scale images. This paper presents that kind of operators in computer vision applications. The gradient and standard deviation is used as input for fuzzy system. The algorithm in which fusion of hue component and principal component are implemented and then the results are compared with modified fuzzy based algorithm.

Keywords: Edge detection, image processing, Defuzzification, fuzzy logic

1. Introduction

Unexpected variation in pixel intensity within an image is defined as edge .The edge detection is basically defined as a technique for finding the boundaries of objects within images. Image segmentation and data extraction use edge detection technique. The methods of edge detection such as, kirsch,sobel and Robert based on the calculation of gradient magnitude at each image pixel. In this algorithm, the threshold value is compared with gradient value and the pixel location is categorized as an edge, if the value of threshold is lower than a gradient value. The edge detector which is based on gradient is very sensitive to noise; this is one of the major drawbacks in it. Canny proposed an approach to counter noise the problems of edge detection in which the image is multiplied with the first order derivative of Gaussian filter for smoothing the direction oflocal gradient which is followed by thresholding and edge detection [1].Sometimes second operators are used. Themost commonly used filter is LoG (Laplacian-of Gaussian) .There are three major drawbacks of this operator. Firstly, computational complexity is increases. Secondly, continuous lines are generated so that it can represent all the edges in input image. [3]The description of more general structures is not adequate.

A powerful approach to decision making is represented by fuzzy logic. The fuzzy logic was formulated by zadehin 1965;its applications are used in various areas, such as edge detection, image assessment and image segmentation etc. The advantage of fuzzy logic over existing technique is very clear. In this system described all input to the fuzzy inference system(FIS) system are produced by applying to the input image, first order edge detector filter(sobel operator),a high-pass filter and a low-pass filter. The fuzzy membership functions and the fuzzy rules are defined according to the type of filtering which are used for the execution [2].

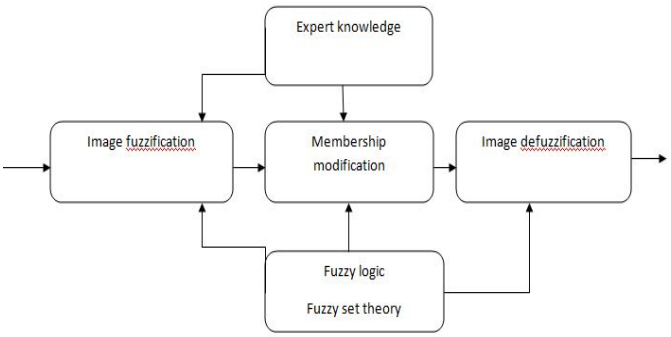

FIG.1 Basic block diagram of fuzzy logic

1. Fuzzy Interference System

Fuzzy systemconsist of expert knowledge and reasoning mechanism called fuzzy interference system. A fuzzy interference system having four main blocks shown in above figure.

1.1 Fuzzification: Convert the crisp inputs into degrees of match with linguistic values. Defuzzification process is just reverse of fuzzification.

1.2 Expert knowledge: It consists of database and rule base. A rule base includes a number of fuzzy if-then rules.The membershipfunction of the fuzzy sets used in fuzzy rules are defined by database.

1.3 Fuzzy Interference Engine: It performs the interference operation on the rules.

1.4 Defuzzification: The conversion of fuzzy set to single crisp value is known as defuzzification.

2. Literature Survey

To solve the problem of existing technique, a color edge detection technique which isbased on the fusion of principal component analysis and hue component are proposed by Lie and Fan (2013).Initially a computational method of hue difference is defined,to obtain accurate edges for hue component which is then applied to classical gradient operators. Moreover by using edge fusion of huecomponent and principal component of color image with lesser computational complexity, complete object edges can be obtained [3]. Wang and Yan(2012) [4] proposed a new edge detection in color image processing which is based on vector morphological operators. A new vector ordering has proposed in RGBcolor space. And then by determining the characteristics of noise contaminating image, we can proposed a vector morphological operators and applied in color edge detection. The new ideal is noise removing and pixels judgement that can be used to represent color morphological dilation and erosion. How edges are efficiently preserved in noise appearance for this, a novel approach of edge detection for color image was proposed by Xu et al.(2012)[5] . Morphological gradient operator is constructed with performance of noise latter which is consistent with human vision perception, for this a multi-structure elements are designed . An improved canny algorithm has proposed byXin and Ki (2012)[6]to detect edges in color images. Algorithm is consistingof vectorsobel gradient computation, non-maxima suppression based on edge detection,quaternion weighted average filter, interpolation and connection. An algorithm is applied to deal with color image of transmission line. This results show that from grey image processing method our

algorithm is still better., XIAO et al. (2016)[7] has proposed a multi-scale edge detection algorithm which took soft threshold methodto implement detail enhancement and reduction in noise of the true color image. A novel color edge detection algorithm is presented by Chen et al.(2010)[8] for the improvement of efficiency and the performance of color edge detection. To smooth the original image,an improved kuwahara filter is used. In RGB color spacing, after edge detection in each channel independently, an adaptive threshold selection method is used to determine the ideal threshold value and this algorithm is known as edge thinning and it is applied to get accurate edge. Based on the concept of self-organizing map (som), Jordan et al.(2011)[9] has presented multispectral images of edge detection. To produce a global ordering of spectral vectors. A one to one correspondence between pixels values and scalars is guaranteed, with global ordering`. The edge probability is only finding by the adjacent human pixels. This method eliminates linearization and uses the SOM more effectively for edge detection while holding greater flexibility. Singh et al.(2013)[10] has presented architecture to reduce the usage of FPGA resources and it use only one processing element for computing gradient of all three R, G and B color component. The FPGA resource usage is decreased by 35% from standard implementations that uses three gradient computational blocks. Somasundaram et al.(2012)[11] has proposed method of edge detection which is built on 32 fuzzy rules.For MRI head scans edge detection is the pre-segmentation processes. It observes more accurate edges than the traditional canny and sobel edge detection operator and time taken for detection of edges is also less. It generates sharp and clear edges for segmentation of brain portions in MRI of head scans of human

3. Proposed Method Of Edge Detection

To obtain the objective, different methodologies are used. Following are the steps which are used to accomplish the objectives of dissertation.

Step1. Input color image- Initially, there is a given input image.

Step2 For transformation,from color image to grey scale,apply RGB2HSV transform and edge detection, here we can see that few edges are missed during transformation. In addition, some of the missing edges results from hue changes. It maintains edges having similar value in grey scale images. As a result, once the problem of edge detection of hue component is findingthen we can describe a upperlevel edge detection representation for colorimage. Then edge detection algorithm is applied to an image which may ease the total of data to be manage and sort outinformation that possibly will be consider as less related while maintaining the main structural properties of digital image. If this step will be successful, the task of explaining the information content in original image may be easy.

Step3. Apply image gradient- Then apply image gradient,image gradient may be used to obtain information from images. Gradient images are generated from original image. After gradient image have been calculated, pixels with higher gradient values is considered as edge pixel. The pixels with highest gradient values in the direction of gradient become edge pixels, and edges that can be detected in the direction which is perpendicular to the direction of gradient. It is used for hue componentto get accurate edges. The formula to find gradient of image is as shown:

$$\nabla f = \frac{\partial f}{\partial x} x^{\wedge} + \frac{\partial f}{\partial y} y^{\wedge} \qquad (1)$$

Where:

$\frac{\partial}{\partial} \frac{f}{x}$ is the gradient along x-direction

$\frac{\partial f}{\partial y}$ is the gradient along y-direction

Step4. Apply PCA and edge detection- image color reduction,all the components are compressed into one that containing a main component of information. It makes complex object unrelated. The PCA involve a mathematical formula that transform a number of related variables into a number of unrelated variables called principal components .PCA is used widely in image classificationand image compression. It calculate a condense and optimal depiction of data set. The first principal component gives a greater variance. The second principal component points the direction of maximum variance which is perpendicular to the first. The third principal component gives greater variance in the subspace which is perpendicular to the variance of first twocomponents. Then apply an edge detection algorithm to manage the overall data and extract information that possibly will be consider as less related while maintaining the main structural properties of digital image. If this step will be successful, the task of explaining theinformation content in input image may be easy. To find the PCA:

$$C_{I,J} = \frac{1}{N-1} \sum_{q=1}^{N} X_{q,i.} . X_{q,,j} \qquad (2)$$

$C_{i,,j}$ (Diagonal) is the variance of variable i.

$C_{I,,,J}$ (Off diagonal) is the co-variance between i and j.

Step5. Apply fuzzy frication and determine edge which islocatedon fuzzy templates- The fuzzy edge detection is used as template matching in edge detection. The fuzzy edge detection detects accurate edges in an image. It maintains edges even in poor images and give best results even if, ithavean image with low intensity. In the first step, the average(T_1) of intensity values off every pixel in the input image I is calculated as:

$$T_1 = \frac{\sum^{N-1}_{t=0} x_i}{N} \qquad (3)$$

Here the intensity of the pixel is x, and N is the number of pixels.

Step6. Apply edge fusion- Fusion is the method ofcombining useful information from two or more images into a particular image. From any of the input images, the consequential image will be more useful. By combining all the images of,PCA, hue and fuzzy frication and by applying edge fusion to get fused image.

Step7. Final edge detected image- The output is given which show the detected image.

4. Experimental Results

As given in the below figures, we are comparing the result of different images. As a result show that from existing approaches our proposed approach is much better. To detect edges in color images, here is representation of proposed algorithm.

Fig. 1 (a) Input image

In figure1 (a) there is a input image which shows the stable fracture .

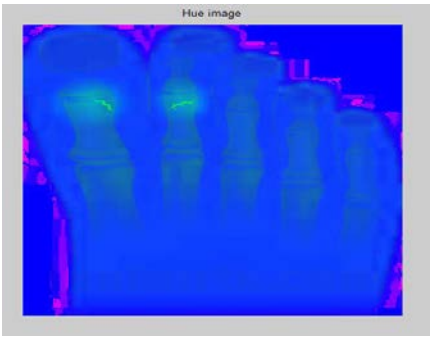

Fig. 1(b) Hue image

Figure 1(b) shows the hue image of original input. As shown in figure 1(b), the true color of an imageis described by hue image. For transformation ofcolor image to grey scale image,we can see that some edges are missed. In addition,most of the missing edges consequences from hue changes. So the pixel values are similar as the intensity of grey scale images. So to determine missing edges we apply hue analysis to color images

Fig 1(c) Hue detected edge image

Figure1(c) shows hue detected edge image, once the problem of edge detection of hue component is solved,we can present superior edge detection for color image

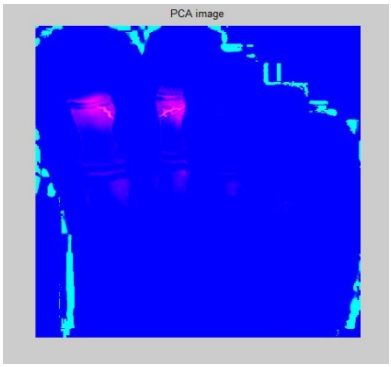

Fig.1 (d) PCA image

Figure1(d) shows the PCA detected image,we can present superior edge detection for color image once the problem of edge detection of PCA component is solved.

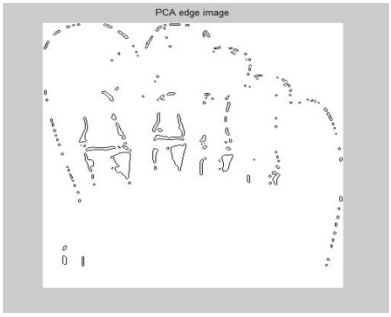

Fig. 1(e) Fusion of hue and PCA edge image

Figure1(e) shows the hue and PCA edge image which combine important information from two or more images into one particular image and gets better results to detect accurate edges in color image

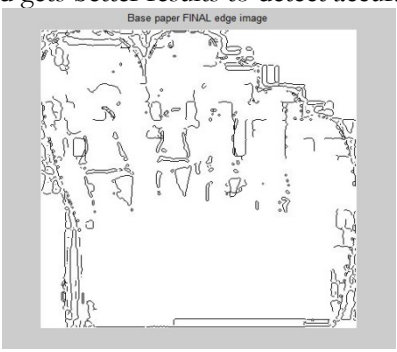

Fig. 1(f) base paper final image

In the figure(1f) shows the base paper final edge image.

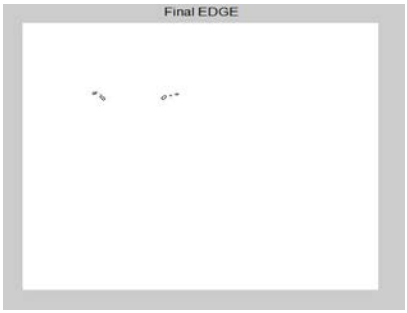

Fig.1(g) fuzzy based edge detection

Figure 1(g) shows the fuzzy based edge detection.To detect fine edges in an image, fuzzy edge detection is used. Even In low intensity images, it preserves edges of an image.

5. PERFORMANCE ANALYSIS

This section includes cross validation between previous and fuzzy based techniques. To prove that the performance of proposed algorithm is much better than available methods, some of the performance parameter like PSNR, MSE, F-measure, Accuracy,Pratt figure of merit for digital images have been selected:

TABLE 1

S.No	Tech. used	PSNR	MSE	F-MEASURE	ACCURACY	PRATT FIGURE OF MERIT
1	Hue tech.	48.5863	0.9003	5.8988	5.8988	0.1167
2	PCA tech.	48.5105	0.9163	2.4552	2.4552	0.1148
3	Existing fusion based tech.	57.6952	0.1106	94.2437	93.6895	0.6424
4	Fuzzy based tech.	59.3345	0.0758	96.0606	95.6343	0.0205

6. Conclusion & Future Scope

In this paper, we estimate a very simple,small and a very efficient, fuzzy rule based edge detection algorithm which saturate the concepts of digital image processing. Comparisons were made with different type of

edge detection method like sobel and canny edge detector. Displayed results have shown the accuracy,pratt figure of merit, MSE,PSNR of edge detection using fuzzy rule based algorithm.

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