FUZZY LOGIC BASED IMAGE EDGE DETECTION METHOD

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Abstract: Digital image processing is rapidly growing area and involve in various fields of research as well as human life. Visual information transmitted in the form of digital images is becoming major methods of communication and often corrupted with noise. An edge in an image is a significantly changing the image intensity. The input images have some noise that cause the quality of the image. Median filter is used to remove noise from the image. Edge detection process significantly reduces the amount of data and filters out useless information, while preserving the essential structuring properties in an image. The performance of a proposed work is analyzed using the factors MSE, PSNR and SNR. The experimental work using Matlab shows that the proposed scheme is efficient and produced expected result.

Keywords: Edge detection, Median filter, Fuzzy inference system.

I. Introduction

The purpose of image processing is to get better image and enhance and detect, classify or segment the objects in the image which are not visible. In order to understand the contents in image during image processing, it is vital to partition the image into objects in an image and background of the image. Partition of the image into object and background is a cruel step in Image interpretation. Edge detection is a fundamental tool used in most image processing applications to obtain information from the frames. Edge detection is the process of finding edge in image. Edge refers to pixel positions of the image where significant abrupt local changes of intensity (either gray or color) occur. There are many ways to perform edge detection. Image is a pictorial representation of a person, scene or object.

An image is a realistic or semi-realistic representation of a variety of subjects produced by a number of methods and in a number of different styles. The term "picture" is also frequently used in the literature therefore, the terms "picture" and "image" are both used in appropriate contexts. In other words, say that an image as described here is any object that could be considered graphical in nature. This includes, but is not limited to, photographs, slides, digital images and any object that is not textual in nature. An image is an artifact that depicts or records visual perception, for example a two-dimensional picture, that has a similar appearance to some subject usually a physical object or a person, thus providing a depiction of it. The purpose of edge detection is to mark the points in a digital image at which the luminance intensity changes.

a. Image Noise

Noise can be understood as a barrier to the sense organs of the received source information to understand the factors. For example, a black and white picture, the surface brightness distribution is assumed to be f (x, y). Then the interference it receives from the brightness distribution of R (x, y) can be called image noise. However, the noise in theory can be defined as unpredictable. It can be used statistical methods to understand the probability of random error. Therefore, the image noise as a multidimensional random process is appropriate. So, it can be described noise is completely random process can borrow the description which uses the probability distribution function and probability density function. However, in many cases, this description is very complicated. The practical application is often unnecessary. That is mean-variance, correlation function and so on. Because, the digital features can be reflected in some aspects of noise characteristics.

In most of digital imaging systems, the input images are used to first freeze and then scanning the image into a one-dimensional multi-dimensional signal. Next it's processing, storage, transmission and other processing transformation. Finally, it is necessary to make up the multi-dimensional image signal and image noise will be equally subject to such a decomposition and synthesis. In these processes affect the electrical system and the outside world will allow the precise analysis of image noise becomes very complicated. The other image can transmit visual information media. The image information of the knowledge to understand the human visual system is determined. Different image noise, people have the different feeling. Image noise in digital image processing technology is growing in importance. Such as in high magnification of the

interpretation of aerial photographs and X-ray imaging systems in the removal of noise has become an indispensable technical step.

b. Image denoising and its Techniques

In various fields and applications use of images are becoming increasingly popular like in field of medical, education etc. But the problem is that noise will be inevitably introduced in the image during image acquisition process. Another problem that arises after denoising process is the destruction of the image edge structures and introduction of artifacts. For this there are several techniques proposed by other authors for image denoising as well as for edge preservation.

Denoising Techniques

Removing Noise by Linear Filtering

Linear filtering is use to remove certain types of noise. Averaging filters are appropriate for this purpose. For example, an averaging filter can remove noise or grain from a photograph by replacing each pixel value with the average value of its neighbourhood pixels. By this local variations caused by grain are reduced.

Removing Noise by Median Filtering

Median filter is a non-linear filter which is similar to an averaging filter. In this the value of an output pixel is determined by replacing the value of each corresponding pixel by the median of the neighbourhood pixels, rather than the mean. The median is much less sensitive than the mean to outliers (extreme values). Median filtering is therefore better to remove outliers without reducing the image sharpness.

Removing Noise by Adaptive Filtering

A Wiener filter (a type of linear filter) is applied using wiener2 function to an image adaptively, tailoring itself to the local image variance. Whenever there is large variance, wiener2 performs little smoothing and vice versa. This approach produces better results than linear filtering. The adaptive filter is more selective than a comparable linear filter, as it preserves the edges and other high-frequency parts of an image. In addition, there are no design tasks; the wiener2 function handles all preliminary computations and implements the filter for an input image. wiener2, however, does require more computation time than linear filtering.

c. Edge based Image Segmentation

In image processing field, edge plays a vital role. Edge defines as a boundary of an object. It is used to detect the object boundaries in image segmentation process. Edge based segmentation depends on the edges that are found in an image by using edge detecting operators. A group of connected pixels known as edge that can be differentiated using intensity gradient estimation. It divides the image by observing the changes in pixels on basis of their intensity value of an image in segmentation process. Edges are detected when there is suddenly change in the brightness of image.

Fuzzy based Image Segmentation

To analyze the any type of images as well as extract the useful data as per our requirement this techniques plays an important role. By default, unwanted noise occurred in an image, to remove it a function is used in this approach that is called Fuzzification function. For converting an intensity image into fuzzy image

Fuzzification function is used for getting a better result, different morphological operators are collective with fuzzy method. There are many approaches that are included in this method are following:

- Fuzzy Clustering Algorithm
- Fuzzy connectedness using dynamic weights
- Fuzzy Rule-Based Approach

In fuzzy clustering approach is very ancient to segmentation. The generally used algorithms are Fuzzy k-Means and Fuzzy C-means (FCM) that are used to make the clusters.

Fuzzy connectedness using dynamic weights is to integrate the relationship among pixels, fuzzy rule-based approach is used. In this method a function is used which is having three types that are used to segmenting an image, that function is called membership function. Membership function's types are: Region pixel distribution, to measure the nearness of the region, and to find the 3D relationship between pixels.

Finally, Fuzzy Rule-Based Approach is customary segmentation outlines can't resolve the difficulties that are related to fuzzy medical images. For resolving these difficulties, and introduce a new algorithm that is known as dynamic weight algorithm which vigorously corrects the exact weights. This algorithm is also applicable in distingue images types.

II. Existing Methodology

To sense and detect abrupt change at edges, several operators have been constructed based on different ideas. There are different segmentation methods that have been used to identify, detect, and extract information from images. Edge detection is the process of determining where edges of objects fall within an image. To sense and detect abrupt change at edges, several operators have been constructed based on different ideas. Edge detection is one of the challenging tasks in medical image processing. Some examples are the Fuzzy C-Mean Algorithm, K-Mean Clustering, the edge based segmentation method, Otsu method, and the thresholding method. Each one of these techniques has its own advantages and disadvantages. Otsu's thresholding method has been proposed to isolate information from other regions of the images. It is compared with different standard segmentation techniques.

i) OTSU Method

Otsu's thresholding method has been proposed to isolate information from other regions of the images. It is compared with different standard segmentation techniques.

For each potential threshold T,

Step1: *Separate the pixels into number of clusters according to the threshold.*

Step2: *Find the Mean of each cluster.*

Step3: *Square the mean of each cluster.*

Step4: *Multiply by the number of pixels in one cluster times the number in the other.*

ii) Genetic Algorithm

Genetic algorithms are based on natural selection discovered by Charles Darwin. They employed natural selection of fittest individuals as optimization problem solver. Optimization is performed through natural exchange of genetic material between parents. Off springs are formed from parent genes. Fitness of off springs is evaluated. The fittest individuals are allowed to breed only. In computer world, genetic material is replaced by strings of bits and natural selection replaced by fitness function. Matting of parents is represented by crossover and mutation operations.

step 1: *Start with a randomly generated population of N chromosomes, where N is the size of population, 1-length of chromosome x.*

step 2: *Calculate the fitness value of function φ(x) of each chromosome x in the population.*

step 3: *Repeat until N off springs is created:*

(i) Probabilistically select a pair of chromosomes from current population using value of fitness function.

(ii) Produce an offspring yi using crossover and mutation operators, where i = 1, 2, …, N.

step 4: *Replace current population with newly created one.*

step 5: *Go to step 2.*

III. Fuzzy Edge Detection Method

At present, the application of Fuzzy Logic exceeds the control domain since it is also employed for other knowledge based decision making tasks. It involves medical diagnosis, business forecasting, traffic control, network management, image processing, signal processing, computer vision, geology and many more.

The following block diagram Figure 3.1 shows the methodology of fuzzy logic based edge detection. First the color image is given as input and converted to gray scale image than for getting better results and to highlight edges Median filtering is applied for gray scale image, since the Fuzzy Logic Toolbox software operates on double-precision numbers so, filtered image, is converted to a double array next is the main step that is fuzzy logic based edge detection to detect the edges .The fuzzy logic edge detection can performed by using FIS.

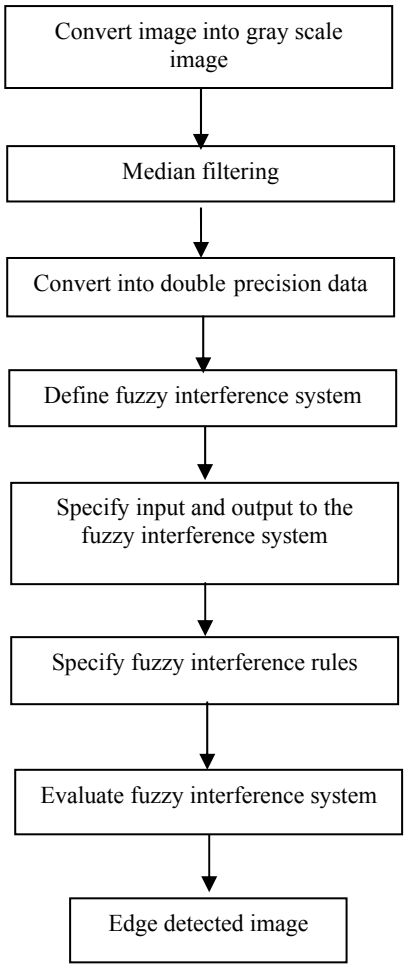

Figure 3.1 Edge Detection Model

Fuzzy method is one of the new methods and it was based on set theory. The main benefit of fuzzy set theory is the able to model the ambiguity and the uncertainty. In the proposed method trapezoidal and triangular membership function of mamdani type FIS is used for four inputs containing two fuzzy set and one output containing one fuzzy set. The 2*2 masks is slide over the entire image, and then pixels values of masks are examined through various ten rules which are defined in FIS rule editor. Based on these set of rules the output of fuzzy is decided that particular pixel is edge or not. For getting better results Median filtering is used.

IV. Experiments and Results

The Proposed methodology is experimental with various image databases and the results are presented separately. The different classes of images in the database have different sizes and are categorized. The performance of a proposed method is evaluated based on the parametric standard like

- Peak Signal to Noise Ratio (PSNR),
- Mean Squared Error (MSE) and
- Signal to Noise Ratio (SNR)

are most commonly used as a measure of quality of resultant images. The PSNR is defined as:

$$PSNR = 10 \log_{10} \left(\frac{MAX_I^2}{MSE} \right)$$

Here, MAX_I is the maximum pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255. More generally, when samples are represented using linear PCM with B bits per sample, maximum possible value of MAX_I is 2^B-1.

The PSNR is most commonly used as a measure of quality of reconstruction in image compression and is defined via the mean squared error (MSE) which for two m×n monochrome images I and K where one of the images is considered a noisy approximation of the other is defined as:

MSE = sum(sum((I-Ieval).^2))/(M*N)

In general, a good reconstructed image is one with low MSE and high PSNR. That means that the image has low error and high image fidelity.

The signal-to-noise ratio (SNR) is used in imaging as a real measure of the sensitivity of a (digital or film) imaging system. A better definition of SNR is the ratio of the average signal value to the standard deviation of the signal.

SNR=10*log10 ((imax-imin)./sd)

Table 4.1 Performance Analysis for PSNR Value

Image Name	OTSU Method	Genetic Merhod	Fuzzy Method
Vegetables	34.68	42. 23	47.87
Bridge	35.88	36.70	46.98
Bird	36.83	38.68	39.37
Temple	37.70	41.51	43.15

Table 4.2 Performance Analysis for MSE Value

Image Name	OTSU Method	Genetic Method	Fuzzy Method
Vegetable	0.09	0.06	0.09
Bridge	0.08	0.09	0.07
Bird	0.09	0.06	0.05
Temple	0.06	0.05	0.04

Table 4.3 Performance Analysis for SNR Value

Image Name	OTSU Method	Genetic Method	Fuzzy Method
Vegetable	1.12	1.19	0.35
Bridge	1.14	1.17	0.61
Bird	1.13	1.16	0.59
Temple	1.12	1.14	0.31

V. Conclusion

The performance of these algorithms has been tested using various quantitative and qualitative measures like PSNR, MSE and SNR. From the experimental analysis it has been proved that the proposed fuzzy edge detection technique gives better performance compared to conventional as well as advanced filters. The efficiency of the proposed algorithm is proved using standard images and has been found that produce better results in terms of quantitative and qualitative measures. The capability of the proposed method to preserve the edge details has been proved with the help of edge maps extracted from the images.

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