Threshold Based Edge Detection Algorithm

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Abstract- **Edge detection is one of the most commonly used operations in image processing and pattern recognition. Edge detecting in an image significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image. In this paper, edge detection methods such as Sobel, Prewitt, Robert, Canny, Laplacian of Gaussian (LOG), Expectation-Maximization (EM) algorithm, OSTU and Genetic algorithms are also used for segmenting. A new edge detection technique is proposed which detects the sharp and accurate edges that are not possible with the existing techniques. This implemented edge detection technique will be improved by combining it with other types of filters namely Weiner, STD, Hormonic, Geometric filters to remove the noise from the image. The proposed method is applied over large database of color images both synthetic and real life images and performance of the algorithm is evident from the results with different threshold values for given input image which ranges between 0 and 1. When the threshold value is 0.68 it is noticed that the sharp and accurate edges are detected.**

Index Terms— **Colour images Edge detection, threshold**

I. Introduction

Image segmentation is the process of partitioning/ subdividing a digital image into multiple meaningful regions or sets of pixels regions with respect to a particular application [1]. The segmentation is based on measurements taken from the image and might be grey level, colour, texture, depth or motion. The result of image segmentation is a set of segments that collectively cover the entire image. All the pixels in region are similar with respect to some characteristic or computed property, such as colour, intensity, or texture. Adjacent regions differ with respect to same characteristics. Edge detection is one of the frequently used techniques in digital image processing.

Edge detection produces something like a line drawing of an image, which highlights the intensity changes. In general, the boundaries of objects tend to produce sudden changes in the image intensity. For example, different objects are usually different colors or hues and this causes the image intensity to change as we move from one object to another [3]. In addition, different surfaces of an object receive different amounts of light, which again produces intensity changes.

Manuscript received April 25, 2011; revised June 20, 2011.
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Therefore the intensity boundary information that we extract from an image will tend to indicate object boundaries, but not always.

Image segmentation is done using various edge detection techniques such as Sobel, Prewitt, Robert, Canny, LOG, EM algorithm, OSTU and Genetic Algorithm. Some of the practical applications of image segmentation are:

- Medical Imaging
  - Locate tumors and other pathologies
  - Measure tissue volumes
  - Computer-guided surgery
  - Diagnosis
  - Treatment planning
  - Study of anatomical structure
- Locate objects in satellite images (roads, forests, etc.)
- Face recognition
- Fingerprint recognition
- Traffic control systems
- Brake light detection

In this paper, section II discusses different filters used for eliminating noise and various edge detection techniques. Section III presents implementation and the proposed method in Section IV. Observations and conclusions are presented in Section V and Section VI.

II. Noise Removal FILTERS AND Edges Detection Techniques in Greyscale Image

Filter is a device or process that removes from a signal some unwanted component or feature. Filtering means removing some frequencies and not others in order to suppress interfering signals and reduce background noise. However, filters do not exclusively act in the frequency domain; especially in the field of image processing many other targets for filtering exist. High-pass and low-pass filters are also used in digital image processing to perform image modifications, enhancements, noise reduction, etc., using designs done in either the spatial domain or the frequency domain. In our experimentation, Harmonic low-pass filters are used.

The various edge detection techniques are [7]

A. SOBEL method

BW=edge(I,'sobel') specifies the Sobel method.

BW = edge (I,'sobel',thresh) specifies the sensitivity threshold for the Sobel method. Edge ignores all edges that are not stronger than thresh. If you do not specify thresh, or if thresh is empty ([]), edge chooses the value automatically.

B. Prewitt method

BW = edge (I,'prewitt') specifies the Prewitt method.

BW = edge (I,'prewitt',thresh) specifies the sensitivity threshold for the Prewitt method. Edge ignores all edges that are not stronger than thresh. If you do not specify thresh, or if thresh is empty ([]), edge chooses the value automatically.

C. Roberts method

BW = edge (I,'roberts') specifies the Roberts method.

BW = edge (I,'roberts',thresh) specifies the sensitivity threshold for the Roberts method. Edge ignores all edges that are not stronger than thresh. If you do not specify thresh, or if thresh is empty ([]), edge chooses the value automatically.

D. Laplacian of Gaussian method

BW = edge (I,'log') specifies the Laplacian of Gaussian method.

BW = edge (I,'log',thresh) specifies the sensitivity threshold for the Laplacian of Gaussian method. Edge ignores all edges that are not stronger than thresh.

E. Canny Method

BW = edge (I,'canny') specifies the Canny method.

BW = edge (I,'canny',thresh) specifies sensitivity thresholds for the Canny method [2]. Here thresh is a two-element vector in which the first element is the low threshold, and the second element is the high threshold.

F. Expectation-Maximization (Em) Algorithm

The EM algorithm is an efficient iterative procedure to compute the Maximum Likelihood Estimate (MLE) in the presence of missing or hidden data. Each iteration of the EM algorithm consists of two processes: The E-step, and the M-step. In the expectation, or E-step, the missing data are estimated given the observed data and current estimate of the model parameters. In the M-step, the likelihood function is maximized under the assumption that the missing data are known. The estimates of the missing data from the E-step are used in lieu of the actual missing data.

G. OTSU algorithm

Threshold selection is used in OTSU algorithm. The OTSU method is one of the applied methods of image segmentation in selecting threshold automatically for its simple calculation and good adaptation.

The major problem with thresholding is that we consider only the intensity, not any relationships between the pixels. There is no guarantee that the pixels identified by the thresholding process are contiguous.

The steps of the OTSU algorithm: For each potential threshold **T**,

1. Separate the pixels into two clusters according to the threshold.
2. Find the mean of each cluster.
3. Square the difference between the means.
4. Multiply by the number of pixels in one cluster times the number in the other.

H. Genetic Algorithm

Genetic Algorithms (GAs) can be seen as a software tool that tries to find structure in data that might seem random, or to make a seemingly unsolvable problem more or less 'solvable'. Basically, a genetic algorithm consists of three major operations: selection, crossover, and mutation. The selection evaluates each individual and keeps only the fittest ones in the population. In addition to those fittest individuals, some less fit ones could be selected according to a small probability. The others are removed from the current population. The crossover recombines two individuals to have new ones which might be better. The mutation operator induces changes in a small number of chromosomes units. Its purpose is to maintain the population diversified enough during the optimization process.

III. Implementation and Results

Implementation of the techniques was done on different images. Colored images were converted into gray scale image and then harmonic filter was used to remove noise. On the resultant image different edge detection techniques were applied. A sample color image (figure 1) is considered and the resultant gray scale image is shown in figure 2. Figure 2 was experimented with various filters and edge detection techniques like Sobel, Prewitt, Robert, Canny, LOG, EM algorithm, OSTU and Genetic Algorithm and compared with the edges detected by the proposed method [4]. The various filters output is shown in Table 1. The segmented image using different edge detection techniques are shown in Table 2.

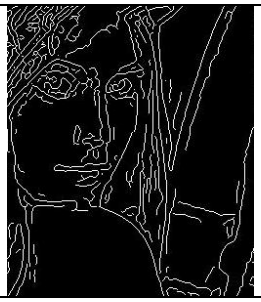
Figure 1. Original image

Figure 2. Gray scale image

TABLE 1: IMAGES USING DIFFERENT FILTERS

			
Hormonic Filter Output	Wiener Filter Output	STD Filter Output	Correlation Filter Output

TABLE 2: SEGMENTED IMAGES USING DIFFERENT EDGE DETECTION TECHNIQUES

SOBEL	PREWITT	LOG	ROBERTS
			
CANNY	**EM**	**OSTU**	**GENETIC**
			

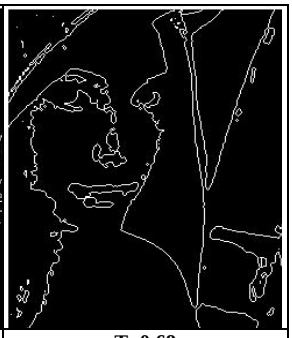
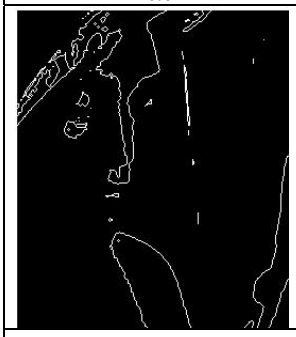
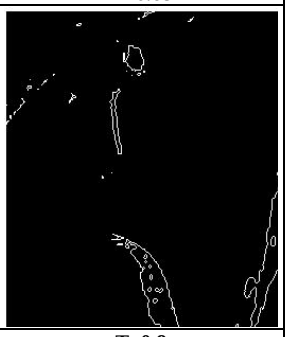
IV. PROPOSED METHOD

The proposed method makes use of the following function to detect the edge and a filter to remove the noise[6] and the resultant image for various threshold values are shown in table 3.

function h=proposededge(im,thr,T)

Where im is an input image, thr is a threshold between 0-1, T is the thickness of the line to indicate the edge and h is a uint8 black and white image with values of 0 and 255[5].

TABLE 3: SEGMENTED IMAGES USING VARIOUS THRESHOLD VALUES FOR THE PROPOSED METHOD

		
T=0.62	**T=0.65**	**T=0.68**
		
T=0.7	**T=0.75**	**T=0.8**

V. OBSERVATIONS

It is observed from table 2 harmonic filter gave better output than other filters, and from table 3 it is observed that when the threshold value T is less than 0.65 or greater than 0.70 then the edges are not detected properly. When the threshold value is in between 0.**65<=T<=0.70** then the edges are determined properly and we found that at T=0.68 sharp and accurate edges are determined.

VI. CONCLUSIONS

This paper focuses mainly on the noise elimination and image segmentation using edge detection operators. The edge detection with the Sobel, Prewitt, Robert, Canny, LoG, Expectation-Maximization (EM) algorithm, OSTU and Genetic Algorithm are studied. A new edge detection technique is proposed which detects the sharp and accurate edges that are not possible with the existing techniques. The proposed method with different Threshold values for given input image is shown that ranges between 0 and 1 and it is observed that when the threshold value is 0.68 the sharp edges are recognised properly.

VII. REFERENCES

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