Algorithm of Segmentation on an Image and Analysis of Energy and Entropy Values by Applying Different Class of Filter

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Abstract – Digital images occur very frequently in the world today. All images on the Internet are in digital form; most images seen in magazines and newspapers have been in digital form at some point before publication; and many films have been converted to a digital format for premastering. Digital Images are processed simply to improve the quality of the image, or they may be processed to extract useful information, such as the position, size or orientation of an object. Image segmentation falls into the low level category and is usually the first task of any image analysis process. All subsequent tasks such as feature extraction and object recognition rely heavily on the quality of the segmentation. For example, if the segmentation algorithm did not partition the image correctly the recognition and interpretation algorithm would not recognize the object correctly [1]. Segmentation algorithms generally are based on one of 2 basis properties of intensity values. Discontinuity: to partition an image based on abrupt change in intensity (such as edges).Similarity: to partition an image into region that is similar according to a set of predefined criteria [2]. Several general purpose algorithms and techniques have been developed for image segmentation. Since there is no general solution to the image segmentation problem, these techniques often have to be combined with domain knowledge in order to effectively solve an image problem for a problem domain. Using the otsu method, the problem of its sensitivity to the object size can be overcome. It is very helpful for the subsequent processing and improves the success ratio of image segmentation. As the size of widow decreasing energy of the image increasingly linearly and on other hand entropy of image decreasing so from this we conclude that window size of image directly proportional to entropy of the image and inversely proportional to energy of the image.

Keywords – Image segmentation, Edge detection, Gaussian filter, recognition, signal-to-noise ratio, Discontinuity

I. INTRODUCTION

Image segmentation refers to partition an image into different regions that are homogenous with respect to one or several image features. The process of segmenting an image is easy to define but difficult to develop. Digital images occur very frequently in the world today. All images on the Internet are in digital form; most images seen in magazines and newspapers have been in digital form at some point before publication; and many films have been converted to a digital format for premastering. Digital Images are processed simply to improve the quality of the image, or they may be processed to extract useful information, such as the position, size or orientation of an object.
Image analysis is an area of image processing that deals with techniques for extracting information from an image. In the simplest form, this task could be reading an address on a letter or finding defective parts on an assembly line. More complex image analysis systems measure quantitative information and use it to make a sophisticated decision such as trying to find images with a specified object in an image database. The various tasks involved in image analysis can be broken down into conventional (low level) techniques and knowledge-based (high level) techniques.

Over-segmenting an image will divide an object into different regions. Under segmenting the image will group various objects into one region. The segmentation step determines the eventual success or failure of the image analysis process. For this reason, considerable care is taken to improve the probability of a successful segmentation Image segmentation is an important accepts of the human visual perception. Segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). Human use their visual scene to effortlessly partition their surrounding environment into different object to help recognize their objects, guide their movements, and for almost every other task in their lives. It is a complex process that includes many interacting components that are involved with the analysis of color, shape, motion and texture of objects. The result of image segmentation is a set of regions that collectively covers the entire image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristics or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to certain characteristics.

II. BACKGROUND HISTORY

The main aim of the proposed hybrid segmentation method is to segment the foreground object in the given image and mark the segmented region with precision. The purpose of developing this method is to identify a prominent single object based photographs, automatically in real time. Also the algorithm must work for worst cases (fog, mist, blur, noise etc).This requirement needs a precise segmentation approach which must be computationally less costly and easy to implement with better quality of segmenting the objects as Region of interest. Image segmentation plays an important role in image analysis and computer vision system. Among all segmentation techniques, the automatic thresholding methods are widely used because of their advantages of simple implement and time saving. Otsu method is one of the thresholding methods and frequently used in various fields. Two dimensional (2D) Otsu method behaves well in segmenting images of low signal-to-noise ratio than one-dimensional (1D).But it gives satisfactory results only when the number of pixels in each class is close to each other. Otherwise, it give the improper results.2D histogram projection is used to correct the Otsu threshold. Edge detection are very important in the digital world to find the information about an object like range, boundaries, level, hidden and missing fields or edges etc. There are very few approaches and algorithms to show the finer details of an object.

III. METHODOLOGY AND PLANNING OF WORK

The objective is to do the comparison of various edge detection techniques and analyze the performance of the various techniques in different conditions. There are many ways to perform edge detection.

A. Laplacian of Gaussian Techniques: The Laplacian is a 2-D isotropic measure of the 2nd spatial derivative of an image. The Laplacian of an image highlights regions of rapid intensity change and is therefore often used for edge detection.

0	−1	0
−1	4	−1
0	−1	0

−1	−1	−1
−1	8	−1
−1	−1	−1

0	0	−1	0	0
0	−1	−2	−1	0
−1	−2	16	−2	−1
0	−1	−2	−1	0
0	0	−1	0	0

Fig.1 Laplacian mask used for detecting edges

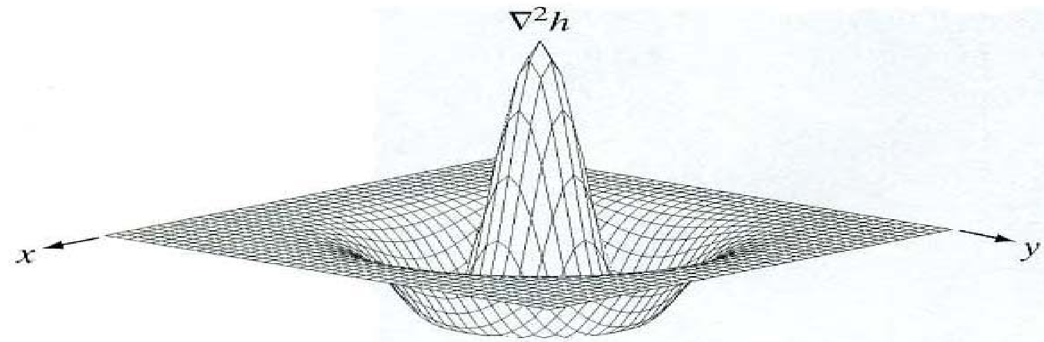

Fig.2 Laplacian of Gaussian

B. Prewitt operator Techniques

Prewitt operator is similar to the Sobel operator and is used for detecting vertical and horizontal edges in images.

−1	−1	−1		−1	0	1
0	0	0		−1	0	1
1	1	1		−1	0	1

Fig. 3 Prewitt mask used for detecting edge

C. The Canny Edge Detection Algorithm :The algorithm runs in 5 separate steps:

1. Smoothing: It is inevitable that all images taken from a camera will contain some amount of noise. To prevent that noise is mistaken for edges, noise must be reduced. Therefore the image is first smoothed by applying a Gaussian filter.

$$G_{\sigma_1}(x,y) = \frac{1}{\sqrt{2\pi\sigma_1^2}} e^{\left[-\frac{x^2+y^2}{2\sigma^2}\right]}$$

Computing the gradient of the result, then using the gradient magnitude and direction to estimate edge strength and direction at every point.

2. Finding gradients: The Canny algorithm basically finds edges where the grayscale intensity of the image changes the most. These areas are found by determining gradients of the image. Gradients at each pixel in the smoothed image are determined by applying what is known as the Sobel-operator. First step is to approximate the gradient in the x- and y-direction respectively by applying the kernels

$$g_1(x,y) = G_{\sigma_1}(x,y) * f(x,y)$$

With a different width, a second smoothed image can be obtained

$$g_2(x,y) = G_{\sigma_2}(x,y) * f(x,y)$$

It shows the difference of these two Gaussian smoothed images, called *difference of Gaussian (DoG)*, can be used to detect edges in the image

$$g_1(x,y) - g_2(x,y) = G_{\sigma_1} * f(x,y) - G_{\sigma_2} * f(x,y) = \left(G_{\sigma_1} - G_{\sigma_2}\right) * f(x,y) = DOG * f(x,y)$$

The DoG as an operator or convolution kernel is defined as :-

$$DoG \triangleq G_{\sigma_1} - G_{\sigma_2} = \frac{1}{\sqrt{2\pi}}\left[\frac{1}{\sigma_1} e^{-(x^2+y^2)/2\sigma_1^2} - \frac{1}{\sigma_2} e^{-(x^2+y^2)/2\sigma_2^2}\right]$$

3. Non-maximum suppression: This is used to thin those ridges, The purpose of this step is to convert the “blurred” edges in the image of the gradient magnitudes to “sharp” edges. Basically this is done by preserving all local maxima in the gradient image, and deleting everything else. The algorithm is for each pixel in the gradient image

A) Round the gradient direction to nearest 45, corresponding to the use of an 8-connected neighborhood.

B) Compare the edge strength of the current pixel with the edge strength of the pixel in the positive and negative gradient direction. I.e. if the gradient direction is north (theta =90),compare with the pixels to the north and south. If the edge strength of the current pixel is largest; preserve the value of the edge strength. If not, suppress (i.e. remove) the value.

4. Double thresholding: Use double thresholding and connectivity analysis to detect and link edges. The final operation is to threshold $g_N(x,y)$ is to reduce false edge points. If we set the threshold too low, there will still be some false edges(called faste positives).If the threshold is set too high, then actual valid edge points will be eliminated(false negatives.)

5. Edge tracking by hysteresis: Canny's algorithm improves by using hysteresis thresholding. Canny suggested that the ratio of the high to low threshold should be two or three to one [8].

Thresholding operation

$$g_{NH}(x,y) = g_N(x,y) \geq T_H \quad \text{and} \quad g_{NL}(x,y) = g_N(x,y) \geq T_L$$

Initially, both $g_{NL}(x,y)$ and $g_{NH}(x,y)$ are set to 0.After thresholding, $g_{NH}(x,y)$ will have fewer nonzero pixels than $g_{NL}(x,y)$.We eliminate from $g_{NL}(x,y)$ all the non zero pixels from $g_{NH}(x,y)$ by

$$g_{NL}(x,y) = g_{NL}(x,y) - g_{NH}(x,y)$$

The non zero pixels in $g_{NH}(x,y)$ and $g_{NL}(x,y)$ may be viewed as "strong" and "weak" edge pixels.

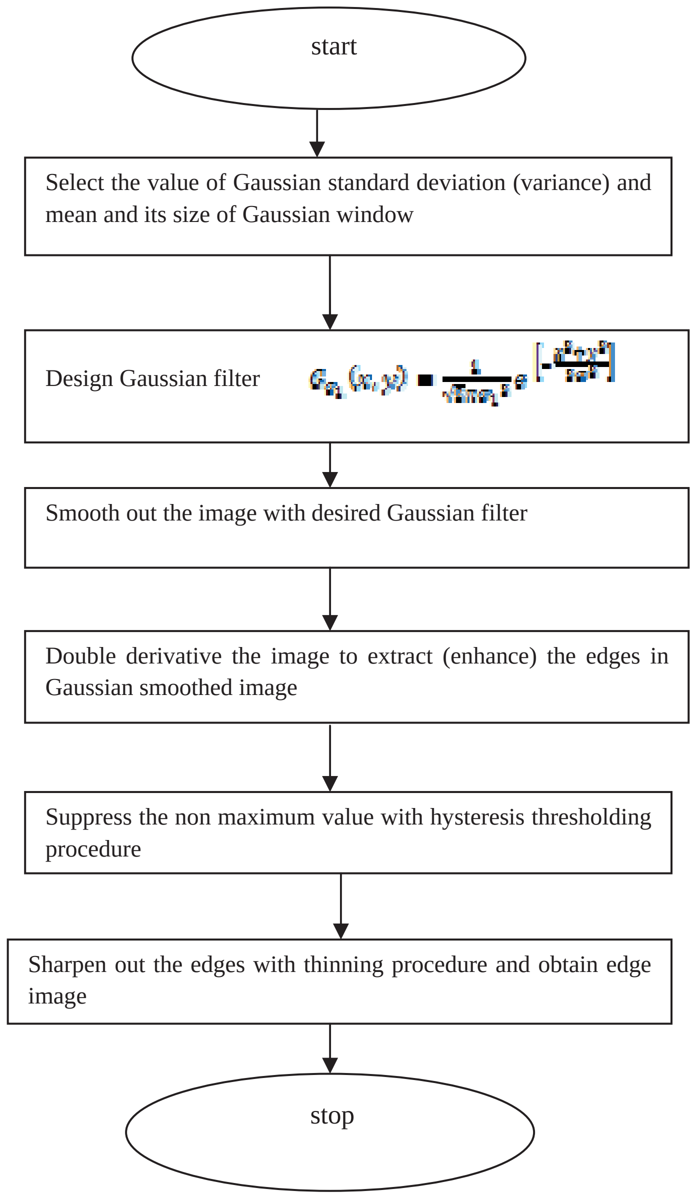

Table I- Comparison of global, adaptive and segmented image with different Window size

SR. NO.	WINDOW SIZE	ENERGY	ENTROPY
1	25	0.8684	0.3690
2	20	0.8871	0.3278
3	15	0.9053	0.2857
4	10	0.9229	0.2430
5	5	0.9533	0.1630

From table I it is clear that as the size of widow decreasing energy of the image increasingly linearly and on other hand entropy of image decreasing so from this we conclude that window size of image directly proportional to entropy of the image and inversely proportional to energy of the image.

Table II- Comparison of Edge detection Technique

EDGE DETECTION	ENERGY	ENTROPY
LOG	0.9503	0.1712
Robert	0.9588	0.1472
Canny edge detector	0.9271	0.2326
Prewitt	0.9638	0.1325
Sobel	0.9636	0.1333

The result shows different segmentation techniques are used to smooth an image taking segments of an image. Otsu method is used to segment an image. Median has lower energy and therefore is used to smooth the blurred image. Median filter replaces the value of a pixel by the median of the intensity levels in the neighborhood of that pixel. The result also shows canny edge detector is better. Its detect edge in all the direction. Lower the energy better is the edge detection technique. More is the entropy better is the edge detection technique.

V. CONCLUSION

The objective is to do the comparison of various edge detection techniques and analyze the performance of the various techniques in different conditions. There are many ways to perform edge detection. The objective function was designed to achieve the following optimization constraints maximize the signal to noise ratio to give good detection. This favors the marking of true positives. Achieve good localization to accurately mark edges. Minimize the number of responses to a single edge. This favors' the identification of true negatives, that is, non-edges are not marked

The image segmentation allow the user to divides an image into parts that have strong correlations with objects to reflect the actual information collected from the real world. Image segmentation are most practical approaches among virtually all automated image recognition systems. Using the otsu method, the problem of its sensitivity to the object size can be overcome. It is very helpful for the subsequent processing and improves the success ratio of image segmentation.

REFERENCES

[1] Zhengmao ye, "objective assessment of Nonlinear Segmentation Approaches to Gray Level Underwater Images", ICGST-GVIP Journal, pp.39-46, No.2, Vol. 9, April 2009

[2] Rafael C.Gonzalez and Richard E.Woods,"Digital Image Processing",Third Edition,Pearson Education.

[3] Wen-Xiong Kang, Qing-Qiang Yang, Run-Peng Liang, "The Comparative Research on Image Segmentation Algorithms," First International Workshop on Education Technology and Computer Science, pp.703-707, , vol. 2, 2009

[4] Jun Zhang and Jinglu Hu, "Image Segmentation Based on 2D Otsu Method with Histogram Analysis", proceedings of International Conference on Computer Science and Software Engineering , IEEE pp. 105-108, 2008.

[5] Ali Mohammad-Djafari, "A Matlab Program to Calculate the Maximum Entropy Distributions," [Physics-Data-an], Nov. 2001

[6] Qingming haung, wen gao, wenjian cai, ―Thresholding technique with adaptive window selection for uneven lighting image‖, Elsevier, Pattern recognition letters, vol 26, page no 801-808, 2005

[7] M. Sezgin and B. Sankur, "Survey over Image Thresholding Techniques and Quantitative Performance Evaluation", Journal of Electronic Imaging, Vol. 13, pp. 146-165 , 2004.

[8] N. Otsu, "A Threshold Selection Method from Gray-Level Histogram",IEEE Trans. Systems Man, and Cybernetics, Vol. 9, pp. 62-66, 1979.