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A survey of the algorithms for image noise removal and edge detection

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***Abstract*— Image processing techniques has common problems that have had many researchers spending time and money addressing them and trying to find solutions. These problems include poor edge detection in low contrast images, presence of noise in images which hinders the process of edge detection. Traditional methods produce edges which are not linked and noise present in the image poses hindrance to accurate edge detection. The goal of this paper is to study the various algorithms for the removal of the noise from the images and detection of edges from images.**

Keywords : Edge detection, Noise, Genetic algorithm .

I. Introduction

Edge detection is the process of localizing pixel intensity transitions. The success of edge detection provides a good basis for the performance of higher level image processing tasks such as object recognition, target tracking and segmentation, since it reduces the amount of information to be processed over the years. Many methods have been proposed for edge detection.

Typically, edge detection is performed by computing an edge image by a linear filter that is an approximation of a first or a second order derivative. Then a decision stage, which requires an application of a threshold, takes place. Due to sensitivity of derivative operators to noise, a smoothing step may also be required prior to derivative calculation. While the smoothing operation suppress noise and removes small details, it may cause localization errors.

The most important part for image processing is to calculate the Region of interest from an image and Edge detection plays an important part in it. A Region of interest is the part of the image which we want to filter or apply operation on it. A Region of interest is defined by creating a binary mask, which is a binary image that is the same size as the image we want to process with pixels that define the ROI set to 1 and all other pixels set to 0. The Edge detection can be used to find the ROI in mammograms which means finding the area with varying intensity and ignoring the area with constant intensity

In[1] the total grey level value of an image at any spatial coordinates is dependent on the amount of noise present at that coordinate. By convolving the image with LoG operator, smoothening will take place before edges are located.The larger the value of standard deviation (σ) of the Gaussian function, the heavier the smoothening and larger the reduction of edges due to noise N. This can be expressed as:

$$\sigma = 1/N$$

A compromise has to be made in order to eliminate the noise present within the image and, at the same time, preserve all the edges of the objects within the image. The determination of such a scale i.e. ideal sigma depends on the choice of the result of convolution between image and LoG function. The relationship between the Ideal Sigma and the amount of noise present within an image prior to convolution can be expressed as:

$$\sigma_{\text{ideal}} = F(N)$$

Since the mapping of the input (i.e. the image) and the output (i.e. the scale) represents a nonlinear function, then going from one scale to another at the output is also nonlinear. Alteration in amount of noise present within an image causes a change in the choice of the ideal scale σ_{ideal} and thus the ideal edged detection of the image.

In [2], an algorithm is described for the design of the efficient edge detection operator. In this hierarchical edge detection proceeds as a twostep process, consisting of a coarse oriented gradient measurement, followed by the application of a particular orientation of one of the efficient one dimensional edge detectors.

In [3] the performance of edge detection can be improved by conducting the operation in closed loop system. Certain main characteristic of edge pixels can be described in patterns formed by pixels in a d x d (d>=3) region of its neighbourhood. In this total strength of a pattern group is calculated based on the strength measures of the edge pattern groups and the number of edges in each of the edge pattern groups. The strength to each pattern group is given by the function s(pd(n)) and is in the range of 0 to 1.The total strength of a pattern group pd(n) is given by:

$$s\left(p_d(n)\right) = \frac{\sum_i s\left(p_d{}^i(n)\right)}{\sum_i \left(p_d{}^i(n)\right)}$$

Where s (pd i(n)) stands for the strength value of its ith pattern in the pd (n) group.

In[4] a functional from consisting of the linear combinations of the tensor products of discrete directional derivatives are easily computed from this kind of functions. One function of data pre-processing is to convert a visual pattern into an electrical pattern or to convert a set of discrete data into a mathematical pattern so that those data are more suitable for computer analysis. Various results of computer analysis by using different window size and intensity function were discussed and the best combination of the parameters for the second order derivatives in edge finding were evaluated.

In [5] a method for automated determination of parenchymal patterns in mammograms that is insensitive to changes in mammogram imaging technique. The method was designed to study the relation between breast cancer risk and changes of mammographic density. It includes a new method for automatic segmentation of the pectoral muscle in oblique mammograms, based on application of the Hough transform. The technique developed for the classification of parenchymal patterns is based on a distance transform that subdivides the breast tissue area into regions in which distance to the skin line is approximately equal. Features are calculated from grey level histograms computed in these regions.

Due to presence of noise and quantization of the original image, during edge detection it is possible to locate intensity changes when edges do not exist. Due to noise and quantization, it is possible to locate intensity change when they do not exist. Addition of noise may cause the position of the edge to be shifted. Some form of smoothening is necessary since edge depends on differentiating the image function and this amplifies the high frequency components of the signal, including those of noise. The amount of smoothening applied depends on the size or scale of the smoothening operator. Selecting a single scale of smoothening which is optimal for all edges in an image is difficult.[6]

In [7] , algorithms using 3 x 3 window for the convolution where each of the pixel is either +1 , -1or 0 were described. For smoothening using mean filter and detection of line, point and gradient, each of the nine positions is weighed and projection of candidate pixels and its neighbours are calculated. As the weights are 0 or 1, the addition is the main concern in the calculation. Since the addition requires very little time in computer or processor and the computer time complexity is of the linear order O (n), but when performed over the whole image the processing time becomes reasonable. In this the algorithm was designed which reduced the number of operations required for implementing the convolution by looking for redundancy. For median filtering the determination of median of eight neighbours by straightforward method requires 28 comparison. This can be reduced by using Merge sort algorithm which partitions the elements successively in power of two and works by revealingly selecting the larger of the largest element when merging two partitions.

In [8], an algorithm was proposed for segmenting and extracting moving object for the video surveillance and video conferencing applications, where still a background frame can be captured beforehand is studied. In this first step is to detect the two kinds of edge points which are detected from frame difference and background subtraction. After removing the edge point that belonged to background frame, the resulting moving edge map is fed into the object extracting step .

In [9],an algorithm was proposed which used a fixed width Gaussian kernel to smooth the mammogram and generated iso intensity contours by thresholding the image at a grey level close to zero. The contour enclosing the largest area was selected as the breast border.The method was tested on many mammogram images and all the borders were described as being "successfully detected"

In [10], a new method for the automated mass detection in digital mammographic images using templates was discovered. In this mass template was used to categorize the ROI as true mass or non-masses based on their morphologies. Each pixel of the region of interest was scanned with a mass template to determine whether there was a shape similar to the mass in the template.

In [11], a system was proposed to detect the malignant masses in mammograms. The behavior of the iris filter was found at different scales. After iris filter was applied the suspicious region were segmented by means of adaptive threshold and the suspected regions were characterized with features based on the iris filter output, grey level features and morphological features extracted from the image .

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In [12], it was found that the Prewitt Edge Detector works well with both Gaussian and Poisson noise corrupted images. However the performance decreases with Salt & Pepper noise as well as Speckle noise corrupted image. Prewitt operator does the averaging of the neighbouring pixels. Since the salt & pepper as well as speckle pixel values tend to be different from the surrounding values, they tend to distort the pixel average calculated by averaging of neighbouring pixels significantly.

In[13], an enhancement algorithm was designed that improves image contrast based on local statistical measures of the mammograms is proposed and after enhancement, regions are segmented via thresholding at multiple levels, and set of features is computed from each of the segmented regions .

In [14], an algorithm was developed the model based framework for the detection of the speculated masses. In this new class of linear filters i.e. speculated lesion filters for the detection of converging lines or speculations. These filters are specific narrowband filters, which are designed to match the expected structure of speculated masses.

In [15] , an algorithm was developed which is an effective improvement over the original Otsu's Thresholding algorithm under low SNR conditions. In this integral image to simplify the redundant calculation for searching optimal threshold was used. Instead of repeating accumulators the sum of rectangles was calculated by using several addition operations.

Kang et al. (2009) [16] enumerated and reviewed main image segmentation algorithms, then presented basic evaluation methods for them and then the prospects of the image segmentation was discussed. In this analytical and experimental techniques are used to evaluate the various segmentation algorithms. The analytical technique evaluates an image segmentation algorithm by analysing the principle of principle of algorithm, its complexity, prior knowledge needed and so forth. The experimental technique which is widely used interprets and compares experimental results of image segmentation algorithm to make an evaluation.

Khellaf et al. (2009) [17] describes a technique for the contrast enhancement of the picture. The algorithm rest on the use of the local contrast to define digital entropy and the contrast was enhanced by transforming global entropy. In this proposed method uses the local contrast to define digital entropy. The basic idea is to transform the global information, the digital entropy, as a function of local quantity, the contrast and this method worked well for finding out contours.

Yoyni et al. (2009) [18] compared the two edge detectors Laplacian of Gaussian and Canny edge detector are compared and results were found. In Laplacian of Gaussian the advantages are that the edge continuity is good and can extract weak contrast boarders. The disadvantages are when the boundary width is smaller than the operator width, then zero cross ramps will have fusion and details will be lost which is less than $2\sqrt{2}\sigma$ border. However when σ increases, the LoG operators edge positioning accuracy also drops.

The latest trend in edge detection techniques is to use soft computing techniques and genetic algorithms. Many of the problems which occur by traditional methods of edge detection can be overcome by designing hybrids of fuzzy logic, neural network and genetic algorithms. Many GA- based segmentation tools of the edge detection like GENIE can also be used.

CONCLUSION

In this paper, the various techniques of detection of edges in the images were discussed. No one specific edge detection technique can work on all the images. One technique showing good results on one set of images might not work properly on the other set of images. The traditional edge detection techniques suffers from some drawbacks which can be overcome by modern techniques of soft computing which includes fuzzy logic, neural network and genetic algorithm. The hybrid combination of these have shown good results and are widely used in the modern techniques for edge detection.

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