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A Comparison of Multiple Filtering Methods for Edge Detection of Breast Cancer Cells

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Abstract

Breast cancer is second most commonly diagnosed cancer worldwide. In order to find the cure, it is necessary to quickly diagnose the disease accurately and treat it based on the kind of symptoms appeared. Breast cancer has several classifications, which may help to determine the best treatment. The most important of these classifications are binary classification, either benign or malignant. If the cancer is in benign stage, less invasive and risk of treatments is used than for malignant stage. The main cause of breast cancer is when a single cell or group of cells escapes from the usual controls, that regulate cellular growth and begins to multiply and spread. This activity may result in a mass, tumor or neoplasm. The present paper implies the edge detection techniques for the cancer cell detection purpose. The present paper deals with observation of breast cancer classification through Image Processing using the various filters which are mainly gradient based Roberts and Sobel. Laplacian based edge detector which is Canny edge detector. The various aspects and the implementation of above mentioned filters has been put across in the present paper. The images and data sample have been taken from the Digital Database for Screening Mammography (DDSM) and American cancer society and an effort has been made for the detection of malignant cells responsible for cancer.

Keywords: Canny, Robert, Sobel

1. Introduction

Recently studies show that one in 10 women will contract breast cancer in their lifetime, and that breast cancer is the leading cause of death of women between the ages of 35 and 54 [1]. Every year 27% of the new cancer cases in women are breast cancers. Although X-ray mammogram detection is best way of screening the breast cancer and ultrasound method is more popular because of its non-invasiveness and low cost. Due to high noise, low contrast radiologists cannot detect and classify the tumor or dense in breast cancer. Image enhancement is a best way for the diagnostic reliability by reducing noise effects in mammogram and filtering is a challenging process in ultrasound image processing since the noise is of unknown source with nonspecific form and trend[2]. Several algorithms have been proposed to enhance the signal-to- noise ratio and to eliminate noise speckles.

Breast cancer takes years to develop. It is commonly classified into four stages according to size of tumors and degree of cancer spread from the breast to other parts of the body. There is one pre-cancerous stage called Ductal Carcinoma In Situ (DCIS) when a pre-cancerous lesion has not developed into a cancer tumor. In the first stage, a 0-2 centimeter tumor forms without spreading outside the breast[3]. If the cancer is detected in this stage the five- year survival rate is 96%. In the second stage, the cancerous cells form new malignant foci in positive lymph nodes or the tumor enlarges to 2-5 centimeter. In this stage, the survival rate drops to 73%. In the third stage, a tumor is larger than 5 centimeters with positive lymph nodes, or a tumor has skin and chest wall involvement. The surgical intervention performed would be quite heavy; it may need partial or total breast removal and lymph nodes dissections. In the fourth stage, obvious metastases to other organs of the body, most often

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the bones, lungs, liver, or brain occur and the five-year survival rate drops to 20%[2].

Although breast cancer can be fatal, people have the highest chance of survival if cancer could be detected at the early stages. Early diagnosis and treatment play critical roles in increasing the chance of survival. This study involves a literature research on diagnostic techniques used for breast cancer and development of a computer-aided diagnosis tool using MATLAB for breast segmentation in mammograms. Image enhancement techniques commonly used are spatial and frequency domain filters; moreover, fractal analysis could serve as a preprocessing stage before segmentation in mammograms[4]. In order to extract boundaries of suspected tumor masses, region growing and morphological edge detection algorithms are implemented. In this research, mammograms from the Digital Database for Screening Mammography (DDSM) are used. This paper is organized into five sections. In section II, enhancement of the image and characteristics of the image is described.

In section III I introduce the methodology that is various kinds of filters are used. In section ☐ describe the comparison of various filtering methods contrast. Parameters are determined using experimental methodology.

2. Image Enhancement

Image enhancement is basically improving the interpretability or perception of information in images for human viewers and providing `better' input for other automated image processing techniques. The principal objective of image enhancement is to modify attributes of an image to make it more suitable for a given task and a specific observer[5]. During this process, one or more attributes of the image are modified. The choice of attributes and the way they are modified are specific to a given task. Moreover, observer-specific factors, such as the human visual system and the observer's experience, will introduce a great deal of subjectivity into the choice of image enhancement methods. There exist many techniques that can enhance a digital image without spoiling it. The enhancement methods can broadly be divided in to the following two categories, Spatial Domain Methods and Frequency Domain Methods, Figure 1 shows the techniques of enhancement of image. In spatial domain techniques[6], we directly deal with the image pixels. The pixel values are manipulated to achieve desired enhancement. In frequency domain

Figure 1. Input image.

methods, the image is first transferred in to frequency domain. It means that, the Fourier Transform of the image is computed first. All the enhancement operations are performed on the Fourier transform of the image and then the Inverse Fourier transform is performed to get the resultant image. These enhancement operations are performed in order to modify the image brightness, contrast or the distribution of the grey levels. As a consequence, the pixel value (intensities) of the output image will be modified according to the transformation function applied on the input values.

In digital image processing some general image intensification method like Robert, Sobel, Canny filter, the low pass filtering, the edge enhancement and so on mainly aim in the image the stochastic noise, but in the fuzzy image's grain line flaw belongs to the constitutive noise, therefore is not ideal to the image's enhancement effect The essential procedure is to the primitive gradation image after the low- pass filtering, the histogram transformation and so on general image intensification method carries on processing, carries on the binaryzation and refinement processing.

3. Methodology

There are many ways to perform the edge detection. However, it may be grouped into two categories, that

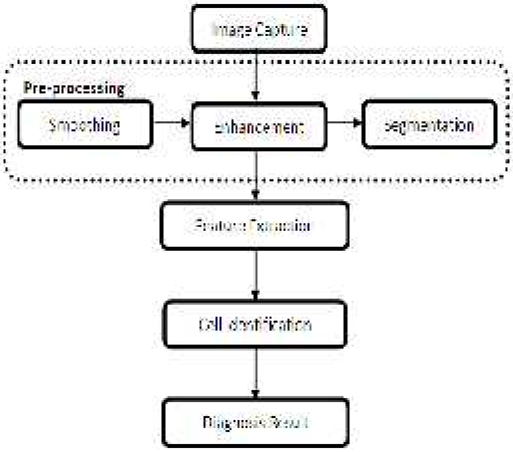

Figure 2. Diagnosis process.

are gradient and Laplacian. The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. The Laplacian method searches for the zero crossings in the second derivative of the image to find edges. The edges of an image detected using the gradient method (Roberts, Sobel) and the Laplacian method (Canny filter). It can compare the feature extraction using the Sobel edge detection with the feature extraction using the Laplacian[7]. It seems that although it is better for some features but it still suffers from misshaping so.

3.1 Robert Filter

The Roberts cross operator is used in image processing and computer vision for edge detection. As a differential operator, the idea behind the Roberts cross operator is to approximate the gradient of an image through discrete differentiation which is achieved by computing the sum of the squares of the differences between diagonally adjacent pixels. The Roberts Cross operator performs a simple, quick to compute, 2-D spatial gradient measurement on an image. Pixel values at each point in the output represent the estimated absolute magnitude of the spatial gradient of the input image at that point. The operator consists of a pair of 2×2 convolution kernels. One kernel is simply the other rotated by 90°[4]. This is very similar to the Sobel operator.

3.2 Sobel Filter

The operator consists of a pair of 3×3 convolution kernels. These kernels are designed to respond maximally to edges running vertically and horizontally relative to the pixel grid, one kernel for each of the two perpendicular orientations. Operators can be optimized to look for horizontal, vertical, or diagonal edges. Edge detection is difficult in noisy images, since both the noise and the edges contain high-frequency content. Attempts to reduce the noise result in blurred and distorted edges. Operators used on noisy images are typically larger in scope, so they can average enough data to discount localized noisy pixels. This results in less accurate localization of the detected edges. Not all edges involve a step change in intensity. Effects such as refraction or poor focus can result in objects with boundaries defined by a gradual change in intensity[1]. The operator needs to be chosen to be responsive to such a gradual change in those cases. So, there are problems of false edge detection, missing true edges, edge localization, high computational time and problems due to noise etc.

3.3 Canny Edge Detection Algorithm

The Canny edge detection algorithm is known to many as the optimal edge detector. Canny's intentions were

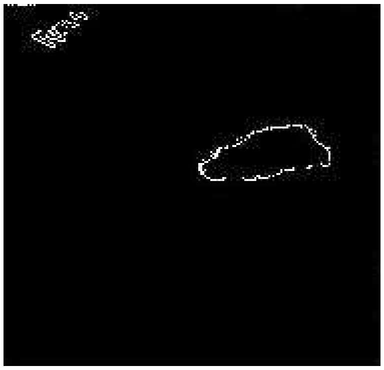

Figure 3. Output of Robert Filter.

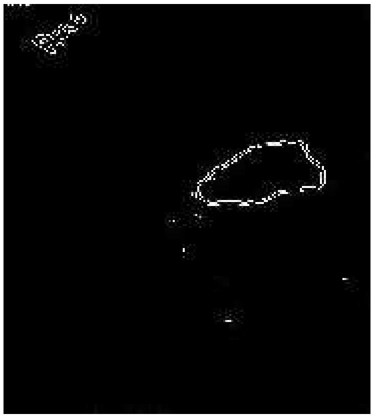

Figure 4. Output of Sobel Filter.

to enhance the many edge detectors. “A Computational Approach to Edge Detection”[11]. In this paper, he followed a list of criteria to improve current methods of edge detection. The first and most obvious is low error rate. It is important that edges occurring in images should not be missed and that there be no responses to non-edges. The second criterion is that the edge points be well localized. In other words, the distance between the edge pixels as found by the detector and the actual edge is to be at a minimum.

A third criterion is to have only one response to a single edge. This was implemented because the first two was not substantial enough to completely eliminate the possibility of multiple responses to an edge. Based on these criteria, the canny edge detector first smoothens the image to eliminate the noise. It then finds the image gradient to highlight regions with high spatial derivatives. The algorithm then tracks along these regions and suppresses any pixel that is not at the maximum (non maximum suppression). The gradient array is now further reduced by hysteresis. Hysteresis is used to track along the remaining pixels that have not been suppressed. Hysteresis uses two thresholds and if the magnitude is below the first threshold, it is set to zero (made a non-edge). If the magnitude is above the high threshold, it is made an edge. And if the magnitude is between the 2 thresholds, then it is set to zero unless there is a path from this pixel to a pixel with a gradient.

4. Comparison of Various Filters

Edge detection of three types of filters was performed on Figure 6. Canny yielded the best results. This was

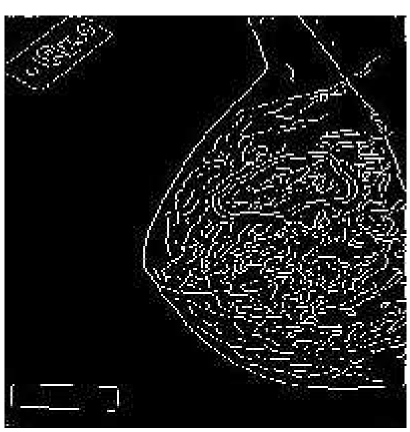

Figure 5. Canny Filter output.

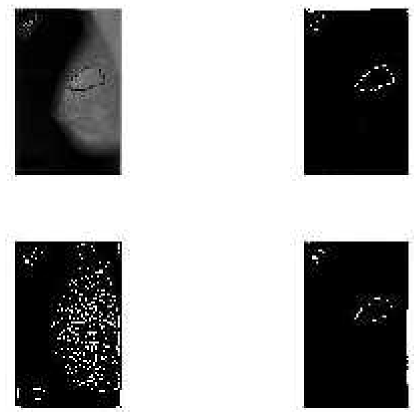

Figure 6. Comparison of all the filtering techniques

expected as canny edge detection accounts for regions in an image. Canny yields thin lines for its edges by using non- maximal suppression. Canny also utilizes hysteresis with thresholding. As edge detection is a fundamental step in computer version. it is necessary to point out the true edges to get the best results from the matching process. That is why it is important to choose edge detectors that fit best to the application.

5. Conclusions

The edge detection is the primary step in identifying an image of an object, so it is essential to know the advantages and disadvantages of each edge detection filters. In the present paper we have adopted edge detection techniques of Gradient-based and Laplacian based. Edge Detection Techniques are compared with case study of identifying the breast cancer cell. It has been observed that the Gradient- based algorithms have major drawbacks in sensitive to noise. The performance of the Canny algorithm relies mainly on the changing parameters. The size of the Gaussian filter is controlled by the greater value and the larger size. The larger size produces more noise, which is necessary for noisy images, as well as detecting larger edges. Canny’s edge detection algorithm is costlier in comparing to Sobel and Robert’s operator. Even though, the Canny’s edge detection algorithm has a better performance instead of all the others filters. Canny filter is responsible for improving signal to noise ratio as well better detection capability. The evaluation of the images showed that under the noisy conditions, Canny, Sobel, Roberts’s are exhibited better performance, respectively. The various methodologies of using edge detection techniques namely the Gradient and Laplacian transformation. It seems that although Laplacian does the better for some features, it still suffers from mismapping some of the lines.

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