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Microscopic Image Processing of Automated Detection for Human Cancer Cell

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Abstract— Automated Detection for Human Cancer Cell is one of the most effective applications of image processing and has obtained great attention in latest years, therefore. In this study, we propose an automated detection system for human cancer cells based on breast cancer cells. This study was conducted on a set of Fine Needle Aspiration (FNA) biopsy microscopic images that have been obtained from the *"Pathology Center - Faculty of Medicine - Mansoura University Hospital - Egypt"* is made up of 72 microscope image samples of benign, 72 microscope image samples of malignant. The aim of this study is to distinguish benign from malignant cells in the breast biopsy. The images are exposed to a series of pre-processing steps, which include resizing image such as 1024*1024, 512*512, enhance images by remove noise through (*Median Filter – Wiener Filter*) and contrast enhancement through (*Unsharp Masking – Adjust Intensity*). This process is evaluated by Peak signal-to-noise ratio (*PSNR*) and Mean Square Error (*MSE*). The system depends on breast cancer cells detection using clustering-based segmentation (*K-means clustering, Fuzzy C-means clustering*) and region-based segmentation (*Watershed*). *Shape, Texture and Color* features are extracted for Detection. The results show high Detection Rate for breast cancer cells images either (*Benign* or *Malignant*).

Keywords — (Digital Image Processing , Breast Cancer Cells, Contrast Enhancement , (MSE) Mean Square Error, Peak signal-to-noise ratio (PSNR), K-Means Clustering, Fuzzy C-Means, Watershed)

I. INTRODUCTION

Cancer starts when cells begin to grow out of control. Abnormal cell growth with the potential to invade or spread to other parts of the body. The tumor is malignant (cancerous) if the cells can grow into (invade) surrounding tissues or spread (metastasize) to distant areas of the body. For Breast cancer which is our concern occurs almost entirely in women, but men can get it, too. Breast cancers can start from different parts of the breast. In breast cancer primary tumor, a desmoplastic reaction usually arises, creating a suitable microenvironment for a cross talk between stromal fibroblasts and malignant cells. A few studies have explored the epithelial–mesenchyme interactions through co-culture systems and their results suggest that fibroblasts originated from normal tissue tend to inhibit, contrary to fibroblasts obtained from tumors, which tend to induce, epithelial cell proliferation. In addition, it seems likely that direct contact between these cell types or soluble factors secreted by them may differentially interfere with epithelial cell proliferation [1-4].

II. DIGITAL IMAGE PROCESSING (METHODS)

The procedure for Breast Cancer Cells (BCCs) detection in microscopic images consists of pre-processing (resize, remove noise and contrast image), segmentation using (k-means clustering, fuzzy c-means and watershed), feature extraction (shape – texture – color), detection will display the infected cells . The proposed system is shown in Fig. 1.

A. ***Pre-processing***

Pre-processing methods can be divided into the three groups according to the goal of the processing:

A.1. ***Image resizing***

Resizing images in database by using several sizes such as 1024 * 1024 and 512 * 512.

A.2. ***Remove Noise***

Digital images are prone to a variety of types of noise. Noise is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of the real scene. There are several ways that noise can be introduced into an image, by using:

A.2.1 Median Filter:

The best-known order-statistics filter is the median filter, which replaces the value of a pixel by the median of the gray levels in the neighborhood of that pixel. The original value of the pixel is included in the computation of the median. Median filters are quite popular because, it preserves edges and for certain types of random noise they provide excellent noise reduction capabilities, with considerably less blurring than linear smoothing filters of similar size [5][6].

A.2.2 Wiener Filter:

That used to filter out the noise from the corrupted signal to provide an estimate of the underlying signal of interest [7].

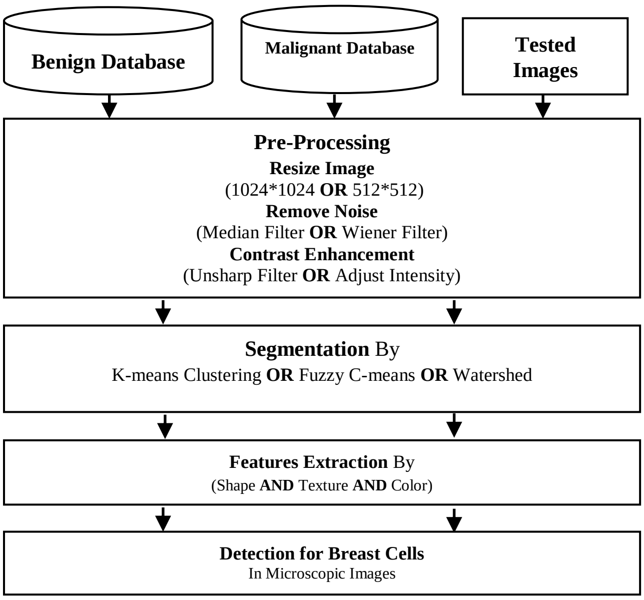


Fig.1. System Overview

A.3. Contrast Enhancement

That is a techniques to improve the quality of a color image by using:

A.3.1. Unsharp Masking:

Unsharp masking enhancement process is one of the most widespread algorithms used for image enhancement [8], unsharp masking is a flexible and powerful way to increase sharpness

A.3.2. Adjust Intensity:

Intensity adjustment is a technique for mapping an image's intensity values to a new range.

B. *Segmentation*

Segmentation is to perform the detection of Breast Cancer Cells (BCCs) from the microscopic images using color based clustering. Initial segmentation can achieve by K-means clustering, Fuzzy C-means and Watershed.

B.1. K-means clustering

K-means clustering followed by nearest neighbor classification in L*a*b* space. K-means is a semi supervised clustering technique, which is a use to create K clusters from n observations. It attempts to achieve partition such that objects within each cluster are as close to each other as possible, and as far from objects in other clusters as possible [10]. Each pixel of an object is classified into four clusters based on corresponding a* and b* values in L*a*b* color space. In order to overcome the undesirable overlapping of regions, a second stage segmentation is performed using nearest neighbor classification. In the second stage we select a sample region randomly from each of the four clusters obtained using K–means. The mean color of each sample regions are calculated in a*b* space and those values act as color indicators. Now each pixel in the L*a*b* space is classified into any of the four classes by calculating the Euclidean distance between that pixel and each color indicator. Each pixel of the entire image will be labeled to a particular color depending on the minimum distance from each indicator [11].

B.2. Fuzzy C-means clustering

Fuzzy c-means (FCM) is a data clustering technique in which a dataset is grouped into n clusters with every data point in the dataset belonging to every cluster to a certain degree. For example, a certain data point that lies close to the center of a cluster will have a high degree of belonging or membership to that cluster and another data point that lies far away from the center of a cluster will have a low degree of belonging or membership to that cluster.

B.3. Watershed

The main goal of watershed segmentation algorithm is to find the “watershed lines” in an image in order to separate the distinct regions.

A watershed definition for the continuous case can be based on distance functions. Depending on the distance function used, one may arrive at different definitions. but other choices have been proposed as well [12]. Segmentation using the watershed transforms works well if you can identify, or "mark," foreground objects and background locations.

C. *Morphological Filter*

Morphological Filtering: An image is partitioned into several regions depending on the features to be extracted. Image enhancement ensures that perceptibility and visibility of these regions gets improved [13]

Many of the above enhancing techniques were employed on the breast tissue specimen that is obtained from biopsy. Some of the methods were[16]:

Sobel: it is a discrete differentiation operator, computing an approximation of the gradient of the image intensity function. At each point in the image, the result of the Sobel operator is either the corresponding gradient vector or the norm of this vector. The Sobel operator is based on convolving the image with a small, separable, and integer valued filter in horizontal and vertical direction and is therefore relatively inexpensive in terms of computations.

Dilation: Dilation is the process of adding pixels to the boundaries of objects in an image, while erosion is the process of removing pixels on object boundaries. The parameter called structuring element decides the number of pixels to be added or removed from the objects. In the morphological dilation operation, the state of any given pixel in the output image is determined by applying a rule to the corresponding pixel and its neighbors in the input image. The rule used to process the pixels defines the operation as dilation [14].

D. *Feature Extraction***:**

Feature extraction in image processing involves reducing the amount of resources required to describe a large set of data. In the present paper, broadly three types of features are extracted (Shape, Texture and Color Features)

1) Shape Feature: According to pathologist which describes how the specimen looks, including the shape, color, size, and other features. Region and boundary based shape features are extracted for shape analysis of the cancer cells. All the features are extracted from the binary equivalent image of the cancer cells with nonzero pixels representing the cancer cells region. The quantitative evaluation of each breast cancer cells images are do using the extracted features under two classes i.e. region based and boundary based. The features are as follows:

- *Area:* The area was determined by counting the total number of none zero pixels within the image region.
- *Perimeter:* It was measured by calculating distance between successive boundary pixels.
- *Compactness:* Compactness or roundedness is the measure of a cells as defined in (1).

$$Compactness = \frac{Perimeter^2}{Area} \qquad (1)$$

- *Solidity:* The ratio of actual area and convex hull area is known as solidity and is also an essential feature for blast cell classification. This measure is defined in (2).

$$Solidity = \frac{Area}{ConvexArea} \qquad (2)$$

- *Eccentricity:* This parameter is used to measure how much a shape of an uncontrolled growing cells inside boundary deviates from being normal. It's an important feature since normal cells are in a uniform way than that in cancer cells. To measure this a relation is defined in (3).

$$Eccentricity = \frac{\sqrt{a^2 - b^2}}{a} \qquad (3)$$

where "a" is the major axis and "b" is the minor axis of the equivalent ellipse representing the cells region.

- *Elongation:* is measured in terms of a ratio called elongation. This is defined as the ratio between maximum distance (R_{max}) and minimum distance (R_{min}) from the center of gravity to the cancer cells and is given by (4).

$$Elongation = \frac{R_{max}}{R_{min}} \qquad (4)$$

where R_{max} and R_{min} are maximum and minimum radii respectively.

- *Formfactor:* This is a dimensionless parameter which changes with surface irregularities and is defined as (5).

$$Formfactor = \frac{4 * pi * Area}{Perimeter^2} \qquad (5)$$

2) Texture Feature: Cell texture measurements were performed on gray scale version of the breast cancer images. These features were computed from the co-occurence matrices for each breast cancer image. This includes:

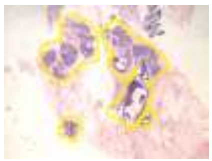
- *Homogeneity*: It is a measure of degree of variation.
- *Energy*: Is used to measure uniformity.
- *Correlation*: This represents correlation between pixel values and its neighborhood.
- *Entropy*: Usually used to measure the randomness.
- *Contrast:* It is a measure of the intensity contrast between a pixel and its neighbor over the whole image.

3) Color Feature: Since color is an important feature that human perceive while visualizing it is considered for extraction from cancer cell regions. Hence, for each breast cancer cells image the mean color values in RGB is found suitable for feature extraction [15].

E. ***Detection****:*

The purpose for detection the stage, that comparing the results of the segmentation process resulting from the three algorithms images of our existing work that has been segmented by an expert and to detect the affected areas and non-infected areas.

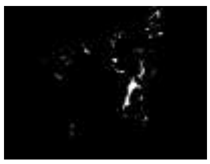
The following figure 2 shows the result of the segmentation process and detection of the breast cancer cells with size 1024*1024 and median with unsharp masking



Detection by Expert

Detection by K-Means

Detection by C-Means



Detection by Watershed

Fig.2 Shows result for detection by using K-Means, C-Means and Watershed

III. EXPERIMENTAL RESULT

The proposed technique has been applied on 142 Breast Cancer Cells images obtained from “*Pathology Center - Faculty of Medicine - Mansoura University Hospital - Egypt*” is made up of 72 microscope image samples of Benign , 72 microscope image of Malignant.

A. Experiment

The experiment work of proposed system consist several steps, all image are preprocessed by MATLAB 2014 platform to resize and remove noise and then contrast enhancement. Then the computer aided detection system segments all dataset breast cancer cells images (benign and malignant) using clustering-based segmentation by (K-means Clustering, C-means Clustering) and region-based segmentation by (Watershed) , and we extract all features (Shape – Texture – Color).

B. Result Analysis

The experimental result has been developed by taking the entire dataset breast cancer cells image. The entire dataset images are gone through the Preprocessing – Segmentation – Features Extraction for detection the breast cancer cells. Now we will review the results to detect the microscopic images of the breast cancer cells through three algorithms (K-Means, C-Means, and Watershed) used to gain access to the best result in the Aided –Computer Detection, as in the following tables

Now we will review the results to detect the microscopic images of the breast cancer cells through three algorithms (K-Means, C-Means, and Watershed) used to gain access to the best result in the Aided –Computer Detection, as in the following Figure [3].

Figure 3 Shows Detection Rate by using segmentation algorithms (K-Means, C-Means and Watershed) for dataset Benign and Malignant image that (72 images for every one) with the size 512*512 and the applied the remove noise filter and contrast enhancement techniques.

Segmentation Algorithms	K-means				C-Means				Watershed			
Size Images	512*512				512*512				512*512			
Remove Noise & Contrast Enhancement	Median & Unsharp	Median & Intensity	Wiener & Unsharp	Wiener & Intensity	Median & Unsharp	Median & Intensity	Wiener & Unsharp	Wiener & Intensity	Median & Unsharp	Median & Intensity	Wiener & Unsharp	Wiener & Intensity
Detection Rate for Benign (72 images)	90.2%	87.3%	0	0	87.5%	77.7%	0	0	83.3%	76.8%	0	0
Detection Rate for Malignant (72 images)	88.8%	87.5%	0	0	86.1%	76.8%	0	0	81.9%	77.7%	0	0

Fig .3 Shows Detection Rate for Benign and Malignant images with size is 512*512

Figure 4 Shows Detection Rate by using segmentation algorithms (K-Means, C-Means and Watershed) for dataset Benign and Malignant image that (72 images for every one) with the size 1024*1024 and the applied the remove noise filter and contrast enhancement techniques.

Segmentation Algorithms	K-means				C-Means				Watershed			
Size Images	1024*1024				1024*1024				1024*1024			
Remove Noise & Contrast Enhancement	Median & Unsharp	Median & Intensity	Wiener & Unsharp	Wiener & Intensity	Median & Unsharp	Median & Intensity	Wiener & Unsharp	Wiener & Intensity	Median & Unsharp	Median & Intensity	Wiener & Unsharp	Wiener & Intensity
Detection Rate for Benign (72 images)	98.6%	93.8%	0	0	97.2%	97.2%	0	0	97.2%	93.0%	0	0
Detection Rate for Malignant (72 images)	97.2%	95.8%	0	0	97.2%	95.8%	0	0	97.2%	91.6%	0	0

Fig .4 Shows Detection Rate for Benign and Malignant images with size is 1024*1024

Through **figure 3** and **4**, we find that: First, was the best detection of the images segmented process, that the results of a 1024 * 1024 sizes better than the image size 512 * 512 as shown previous tables where the ratio was better detection the filter *Median* in the noise removal with a filter (*Unsharp* and *Intensity*) to contrast enhancement. In addition to, we get high detection as shown in figure (4). Second, the consequences: Notice through the practical application of the negative impact of the use of the filter *Wiener* in noise removal with two filters in contrast enhancement during the segmentation with detection process and the results were (zero%). Thus, it will be ignored in the stage classification. Moreover, this will be among the proposals for future work.

IV. CONCLUSION

This paper has present Computer Aided Detection system to detect breast cancer cells in microscopic images either (Benign – Malignant) using database 72 Benign images and 72 Malignant images.. The experiments has been performing in computer type Dell, Processor Intel(R) core (TM) i5-4200 CPU @ 1.60GHz, Memory (RAM) 6.00 GB, System type 64-bit Operating System. The system is less computational requirement this make system well suited for low cost hardware implementation, the system achieved better Detection Rate.

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