International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 9, September - 2013

Automatic Blood Cell Analysis By Using Digital Image Processing: A Preliminary Study

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Abstract

In medical diagnosis blood cell count plays very important role. Increment or decrement in the count of blood cell causes many diseases to occur in the human body. There are different techniques of blood cell counting which involves conventional as well as automatic techniques. The conventional method of manual counting under microscope is time consuming and yields inaccurate results. Although there are hardware solutions such as the Automated Hematology Counter, developing countries are not capable of organizing such unaffordable expensive machines in every hospital laboratory in the country. As a solution to this problem, to provide a software-based cost effective and an efficient alternative in recognizing and analyzing blood cells, This paper presents the preliminary study of automatic blood cell counting based on digital image processing. The number of blood cell count that is RBC & WBC count is then may be use to diagnose the patient as well as detection of abnormalities like leukemia. For this purpose, few pre-processing and post-processing techniques have been implemented on blood cells image in order to provide a much clearer and cleaner image.

Index Terms— Blood cell count , image processing technique, RBC, WBC, differential count.

1.Introduction

Considering the scope of biomedical engineering, the field of blood cell analysis has gained more and more importance. The main purpose of the blood cell image analysis is differentiating the components of blood and counting of RBCs (red blood corpuscles), WBCs (white blood corpuscles) and platelets by observing the blood cell and also detecting various deceases like leukemia (blood cancer), ADIS, if present through analysis of blood cell. [4]. Conventional method requires long time to carry out these analysis tests. This kind of tests requires sophisticated equipments and is time consuming. These tests are costly and monotonous. In the present scenario, the testing and blood analysis is done manually which can result in many human errors. As a solution to this problem, to provide a software-based cost effective and an efficient alternative in recognizing and analyzing blood cells, the proposed method in this paper uses methods of digital image processing [25].

2. Proposed method based on digital image processing.

Digital image processing encompasses a broad range of hardware, software and theoretical underpinnings. To identify and discovering the blood cells from each other, the segmentation and edge

ISSN: 2278-0181
Vol. 2 Issue 9, September - 2013

detection techniques are helpful. Before examine the structure of different blood cell, the images can be recorded with the help of glass slides and images get captured using microscopes. The images get converted color images to gray level images. Classifying the image by gray-level pixels may reduce and simplify some image processing operations such as edge detection, edge smoothing, feature extraction, image processing and image registration. [4]

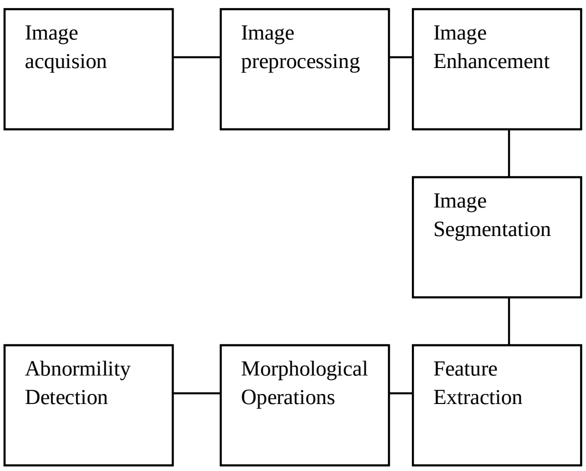

Figure.1 Basic steps to analyse blood cell

Figure 1 shows the basic steps required to analyze the blood cell.

2.1 Image Acquisition

The first step in the process is image acquisition- that is, to acquire a digital image. To do so requires an imaging sensor and the capability to digitize the signal produced by the sensor. The nature of sensor and the image it produces are determined by the application. Figure (a) in table 1 ,shows the acquired blood cell image use for further processing and analysis at a resolution of 600 x 400.
For this study images are taken which are available on internet on the website of standard medical laboratory.

2.2. Image Preprocessing

After the digital image has been obtained, the next step deals with pre-processing that image. The key function of preprocessing is to improve the image in ways that increase the chances of success of the other processes. Pre-processing typically deals with techniques for enhancing contrast, removing noise and isolating regions, Grayscale image, binary image, hsv image whose texture indicates the likelihood of alpha-numeric information. Fig (b) and Fig (c) in table1,shows the example of preprocessing in which first preprocess the image by enhancing the contrast and then converting it into grayscale image.
Acquired images have all blood elements colors close to background color, red blood cells are clustered with white blood cells and the presence of noise and stain in the blood slides is significant (Hengen et al., 2002). To overcome or reduce the effect of such factors, the images posterior standardized by increasing their contrast [9].Fig. (b) in table1, shows contrast stretching on blood cell image.
After contrast stretching image is converted in to Grayscale Image. Original blood cells images are in colour. To ease the process of ratio determination, the original images will be converted into grayscale colour. Grayscale represents the intensity of the image. In Matlab 7.0, this can be done by using RGB2GRAY function. The RGB2GRAY converts RGB image to grayscale by eliminating the hue and saturation information while retaining the luminance[1]. Fig.(c) in table1, shows Grayscale image.

2.3. Image Enhancement

After pre-processing, image enhancement is done. Image enhancement operations improve the quality of an image. They can be used to improve image's contrast and brightness characteristics, reduce its noise content or sharpen its details. Various image enhancement techniques are image negation, histogram plotting, image subtraction and various filtering techniques. Fig(d) in table1,shows the example of image enhancement by using median filtering.

2.4. Image Segmentation

The next stage deals with image segmentation. Segmentation partitions an input image into its constituent parts or objects. On one hand rugged segmentation procedure brings the process a long way towards successful solution of an imaging problem. In the papers different techniques are use for segmentation i.e segmentation by using histogram and threshoulding[1], otsu adaptive threshoulding and watershed transform[9],as well as sengmentation by K-Means clustering followed by EM-algorithm[6] Cytoplasm and nucleus segmentation via mathematical and contour models or a Gram-Schmidt orthogonalization and a snake algorithm . In this field, some methods such as region growing, parameteric active contour deformable models etc.The key role of segmentation is to extract individual characters and words from the background. There are various segmentation techniques are use by individual authors , combination of the watershed technique and a parametric deformable model , Hough transform techniques are introduced in the literature. These methods are more complex and require more processing time in comparison with other methods. However, their advantage is provide more accurate segmentation.[8].

. Fig(d) in table1, shows the results obtain after segmentation using otsu threshoulding .

2.5. Morphological Operations

The next step, is morphological operations. The decision that must be made is whether the data should be represented as a boundary or as a complete region. Morphological technique includes pre or post processing operations such as morphological filtering, dilation, erosion and Granulometry. The two fundamental morphological operations are erosion and dilation. The erosion operation uniformly reduces the size of objects in relation to their background and dilation expands the size of objects. By using dilation and erosion secondary operations like opening (erosion followed by dilation) used to smooth the contours of cells and parasites; and closing (dilation followed by erosion) used to fill the holes and gaps are implemented. Morphological operations are used to eliminate noise spikes and ragged edges. Fig(e) in table1, shows the results obtain after using morphological operations.

2.6. Feature Extraction

Feature extraction is followed by morphological operations, feature extraction also called description deals with extraction features that result in some quantitative information of interest of features that are basic for differentiating one class of objects from another. In terms of character recognition, descriptors such as lakes (holes) and bays are powerful features that help differentiating one part of alphabets from another.
The features considered are based on (i) Shape (ii) Color (iii) Texture.

Shape features are areas of cell and nucleus, ratio of nucleus to overall cell area, cell perimeter, compactness and boundary of the nucleus. Texture features include contrast, homogeneity and entropy derived from the gray-level co-occurrence matrix. Color histogram, mean and standard deviation of the color components in CIE-Lab domain, form the color features.

Feature extraction can be achieve by using various techniques. Features are extracted by Local Binary Pattern (LBP) and co-occurrence matrix are , using a Sequential Forward Selection (SFS) algorithm , or by using classifiers like Artificial NURAL network (ANN), support vector machine (SVM) .

Magudeeswaran V, Karthikeyan P and Thirumurugan P give the various 27 features of cell images in their paper. This included 4 geometrical features, 16 statistical features and 7 moment invariant features [21]. In literature authors uses different feature extraction techniques, By using proper feature extraction technique accurate results are obtain. Feature extraction can be achieved by using various techniques.

2.7. Abnormality Detection

The last stage involves abnormality detection. This includes recognition which is the process that assigns the label to an object based on the information provided by its descriptors. Interpretation is also included which involves assigning meaning to an ensemble of recognized objects. In terms of this project identifying the object as WBCs requires associating the descriptor for that object with label WBC. Interpretation attempts to assign meaning to a set of labeled objects. For example in case of leukemia , counting the number of WBCs in the image and then comparing it to the normal count of WBCs can help us to detect abnormality in the blood cell from which we can conclude that the patient has leukemia or not.

2.8. Differential Count

In blood cell analysis differential count of RBCs & WBCs is also have importance in order to diagnosis of various decease. For differentiating different types of WBCs and that of RBCs, there are also various segmentation and classification techniques are use. For example classification by using various classifiers like NN, KNN, W-KNN, Bayes,SVM,NNet[9], different types of artificial neural networks (ANNs) such as feed-forward back-propagation[4] and , local linear map , fuzzy cellular neural network are often used in the literature. Also to differentiate Blood cells Statistical and dynamic features of cell image may be considered.

3. Results and Discussion

Table 1. Shows the results of the blood cells image pre-processing applied to the blood cell image for blood cell counting.
Fig.(a) shows the captured blood cell image at a resolution of 600 x 400. The preprocess image of blood cell is shown in Fig. (b). Fig. (c) shows the gray scale image. Based on Fig. (c), Since the blood cell slides were stained with chemicals to enable the nucleous of the white blood cells to take a unique color, the gray level intensity in WBC is darker compared to the RBC. The threshold value was selected manually and used to segment the WBC or RBC from the image background. After applying the thresholding method, the binary images of WBC and RBC for each blood cell images were obtained as shown in Fig.(e). Object pixels (WBC and RBC) will have the value of 1 and the background pixels will have the value of 0. There are small spots of object appearing in the WBC background images. This noise was removed to enhance the quality of the images in order to obtain the accurate number of WBC and RBC in blood cell counting. The blood plasma and dust particles in WBC images were cleaned by removing all object containing fewer than 100 pixels and applying the median filter before threshoulding as shown in fig(d). After getting binary image, morphological operations are apply for final counting as shown in fig (f).

Table 1. The results of the blood cells image pre-processing applied to the blood cell image for blood cell counting.

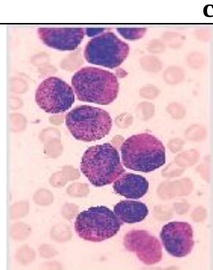
Fig (a) Original image

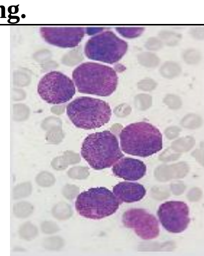
Fig (b) contrast stretching

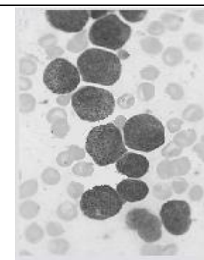
Fig (c) gray scale image

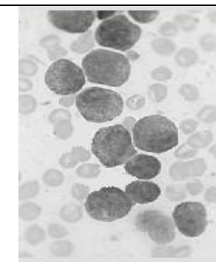
Fig (d) median filtering

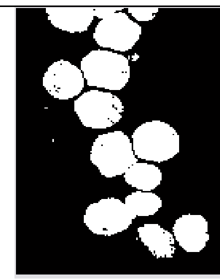
Fig (e) threshoulding

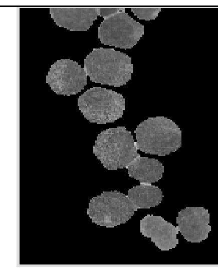
Fig (f) morphological operations

3 Conclusion

By using digital image processing, analysis of blood cell image is more accurate as well as this method is efficient in terms of cost and time consuming compared to existing techniques of blood cell analysis. MATLAB software use for this analysis .Day by day research work is increasing in this field and various image processing techniques are implemented in order to get more accurate result. For medical diagnosis and blood cell counting use of image processing techniques is useful and better than existing techniques provided that standardization of blood smear is done properly to obtain blood cell image.

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