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Blood Microscopic Image Analysis for Acute Leukemia Detection

V. Renuga, J. Sivaraman, S. Vinuraj Kumar, S. Sathish, P. Padmapriya and R. Reethu

ABSTRACT

Leukemia is the type of blood cell cancer and it actually starts from the bone marrow and then it affects the blood cells. It is said to be cancerous when a large number of abnormal White Blood Cells (WBC) enter into bone marrow and it does not respond to the cell growth inhibitors which leads to Acute Lymphocytic leukemia (ALL). The main aim of this paper is to analyze the blood microscopic images for ALL detection. The ALL is detected using the technique such as preprocessing, segmentation, feature extraction and classification. The technique of segmentation and feature extraction aims at the clear view of the structure of WBC nucleus and to classify the lymphocyte as normal or lymphoblast. In this work the leukocytes are separated from the other blood cells and then the lymphocytes are extracted from the subclass, fractal features, shape features and other texture feature. These features greatly help in identifying the structures of lymphocytes and differentiating them from the cancerous cell. This identification process is of importance in differentiating and detecting the cancerous cell.

Keywords: Acute Lymphocytic Leukemia, Image Analysis, Microscopic images, MATLAB, Peripheral blood stream.

1. INTRODUCTION

Acute Lymphocytic Leukemia (ALL) is a disease which often occurs in children. It is said that White Blood cells grow larger in the blood stream [1]. Examination of peripheral blood smear images is one of the most widely used techniques for leukemia detection though it suffers from problems such as subjective interpretations, operator fatigue and efficiency. The samples were taken from ALL-IDB datasets [2]. Segmentation is done to identify the WBC's and for segmentation there are various methods in which clustering technique would give good result. By analyzing the various techniques and getting knowledge about that it is known that shape features would be effective. Shape features like circle, rectangle, ellipse, squares are considered [3]. The most popular unsupervised algorithm is the k-means clustering algorithm. While using this algorithm, sometimes the edges of some nuclei are obtained instead of whole nuclei. This problem can be avoided by using some morphological filtering methods such as edge enhancement by sobel operator and canny edge detector [4], [5]. Automatic thresholding methods are also used but it does not always produce precise results during the selection of segmentation threshold. Pattern recognition is also considered a powerful tool for the differentiation of normal cells and blast cells. It is also done by color based clustering. Some of them are k-means, k-medoid, FCM, GK, FPCM etc., [6], [7]. Fractal geometry is a new tool that can be extremely used for many problems in almost every scientific field. Cancer cells are often referred to as fractals. The likelihood ratio test is employed for hausdorff dimension. Fractal dimension is one of the useful factors to be considered in analysis. There are many ways to define the fractal dimensions in which Box-counting method is one the simplest method in used [8]. The contour signature can also be used for this analysis which is to find the non-routine changes in the boundary of nucleus. Based on the domain from which they are extracted the texture feature is of two types spatial and spectral methods. Among the various important color features the simplest and very effective feature is the color moments. Local Binary pattern is one of the features used in classification in computer vision [9].

Department of Biomedical Engineering, Vel Tech Multi Tech, Chennai–600062

2. METHODS

The Acute Lymphocytic Leukemia is detected using Image processing techniques using MATLAB 2013a. Images are collected from ALL-IDB Database and used as a sample. After that segmentation is done to extract WBC nucleus from the image. Then from the segmented image the features are drawn out. Finally classification is done to classify the abnormal and normal cells. Figure 1 shows the work flow.

2.1. Collection of Blood Smear Images

Fabio Scotti provided a public supervised datasets (ALL-IDB) for study purpose. It is used to test and compare cell segmentation algorithm and the classification of ALL. From this database, the images are taken and used as an input.

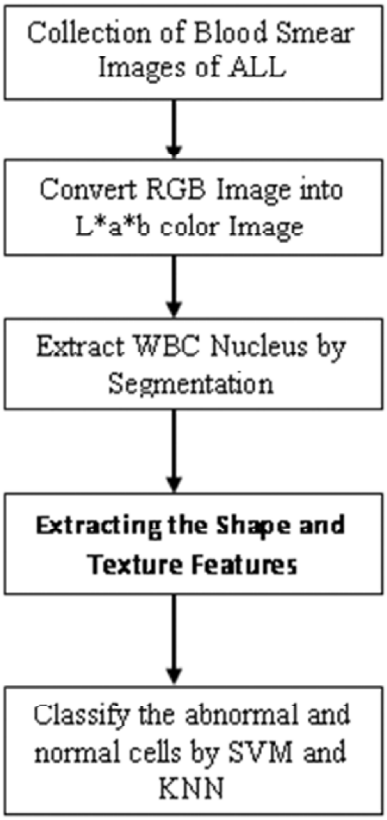

Figure 1: Work Flow

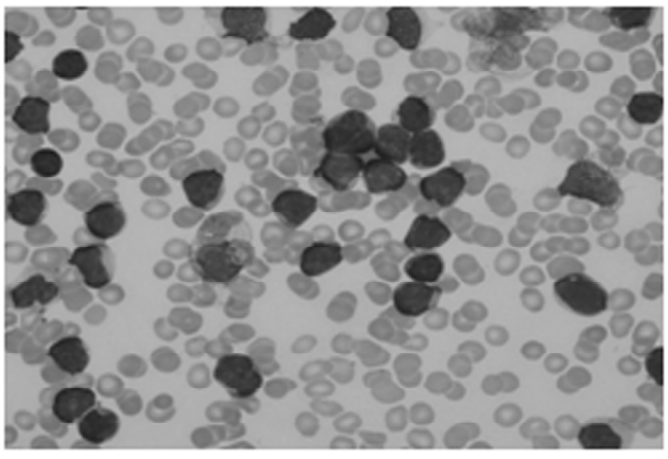

Figure 2: Cancerous Image

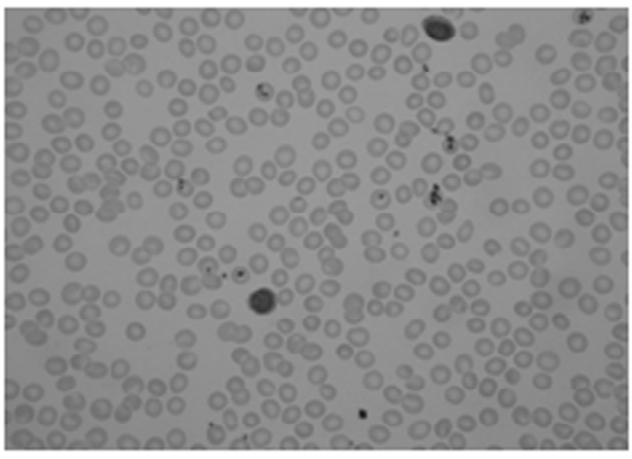

Figure 3: Non-cancerous Image

2.2. Conversion of Color Images

Noises are removed using pre-processing. After preprocessing the colored images are changed into L*a*b images. It is difficult to segment the RGB image and the dimensions can be reduced when compared to RGB. In L*a*b, 'L' is the Luminosity Layer containing the brightness information and 'a' & 'b' are Chromaticity Layer.

2.3. Segmentation to Extract WBC nucleus

In segmentation, the WBC nucleuses are located from the blood smear images. Since color images are employed, color based clustering is used. For this extraction, k-means clustering is used. It is a supervised algorithm. The important step in segmentation is the selection of total number of clusters.

2.4. Feature Extraction

The transformation of some data in the form of features is known as feature extraction. Feature extraction mainly dominates its performance of the classifier. The factors to be extracted from nucleus are geometrical feature and texture features.

i. Geometrical Features: The Geometrical features are very important for defining the blast cells. It is efficient to extract these features from the binary form of image. The features includes Area, perimeter, Compactness, Solidity, Eccentricity, Elongation, Form Factor, Centroid, Diameter, Mean Intensity etc.

ii. Texture Features: The Texture features are good to be extracted from the gray scale images. Gray Level Co-occurrence Matrix is used for feature extraction. The features are Homogeneity, Energy, Correlation, Entropy etc.,

2.5. Image Classification

Classification is done to classify the abnormal and normal leukocytes. The patterns are very close to each other. For classification Support Vector Machine [SVM] and K-Nearest Neighbor [KNN] classifiers are used. Both are supervised algorithms. SVM analyze the data used for classification and does non-linear classification. KNN is applied even for complex applications which are capable of yielding high performance results. [10]

3. RESULTS AND DISCUSSION

The Microscopic images are obtained from the ALL-IDB database. Those images are used as an input. The microscopic input images are shown in Figure 2 and 3. Then RGB images are changed into L*a*b color images. The L*a*b shown in Figure 4. The L*a*b color images makes us to measure the quantity of the optical differences.

Clustering is used to disconnect the group of objects. The important step in segmentation is the selection of total number of clusters. Using k-means three clusters are formed. They correspond to blue nuclei [WBC], background information and other cells respectively. Fig 5 shows the clustered image and Fig 6 shows the separated colour nuclei.

The blue nuclei [WBC] are separated to properly examine the cancer cells. With this separation it is useful to obtain exactly all the essential information about the blast cells.

Using Bounding Box Technique the RGB images are changed into Binary image and Gray image. The binary images are used to find the geometrical features and Gray scale images are used to find the texture features. Then the images are labeled. Fig 7 shows the bounding box images.

Some Morphological features and texture features are extracted and is stored for training and testing purpose. Then classification is done to classify the abnormal and normal leukocytes. Table 1 and 2 shows the extracted texture and morphological features.

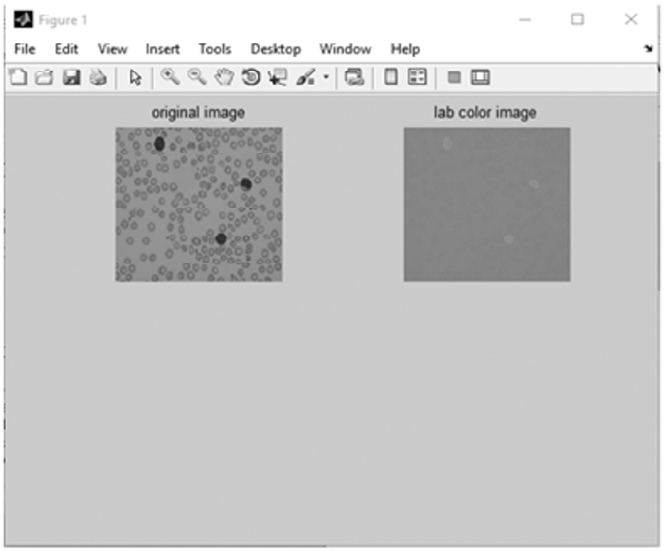

Figure 4: L*a*b conversion

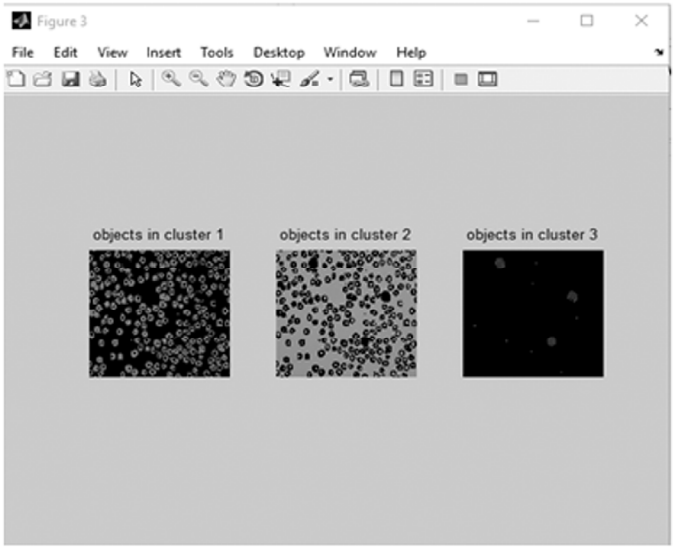

Figure 5: Clustered images

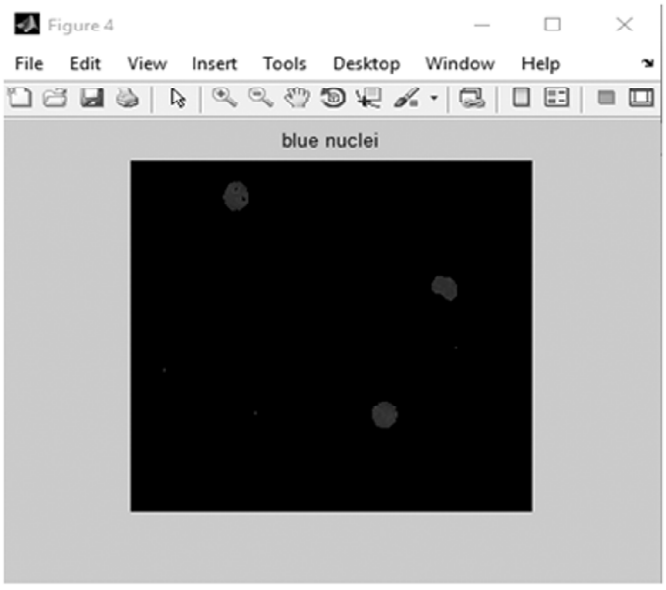

Figure 6: Separation of connected nuclei

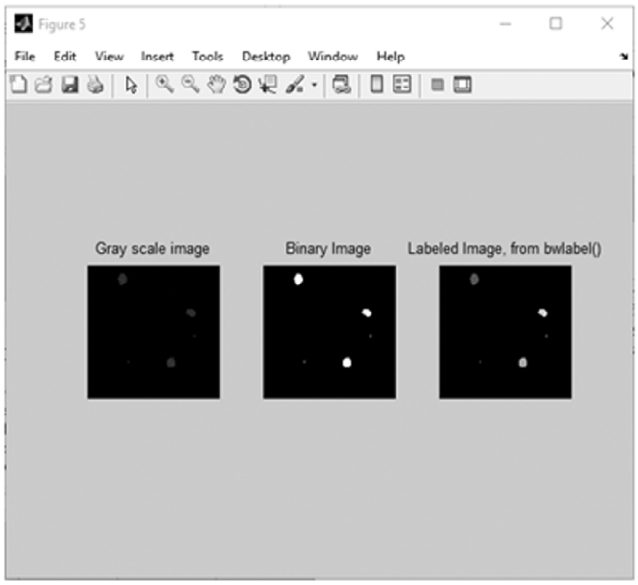

Figure 7: Bounding box images

Table 1
Geometrical feature values

Blob	1	2	3	4	5	6
Mean Intensity	58.5	42.4	58.0	45.2	43.3	57.0
Area	2.0	259.0	2.0	236.0	193.0	2.0
Perimeter	2.0	59.1	2.0	55.5	51.5	2.0
Centroid	22.0	67.7	80.0	162.4	201.0	208.0
Diameter	152.5	26.1	184.5	185.2	92.4	136.5
Solidity	1.6	18.2	1.6	17.3	15.7	1.6
Eccentricity	1.0	1.0	1.0	1.0	1.0	1.0
Compactness	0.9	0.7	0.9	0.5	0.7	0.9
Elongation	2.0	13.5	2.0	13.0	13.7	2.0
Form Factor	2.0	1.3	2.0	1.2	1.4	2.0

Table 2
Texture feature values

Blob	*Correlation*	*Contrast*	*Energy*	*Homogeneity*
1	0.2	0.3	0.1	0.3
2	0.4	0.3	0.4	0.4
3	0.1	0.6	0.3	0.5
4	0.5	0.2	0.5	0.9
5	0.6	0.2	0.4	0.9
6	0.3	0.5	0.7	0.4

4. CONCLUSION

This system detects the Acute Lymphocytic Leukemia using the blood microscopic images. First segmentation is done to separate the WBC nucleus from the blood sample. Then the morphological and texture features are extracted. The features greatly help in identifying the integrity of the structures of the lymphocytes and differentiating them. Finally, classification is done to classify the abnormal and normal leukocytes. For this classification SVM and KNN method are used. The method can be used in real time image analysis of lymphocytes in the clinical field because of its cost effectiveness and robust which is not in the case of morphological analysis. This method will provide for better diagnosis of the Acute Lymphocytic Leukemia [ALL].

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