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A Survey on Detection of Leukemia Using White Blood Cell Segmentation

Pooja Deshmukh[1], Prof.C.R.Jadhav[2]
[1,2]*Computer Engineering, DYPIET*

Abstract— White blood cells analysis is generally done for diagnosis of various diseases. One of those diseases is Acute lymphoblastic leukemia (ALL). ALL is detected by observing morphological changes in white blood cells. Morphological analysis along with classification and segmentation techniques helps to detect leukemia at early stage and accurate detection. There are number of classification techniques which can be used to classify WBC's into different classes as per their respective features. Segmentation techniques segments nucleus and cytoplasm from each WBC and feature extraction process extract features from nucleus and cytoplasm for accurate result.

Keywords—Image Processing; formatting; White Blood Cell Detection; Acute lymphoblastic leukemia; RGB (Red Green Blue)

I. INTRODUCTION

WBC's (White blood cells) also known as leukocytes are important cells in human body which are used to detect number of diseases infected to body. Leukemia is also one of those diseases which is also detected by using WBC's. There are two types of leukemia as Acute leukemia and Chronic leukemia. Growth of acute leukemia is fast and growth of chronic leukemia is slow. If leukemia is detected at early stage then it is curable. It needs some techniques which are fast and work more accurately than manual methods. Manual methods are more time consuming and show less accurate results. Accuracy of results depends on operator's ability.

II. RELATED WORK

Donida Labati R, Piuri V, Scotti F: New ALL-IDB public dataset was designed for comparison of different segmentation and classification algorithms. This dataset is of blood images which are used for detection of diseases. The classification of the cells was given for each image in the dataset, also a specific set of figures of merits were used to compare the performance of different algorithms. In this classification of blood cells provided accordingly. ALL-IDB contains blood sample images from view of expertise. Differentiation between blood cells as white blood cells and red blood cells is done by morphological analysis. Leukocytes are classified into different types as shown in figure 1. Also, features of nucleus and cytoplasm are considered for leukemia detection.

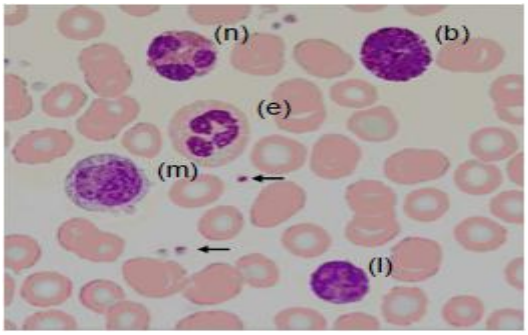

Figure 1: Colored cells are white blood cells: basophil (b), eosinophil (e), lymphocyte (l), monocyte (m), and neutrophil (n). Arrows represents platelets. Others elements are red cells.[2]

FAB method used morphological analysis for classification of white blood cells. Other steps for detection were segmentation, identification of white blood cells and identification of lymphoblast and leukocytes. Generally, lymphoblasts are of irregular shape and have different nucleus features than normal leukocytes.

Madhloom HT, Kareem SA, Ariffin H, Zaidan AA, Alanazi HO, Zaidan BB: Automatic leukemia detection system was implemented for easy, fast and accurate diagnosis. White blood cell segmentation is important procedure in detection of leukemia automatically. This approach only considered white blood cell. All white blood cells have nucleus. So, only nucleated cells were considered for detection process. Different methods such as filtering, global threshold technique and arithmetic operations were used for separation of nuclei from other part of cell. Image conversion of blood image was done from color image to grayscale image to detect nuclei easily which is shown as dark point in grayscale image. In this method, threshold used for segmentation and filter used to increase intensity of nucleus which helped in segmentation. Features of nucleus help to evaluate whether cell is normal or infected by disease. This approach included contrast stretching and histogram equalization for nucleus identification. Threshold calculation is done by Otsu's method and minimum filter.

Sinha N, Ramakrishnan AG.: White blood cell classification into number of classes and counting number of white cells in each class is done by automatic blood count system. This process included k-means clustering for segmentation. Ensemble classifier was used by comparing different classification algorithms such as kNN, NN, W-kNN, Bayes, SVM etc. Feature extraction was also done. Feature extraction process extracts features such as color, texture and shape features of nucleus. This extracted features helps to detect leukemia and other infected diseases. Acquisition was first step which used digital camera for capturing image of blood slide. Remaining steps are segmentation, classification of white cells and feature extraction. Classification is done on extracted features to detect whether cells are normal or suffering from disease.

Kovalev VA, Grigoriev AY, Ahn H.: Robust method is used for recognition of white blood cells from blood smears. Statistical and neural net based approaches are successfully applied for recognition of WBC's from images. Different WBC types are obtained at different conditions. Initial step is acquisition; it included different techniques as per different conditions to capture images of blood smear. There was three step algorithm in image segmentation; first step is extraction of nucleus cell and grouping them into cell. Next step is extraction of approximate cytoplasm around center. Finally use of prior knowledge of background to improve extraction of cytoplasm.

Scotti F.: Accurate measurement of white blood cells properties is done which is a not possible using microscope. Also, enhancement of microscopic images is done by removing undesired background of images. It reduces noisy and unnecessary background from an image. Then, average cell diameter is evaluated. Different techniques are used for segmentation. New segmentation strategy is used for better feature extraction and automatic diagnosis of disease. First step is removal of background to enhance image. Then input image was given to L*a*b color space and Fuzzy k-means clustering and histogram threshold technique used for segmentation of nucleus and cytoplasm. In L*a*b color space L* denotes lightness, a* denotes red/green value and b* denotes yellow/blue value. Fuzzy k-means clustering was used to form cluster of similar blood cells.

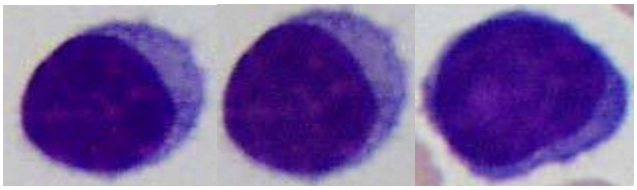

Figure 2: Normal Lymphocytes [4]

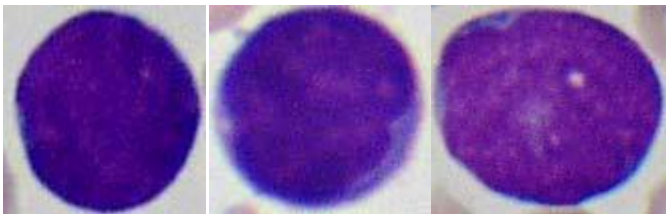

Figure 3: Infected Lymphoblasts [4]

Piuri V, Scotti F.: Automated detection and classification of white cells (leukocytes) was done by microscopic color images. Leukocytes were classified into types as Basophil, Eosinophil, Lymphocytes, monocyte and neutrophil. Neural classifier was used for classification.

Halim NHA, Mashor MY, Hassan R.: Automatic counting of number of blasts present in the slide of leukemia is done by image processing techniques. In this automatic technique segmentation for white blood cells is very difficult technique.HSV color space based segmentation is used to reduce white blood cells from background. It provides fast and effective way for counting white blood cells. There were four different steps as image acquisition which considers blood images and evaluates size and shapes of nuclei. Next step is HSV (Hue Saturation Value) color space model is used for segmentation. Third step is morphological operation which shows geometric properties of images. Here it shows shape and size information of blood images. Next one is counting; it uses function to label blood cells in binary image. From these labels white blood cells can be easily detected and counted.

Mohapatra S, Patra D, Satpathy S.: Quantitative approach is designed for differentiating lymphoblasts from lymphocytes in blood smear and bone marrow samples. It helps in computer aided screening of ALL development. Recognition of lymphoblasts is done automatically by segmentation, classification and feature extraction methods. Detection of diseases is possible by rapidly screening of patients using ensemble classifier and improved segmentation method. First step is subimaging, in this region of interest is selected from an image and lymphoblasts and lymphocytes are selected using K-means clustering algorithm. In this method RGB color space was used by K-means clustering. In next step segmentation of mature and immature lymphocytes is done. Shadowed C-means method was used for segmentation based on L*a*b color space. Then features are selected from cytoplasm and nucleus of each cell. This method explained some quantitative features related to cytoplasm and nucleus. Finally classification of cells is done according to extracted features.

Cheewatanon J, Leauhatong T, Airpaiboon S, Sangwarasilp M.: Segmentation of image to count WBC is done by new developed algorithm. There are two tasks in that algorithm. Filter is used in first task, which is mean shift filter mainly used to remove noise. And second task is effective region growing algorithm is developed for segmentation of image. That algorithm was tested using CIE L*a*b* and RGB color space. Some segmented images are highly over-segmented which can be reduced using color space.

(a) (b)

Figure 4: Segmentation of basophil a) Original image b) Image after segmentation [8]

Lezoray O, Cardot H.: Two-color pixel classification algorithms are studied which are Bayesian classification and K-means classification with color watershed. Color Pixel classification is not sufficient to extract color regions accurately, so new strategy is used which includes three steps as: classification, simplification and color watershed. Color watershed depends on aggregation function which uses local and global criteria. K-means clustering gave better results. Pixels were classified and given to respective class. Bayesian decision theory is pattern classification method. This method used prior knowledge for classification. RGB, HSL and L*u*v color spaces are studied which computes color coordinates.

Putzu L, Di Ruberto C.: White blood cells counting and classification generally used to diagnose number of diseases which is simple evaluation process. Acute lymphoblastic leukemia is one the diseases which is evaluated using white blood cells. Different types of WBCs are identified, whether they are normal or infected. Secondly, identification and classification of leukocytes done and unnecessary components are removed from blood sample image, which means image is cleaning is done. In next step cytoplasm and nucleus from each leukocytes are selected and further classified after feature extraction process completed. CMYK color space model was used. Segmentation process depended on histogram values and image was cleaned by removing background. Adjacent cells were verified using roundness value. This method considered if roundness value was less then cells were adjacent. The Watershed algorithm was used to separate adjacent cells. Selection of nucleus and cytoplasm was done by taking advantages of different selection methods. SVM classifier was used for classification.

Hsu, C-W, Chang C-C, Lin C-J.: A support vector machine (SVM) is a basic and important classification technique. It is used to classify data. This method is useful and easier than other classification methods. SVM produces a model which calculates the target values which is based on training set. This technique uses cross validation to calculate parameters which are helpful to train training set. Numbers are represented in vector real numbers in SVM. If data is given in attributes then it is firstly converted into numerical form.

Seyed Hamid Rezatofighi, Hamid Soltanian-Zadeh: Different image processing algorithms are proposed to distinguish different types of white blood cells. A method is used for segmentation of cytoplasm and nucleus of cells. Then segmented parts are used for number of feature extraction. Sequential Forward Selection algorithm is used to select distinct features from segmented region. Features are extracted based on LBP. Classification algorithms ANN and SVM are compared which shows SVM is more accurate classification algorithm.

Sedat Nazlibilek, Deniz Karacor, Tuncay Ercan, Murat Husnu Sazli, Osman Kalender ,Yavuz Ege: Automatic counting of white blood cells and their sizes are evaluated for easy detection. Output of this system is count of white blood cells, size and their types. Features were extracted using PCA algorithm and classifier was used to classify different types of white blood cells. Five types of WBC's were classified as lymphocyte, monocyte, basophil and neutrophil. To convert grayscale image into binary image Otsu's method was used.

III. CONCLUSION

There are some advanced classification and segmentation methods which help to improve accuracy of results. These techniques are computerized so they reduce complexity and time of detection process. In previous work broken white cells were considered as cells do not having nuclei. It is possible to consider some solution which can identify nuclei of each cell. Also, effectiveness of segmented image was depending on bandwidth. New approach will include effective segmentation

and classification algorithms to classify white cells into respective classes as per characteristics of cells.

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