A Review on White Blood Cells Segmentation

NIMMY THOMAS
M.Tech Student, Electronics and Communication Engineering
St. Joseph’s College of Engineering And Technology, Palai, Kerala
E-mail: nimmyt007@gmail.com

SREEJITH V.
Assistant Professor Dept. ECE
St. Joseph’s College of Engineering And Technology Palai, Kerala
E-mail: sreejithvasu@gmail.com

Abstract. Currently blood smear’s evaluation is important in the diagnosis of different diseases. Usually, the hematologists are curious on diagnosing white blood cells (WBCs) only. White Blood Cell (WBCs) detection is a vital evaluation method. In this paper, a review on some of the common segmentation methods are discussed. It includes K-mean segmentation, Otsu thresholding and Color based segmentation. This review also helps to get more details about the different types of segmentation and classification process.

1. Introduction
Blood is a life-giving fluid that transports oxygen and gives energy to the cells and carries away carbon dioxide and other waste products. Blood circulating in our body consist of 55 percent plasma, 40 percent Red Blood Cell (RBC), 4 percent of Platlets and 1 percent White Blood Cells (WBC). WBCs are important for healthy immune system. Neutrophils, eosinophils (acidophilus), basophils, lymphocytes, and monoocytes are the five types of WBCs. All these cells have nuclei, which differentiate them from the other blood cells. The normal white cell count is between $4 \times 10^9/L$ and $11 \times 10^9/L$. Abnormalities in blood cells are determined by blood smear test. Irregularity in blood cells result in variations in the number of WBCs. The two types of blood count needed for the diagnosis of blood are Complete Blood count (CBC) and the Differential Blood count (DBC). The most commonly performed hematologic test is Complete Blood count (CBC) and the Differential Blood count (DBC).

Detection of the WBCs efficiently diagnosis various diseases. Basically it consist of four steps: preprocessing stage, image segmentation of image, feature extraction and classification as shown in figure 2. The precision of the extracted feature and classification depends on segmentation of WBCs.

2. A review on different Segmentation Techniques
Figure 2 shows the simple block diagram of a WBCs detection system. It includes various functional modules. The input image of blood smear is fed to the system. It consist of four
Figure 1. Blood Smear Microscopic Image

Figure 2. Common Block Diagram for WBC detection

stages: Preprocessing stage, image segmentation, feature extraction and classification. The precision of detection depends on different segmentation process.

2.1. Preprocessing Stage
The pre-processing is a significant stage in image processing in order to improve the image data that avoid unwanted distortions and highlight important blood smear image feature for next processing. Operations like image enhancement, image contrasting, image sharpening and noise filtering gray level conversion are performed in images for better results. In image enhancement process operations like Median and Max/Min filtering, image subtraction, Histogram Equalization, Image smoothing, Neighbourhood Averaging, Image sharpening. The visual appearance and contrast of an image can be improved by histogram equalization. The aim of image smoothing is to diminish the effects of camera noise within an image, spurious pixel and missing pixel values. Image sharpening is to overcome blurring produced by blood smear image and to enhance fine details in the image.

2.2. Segmentation Of WBCs.
Segmentation means dividing the image into different part for various applications. Because of the complex nature of the blood cells and uncertainty in the microscopic blood smear image, WBCs segmentation hard and challenging. Image segmentation methods include threshold-based, edge-based, region-based or clustering methods are used.

2.2.1. K-means clustering is one of the easiest unsupervised learning algorithms based on distance. This algorithm takes distance as calculating parameter of dissimilarity. It divides
Figure 3. Segmented WBCs using K Mean.

Figure 4. Segmented WBC using Otsu

p objects into k clusters in which each object is a part of the cluster with the closest mean. In WBCs detection, blood smear image clustering is done based on the color information of RBCs, WBCs and plasma. This method gives absolutely k different clusters of strong possible distinction. The aim of K-Means clustering is to minimize total the squared euclidean distance:

$$\sum_{i=1}^{m} \sum_{j=1}^{n} ||x_i - c_j||^2$$

c is the number of cluster centers.

c_i is the number of data value in ith cluster.

2.2.2. Otsu Thesholding

Otsu method is commonly used as a result of its easy calculation. Otsu segmentation is threshold based segmentation. It finds a measure of spread for the pixel levels that either fall in object or background via iterating all the feasible threshold values. The aim is to keep clusters as tight as possible by finding a threshold value that minimize variance within the class. This algorithm gives good result in WBCs segmentation since the object area is small compare to background area.

2.3. Feature Extraction

Choosing the best diagnostic feature is almost important task in WBCs detection. This is a process of redefining a large set of similar data into a set of features (or feature vector). For detecting WBS cells several features have been observed viz, area, perimeter and circularity, convex areas, solidity, major axis length, orientation, filled area, eccentricity because structure of the nucleus is relevant feature for differentiation of cells. All the extracted features are choosen from the binary converted image of the nucleus with pixels of non-zero value. The area of blood cell within the image region is calculated from the total number of non-zero pixels.

Perimeter is determined by finding distance between adjacent boundary pixels. Circularity changes with surface irregularities and is defined as,

$$\text{Circularity} = \frac{4\pi \times \text{Area}}{\text{Perimeter}}$$
2.4. Classification
Classification of WBCs depend on characteristics of its cytoplasm and nucleus. The feature extracted will effect the classifier performance. Classification methods used include K nearest neighbor (kNN), Learning Vector Quantization, MultiLayer Perceptron, and Support Vector Machine. kNN classifier is used, where the pixel is classified according to the majority vote of the k closest training data. The kNN classifier does not make underlying conclusion about the statistical structure of the data because it is a non parametric technique.

3. Conclusions
A review of various WBCs detection methods have been discussed in this paper. Most of the methods are image enhancement and noise filtering. Feature extraction has an important role in the process because it effect the result. Segmentation and classification depend on extracted features. Identifying each type of white blood cell has a challenging part because of its irregularity in shapes. So this review helps to get more details about the different types of segmentation and classification process.

Acknowledgments
I would like to show my sincere regards to my supervisor, Prof. Sreejith V., whose guidance made this work possible. His knowledge and encouragement has invaluable help in producing this work.

References
[1] Piuri V, Scotti F., Feb. 2004, Blood leukocytes classification by microscopic images. Information, IEEE International Conference on Intelligence for Measurement Applications.

[2] Nisha Ramesh, Bryan Dangott, 2012 Isolation and two-step classification of white blood cells in blood smears. IEEE Transactions on IT, vol. 52, no.4, , pp. 1289 - 1306.

[3] D T Pham, Selection of K in K-means clustering, Manufacturing Engineering Centre, vol. 14, no. 5-6, pp 629-654, , doi:10.1007/s00041-008-9035-z

[4] Congcong Zhang, 2013 White Blood Cell Segmentation using Color Space Based K-Means Sensors 2014, 14, 16128-16147; doi:10.3390/s140916128

[5] Al-Daoud, M. B., 2007 Fast K-means clustering algorithms, University of Leeds, vol. 23, p. 969,

[6] Putzu, L.; Di Ruberto, C., 1996 White blood cells identification from microscopic blood images. Biomedical Engineering, Guangzhou, China, 1 November 2013

[7] Saraswat, Arya, 2007 Automated microscopic image analysis for WBCs identification: A survey Lett., vol. 14, pp. 707710, .

[8] Huang, D.C.; Hung, Leukocyte nucleus segmentation and recognition in color blood-smear images. IEEE International Instrumentation and Measurement Technology Conference (I2MTC), 13 May 2012; pp. 171176.