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Detection and Segmentation of WBC cells using Image Processing Technique

Manisha Shirvoikar[1], Dr.H.G.Virani[2]
[1]PG Student, [2]Professor & Head of Department
[1]Goa College of Engineering/ Department of Electronics and Telecommunication Engineering, Ponda, Goa, India
Email: shirvoikarmanisha@yahoo.in
[2] Goa College of Engineering/ Department of Electronics and Telecommunication Engineering, Ponda, Goa, India
Email: virani@gec.ac.in

Abstract— **Generally blood test is used as a health indicator for detecting various diseases. Differential blood count is used to determine the state of a person's health based on the count of types of white blood cells. The main problem arises when large amounts of blood samples are required to be processed by the hematologist. As the number of samples increase, the identification process tends to be error-prone. The time and skill required for the task limits the speed and accuracy with which the blood sample can be processed. There are equipment's available to perform differential count but all hospitals and health centers cannot afford to buy these expensive equipment. This paper aims to provide user friendly software based on MATLAB allowing for quick user interaction with a simple tool for the detection and segmentation of white blood cells from images of blood samples. In order to perform the segmentation, this paper uses the techniques such as Green Plane Extraction, Arithmetic operations, Linear Contrast Stretching, Histogram Equalization and Global Thresholding. This paper describes the results of fast and accurate blood cell segmentation of white blood cells.**

Keywords — **MATLAB, peripheral blood smear, RBC, Thresholding, WBC.**

I. Introduction

Human blood consists of three types of major cells: Red blood cell (RBC), White blood cell (WBC) and platelets. Each of them has their own functions in our body. RBC helps in supplying oxygen, WBC fights against infection and platelet helps in clotting of blood. Production of cells is in bone marrow from hematopoietic stem cells. Other cells can be distinguished from WBC based on their color, size and shape. WBC's can be clustered by their morphological appearance into five types of cells called Neutrophils, Lymphocyte, Monocyte, Basophils and Eosinophil.

Blood is use as an indicator for various diseases. For performing Differential Blood Count (DBC) the counts of type of WBC is important. No doubt that manual microscopic evaluation is essential when suspicious abnormality found in blood smear. But manual microscopic evaluation of blood sample is tedious and time consuming and requires expert lab technicians. Analyzers are available to perform differential count (DC) but they are costly and not affordable by remote area hospitals and it cannot detect irregularities in shapes and sizes of cell.

The most significant benefits of automation of visual sample inspection is to help pathologists to recognize types of WBC in blood sample proficiently, accurately and faster.

Steps composing the automation which are: Image acquisition, Image processing, Image segmentation and Image analysis. Segmentation is considered as the most important and critical step in the process as it affects the rest of following steps [1], because all later steps are highly reliant on the image segmentation step.

II. LITERATURE REVIEW

Goal of segmentation of blood cells is to isolate the region of interest from the complicated background and to segment every cell into its components such as nucleus, cytoplasm and other parts.

Farnoosh Sadeghian et al. [2] proposed a method for WBC segmentation into two parts: nucleus and cytoplasm which is based on pixel intensities and morphological operations. It has limitation that is work is carried on the sub-images.

Ongun et al. [3] used active contour model (snakes and balloons) for segmenting the WBC. Shape based and texture based features are utilized for classification purpose.

Cao et al. [4] proposed an algorithm that detected RBC in urine image. Than sobel operator is applied to urine image, localization of RBC done using Hough transform. Features are extracted and selected by principal Component analysis (PCA) than classification is done using Linear Discriminant Analysis (LDA).

Adollah et al. [5] presented a survey on segmentation methods their main aim of study was to develop an automatic system for classification of blood cells.

H.T. Madhloon et al. [6] proposed a method for segmentation using arithmetic operations and explained the effect of minimum filter before and after thresholding.

Thejashwini M et al. [7] developed an algorithm to extract features of the cell and using circular Hough transform detection and counting of RBC done. WBC segmented from the background area using Thresholding.

P. S. Hiremath et al. [8] developed a method to automatically segmentation WBC based on edge detection, Thresholding and histogram equalization.

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Only three types of WBC namely neutrophil, lymphocyte and monocyte are considered in this type of work.

Sedat Nazilibilek et al. [9] proposed a method for segmentation, classification and counting cells based on their size of white blood cells. Classifications of cell were done using multi-layer perceptron (MLP).

III. PROPOSED ALGORITHM

In the proposed idea of work five types of WBC such as Neutrophils, Lymphocyte, Monocyte, Basophils and Eosinophil images are captured from peripheral blood smear images with varying intensities and background. Image with different sizes and stained images conditions are also considered. To eliminate noise and enhance information preprocessing is used.

Image segmentation techniques can be divided into two main groups as follows [10] techniques based on gray level intensities (e.g.: Thresholding, method based on image texture and Edge based segmentation).Proposed method uses gray level intensities for segmentation which require less processing time and suitable for processing.

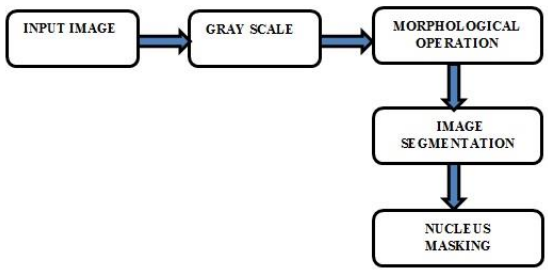

Figure 1: shows flow chart to segment WBCs nucleus

A) Image Acquisition

Peripheral blood samples from patients are collected and processed by Pathology Department at Goa Medical College and Hospital.

From blood smear slides microscopic images are captured by an Olympus BX51 microscope which is connected to a computer and microscope coupled with an Olympus color camera DP11 captures digital images. The size of the captured image is 640 x 480 pixels and all images acquired are than resized in order to standardize the acquired images.

B) Image Pre-processing

Image Enhancement: digital images have to be enhanced for better segmentation of WBC.

- Green plane Extraction:

  Green plane is extracted from the blood sample image. Extracting green plane converts original image to gray scale image.

- Contrast Enhancement:

  Image contrast is adjusted by varying its histogram this enhances the image.

- Histogram Equalization :

  Adjusts intensity values of an image which basically involves intensity transformation so that the histogram of output image approximately matches predefine intensity. It assigns the intensity values of pixels in the input image such that the output image contains a uniform distribution of intensities.

C) Image segmentation

Segmentation involves separating an image into regions corresponding to objects; it involves selecting only the area of interest that is WBC in an image. This is done by removing all the unwanted area that is RBC, platelets and stains in an image and preserving only the required area.

Thresholding creates binary images from gray-level ones by turning all pixels below some threshold to zero and all pixels about that threshold to one.

The details of the proposed algorithm:

In the beginning the original image is resized. Then resized (color) image is converted into gray scale image by extracting green plane from it.

In gray scaled image nuclei is represented as the darkest area in the image. All the subsequent steps will work on the gray scaled image. Two copies of the gray scale images are made on which image enhancement is than performed.

On first image copy intensity values are adjust with a linear contrast stretching representing this image as (C) and on the second copy histogram equalization is performed result obtained by this is referred as (E).

Now arithmetic operations are performed on the enhanced image. Contrast stretched image is than added with histogram equalized image giving resultant image (D) which brightens most of the details in the image except the nucleus.

$$D = C + E \quad (1)$$

The histogram equalized image (E) is than subtracted from the resultant image D forming next resultant image D1 which highlights nucleus of WBC.

$$D1 = D - E \quad (2)$$

The last arithmetic steps involves addition of two images D and D1 which retains the nucleus of WBC with minimum effect of distortion on it and remove other blood component which is not of interest.

$$D2 = D + D1 \quad (3)$$

Then minimum filter is applied three times to the image D1 this increase the intensity values making the nucleus part darker for easy detection.

Then Thresholding technique such as Otsu's method is applied to convert into binary image. Next the binary image is complemented. Then apply morphological opening to remove false objects.

By applying area test remaining false objects are removed. Later eliminate all the area less than 1200 pixels, the value were chosen by trials which gave best accuracy of segmentation.

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Final step is nucleus masking for verification to locate nucleus in WBC and to check if segmented nucleus was correctly obtained from the location.

Proposed result:

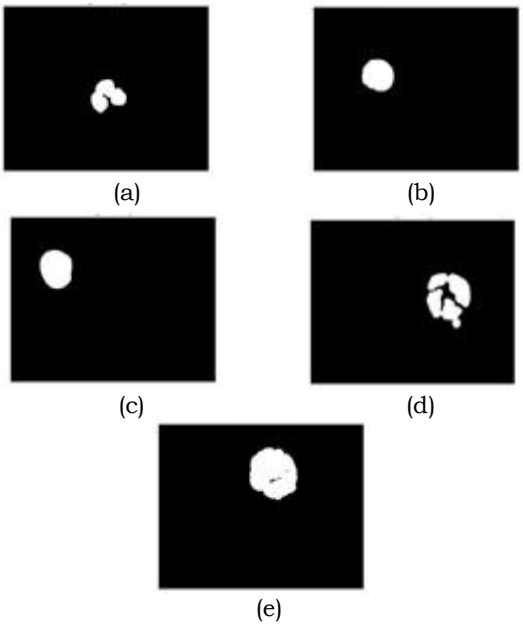

Figure 2: Segmentation Images
(a)Neutrophil (b) Lymphocyte (c) Monocyte (d) Eosinophil (e) Basophil

IV RESULTS & DISCUSSIONS

This paper shows how WBC nucleus is segmented using combination of operations and retains only the required nucleus of WBC. Use of minimum filter thrice improves the segmentation result.

Superimposing resulted nucleus on the original image helps in result verification. This algorithm has been applied to five types of WBC with successful isolation of WBC nucleus part from other blood components in an image. Total number of images tested is 594.

Table 1: shows the accuracy result for each type of WBC using the proposed algorithm. The accuracy for proposed algorithm for each type of cell is given below.

WBC Type	Monocyte	Basophile	Lymphocyte	Eosinophil	Neutrophil
Total Number images of WBC	39	11	206	23	315
Number Correctly segmented WBC	38	10	197	22	312
Percentage	97.43%	90.90%	95.63%	95.65%	99.04%
Overall Segmentation accuracy	95.73%				

V CONCLUSIONS

A simple and efficient way of segmentation is to retrieve the desired components, WBC. The segmentation is the key step in the success of feature extraction and classification process of WBCs from the microscopic images of peripheral blood smear. The proposed algorithm shows better segmentation and average segmentation accuracy of 95.73%. Our future work will be to extract features and classification of different type of white blood cell in the blood smear.

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