Volume 4, Issue 10, October 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

An Absolute Eosinophil Count Test Using Digital Image Processing

Thair A. Salih
Computer Engineering Department,
Technical College/ Mosul, Iraq

Ibrahim M. Younus
M. Tech Student, Computer Engineering Department,
Technical College/ Mosul, Iraq

Abstract— In the last decade, the researches that based on computer in medical diagnostic became very common field. One of these tests which base on medical diagnostic is an absolute Eosinophil count, which is a blood smear test to count the number of leukocytes or White Blood Cells (WBCs) called Eosinophils. This paper aimed to present the medical diagnostic system has the ability to segment the WBC and count the number of Eosinophil cells depending on mathematical, logical, morphological operations and median filter. Several Experiments on creative database are implemented using MATLAB R2011a environment to evaluate the performance of the system and the results reach to 95%.

Keywords— absolute Eosinophil count, allergic diseases, infections, logical operation, median filter, morphological operation

I. INTRODUCTION

White blood cells (WBC) or leukocytes have important role in the diagnosis of special diseases, so that, extracting information about that is precious for haematologists [1]. The recognition and counting of white blood cells is of great value for the diagnosis of different diseases, the indications for treatment [2]. White blood cells consist of five types (with normal percentage of each type in normal blood): Monocyte (from 3% to 9%), Lymphocyte (from 25% to 35%), Basophil (less than 1%), Eosinophil (less than 5%), and Neutrophil (from 40 to 75%) [3]. A last three types have a multi-lobed nucleus. These are differentiated depending on size and the colour of the nucleus, the colour of the cytoplasm [4]. In usual procedure, the glass slides that contain the blood samples are dipped into Lisman solution before insertion it under the lens of microscope [4]. Lisman solution caused Eosinophils appear as orange-red granules.

The digital image processing techniques can be used to present the help to count the blood cells in the human body and, at the same time, give information about the cells morphology [5]. As well as to segment and identify Eosinophil cells, These techniques need only one image and it is therefore cheaper, but at the same time more careful to provide more accurate standards [5]. The detection of Eosinophil cells is done based on its cytoplasm that has Eosinophilic granules. The Eosinophilic granules are a conspicuous reddish orange [6].

The main object of this work is to design cheaper device which can identifying and counting Eosinophil cells in a given smear blood sample efficiently and perfectly.

The paper rest is organized as follows: section two describes the System Architecture that contained the levels of an Absolute Eosinophil Count Test; in section three the experimental and final results of this test are presents and section four describes the conclusion of this work beside the discussions of the future of this work.

II. SYSTEM ARCHITECTURE

This system consists of four levels to produce the required results that provide the proper information to support the medical diagnostic. In the first level collecting images responsible for provide required blood images that used in the test. One of this images that contain two Eosinophil cells is shown in Fig. 1.

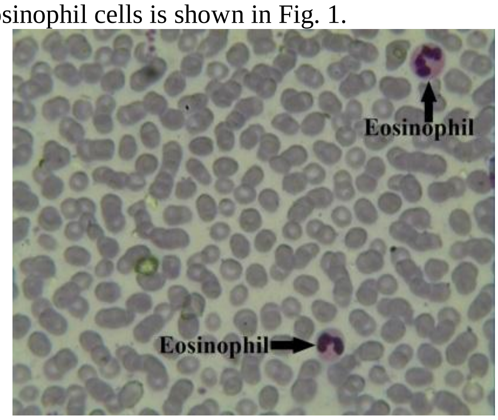

Fig. 1 Eosinophil cell

In the second level WBC segmentation, the captured images are processed by used special algorithm for digital image processing. Then Eosinophil Cells Identification and Counting Eosinophil Cells third and fourth level respectively are used to identifying and counting Eosinophil cells based on its special feature that different from other White Blood Cell types. The system architecture of an absolute Eosinophil count test is shown in Fig. 2.

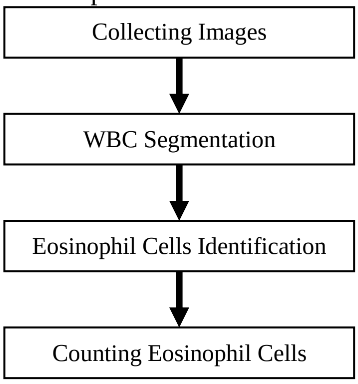

Fig. 2 System Architecture

A. Collecting Images

Collecting images is the first level of this system that in charge of capturing a set of blood images that is taken by special Microscope and save the images in a data base. The sample of blood is taken from the patient's blood, and then placed over class slide after that, the blood images are got by a CCD camera which is mounted upon the microscope and connected to computer then storing each image in the computer’s hard disk, flash memory, or CD/DVD – Disk .as shown in Fig. 3.

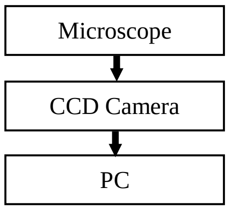

Fig. 3 Collecting Images Architecture

B. WBC Segmentation

The goal of WBC segmentation is to separate leucocytes WBC in each blood image from the other components (other White Blood Cells, Red Blood Cells, Platelets, and background).The WBC segmentation process is executed by using special image processing algorithm as shown in Fig. 4.

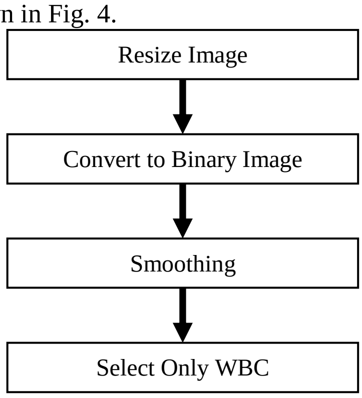

Fig. 4 Block diagram of WBC segmentation algorithm

1) Resize Image: To unify the size of the images that obtained from Collecting Images level bi-cubic interpolation algorithm is can be use, because these images have different sizes according to the dimensions of captured images. Bi-cubic interpolation for interpolating data points on a two dimensional regular grid. In this algorithm the nearest 4 x 4 block of input pixels is used to calculate each output pixel value. The weighting factors of the input pixels average are calculated using a cubic (third-order) function of distance. The weighting coefficients of bi-cubic interpolation are specified by equation (2-1):

$$\boldsymbol{h}_{\boldsymbol{Bicubic}}(\boldsymbol{s}) = \begin{cases} 1 - 2|s|^2 + |s|^3 & , \quad 0 \le |s| < 1 \\ 4 - 8|s| + 5|s|^2 - |s|^3 & , \quad 1 \le |s| < 2 \\ 0 & , \quad 2 \le |s| \end{cases} \tag{2-1}$$

Equation (1) indicates that Bi-cubic convolution interpolation has less computational complexity and the interpolated surfaces that provide by Bi-cubic algorithm is smoother than corresponding surfaces presented by bilinear interpolation or by nearest-neighbour interpolation [7].

2) *Convert to Binary Image:* To simplify the White Blood cells segmentation process the RGB image must convert to binary image because of the colour of WBCs different from the colours of Red Blood Cells (RBCs) and background. The nucleus of WBC is stained with violet colour or blue colour as shown in Fig. 1, so that to segment the WBCs only the converting process must convert only the pixel that have green level small than the desired threshold because the violet colour have small green level (from experimentations the suite threshold is 100). At the first, create zeros array with same size of resized image that produced in privies step (step A), after that must set every pixel in zeros array to 1 when the corresponding pixel in RGB image have green level (0 – 100) else set to 0, then fill all holes in each close shape by using the function (imfill) that fills holes in the binary image as shown in Fig. 5.

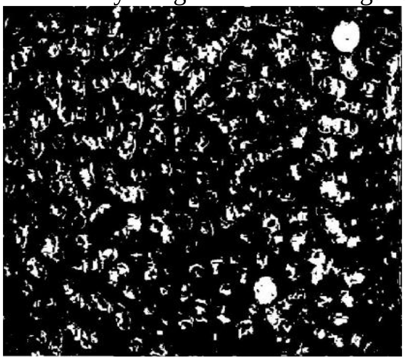

Fig. 5 Binary image

3) *Smoothing:* In order to reduce noise and save edges of the objects from the distortion a median filter that is more efficient than convolution is used. It is a non-linear smoothing scheme that used to decrease the edges blur, the idea is to change the current pixel in the image with the median of the intensity in neighbourhood pixel.

Median filter is a bester filtering technique depending on performance and required less computational time [8]. During the process operations of median filtering, each pixel in image is replaced by the median of the pixels values contained in a window around it. The equation of median filtering can be expressed as following equation [9].

$$\mathrm{IM}(\mathrm{m},\mathrm{n}) = Median[x(m-k, n-1)\ \epsilon\ w] \tag{2-2}$$

Where w representing the window around the pixels m, n. This method is used to smoothing process of binary image as shown in Fig. 6.

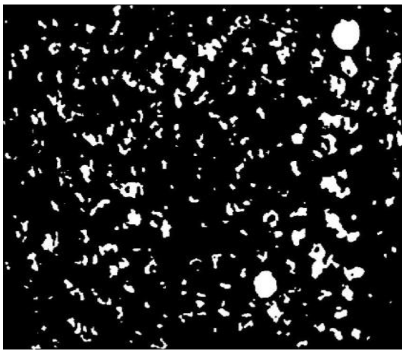

Fig. 6 Smoothed image

4) *Select Only WBC:* To counting the number of objects in smoothed image Fig. 6 the automatically labels objects method is used [L , NUM]=bwlabel (B , n); Here the function, Bwlabel, labels objects in smoothed image and return a matrix L, of the same size as smoothed image, containing labels for the connected objects in smoothed image. The objects in smoothed image are unequal forms for this reason the number of connected objects (n variable) is selected as 8 which mean that any 8-connected object in smoothed image Fig. 6 will be counted. Moreover, the rows and columns for each object must be calculated and the function [r , c]=find(L==k) is used to give the rows and columns for each object in labels matrix (L) that equal K (from 1 to NUM) .to select the WBC and segmented it from other object, the Selection of suitable colour space is not only the source of efficient image segmentation but too associated to the many algorithms and methods used , one of these methods is the HSI colour space, which calculated form RGB colour space. The resized RGB image must converted to HSI image Fig. 7. The transformation computed is [10]:

$$\mathrm{H} = \begin{cases} \theta, & \mathrm{B} \leq \mathrm{G} \\ 2\pi - \theta, & B > G \end{cases} \tag{2-3}$$

Where

$$\boldsymbol{\theta} = \mathbf{arccos}\frac{\frac{1}{2}[(R-G)+(R-B)]}{[(\mathrm{R-G})^2+(\mathrm{R-B})(\mathrm{G-B})]^{1/2}} \tag{2-4}$$

Then we have the S and I components:

$$\mathbf{S} = 1 - \frac{3}{(\mathrm{R+G+B})}[\min(\mathrm{R},\mathrm{G},\mathrm{B})] \tag{2-5}$$

$$\mathbf{I} = \frac{1}{3}(\mathrm{R}+\mathrm{G}+\mathrm{B}) \tag{2-6}$$

The WBC have higher Hue level than other object as well as WBC's nucleus have green level (0-100 from experimentations), the Hue level as well as green level are used to calculate number of pixels in each object of smoothed image that have green level (0-100 from experimentations) and hue level (0.5 – 1 from experimentations) .if the number was more than 50 pixel (threshold from experimentations) then this object is WBC such as one of two cells shown the Fig. 8.

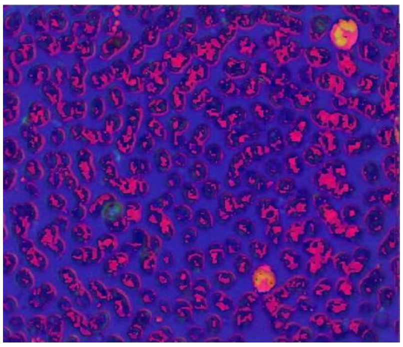

Fig. 7 RGB to HIS converting image

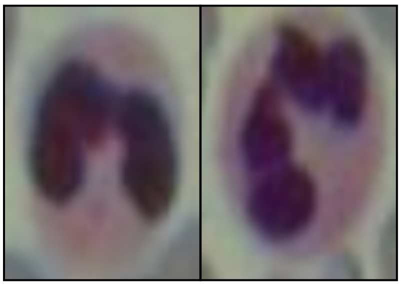

Fig. 8 Two WBCs Image

C. Eosinophil Cells Identification

The main different between the Eosinophil cells and the other types of WBCs is only the cytoplasm of Eosinophil cell have orange-red granules, so that the identification of Eosinophil cell implemented by calculate higher number of pixel in each WBC that its pixels have Red level more than Blue level is considered as Eosinophil cell. If the number of pixels was more than 100 pixels (as threshold from experimentations) then the WBC type is Eosinophil.

D. Counting Eosinophil Cells

The last step of the system is the process of counting the number of Eosinophil cells, and then determined the percentage of Eosinophil cells in 100 WBCs.

The percentage of Eosinophil cells in 100 WBCs is 4% (normal results), while abnormal results caused by one of two reasons:

1) First reason: A high number of Eosinophil cells (Eosinophilia), many diseases are associated with Eosinophilia, including parasitic infestation with tissue-invasive organisms, allergic states (bronchial asthma, allergic rhinitis, pulmonary aspergillosis), vasculatures, various collagen vascular diseases, and paraneoplastic conditions[6].

2) Second reason: A lower Eosinophil count may be due to:

- Alcohol intoxication.
- Excessive production of steroids that created naturally in the body (for example cortisol).

III. THE EXPERIMENTAL AND FINAL RESULTS

The produced method was tested around 85 blood smear slide images that collected from Mosul General Hospital (Ibn Sina..Avicena) and adopted it as a database for this search. These blood images are acquired by special microscope from stained peripheral blood using CCD Camera with magnification of 100. The resolution of the captured image images is 1280*1024 pixels then unify to one resolution. In this work 85 images of blood are tested; the experimental test results evaluated using the manual test results as shown in Table 1.

Table I: similarity measures for the manual test and image processing test

Type of Test	Manual Test	Image Processing Test
No. of Images	85	85
Number of Blood Cells	100	100
No. of Nonidentifying Eosinophils	---	1
No. of Identifying Eosinophils	21	20
Percentage of Proper Identifying	100%	95.23%

In previous table the number of identifying Eosinophil cells was 20 and only one Eosonophil cell was nonidentifying cell from 100 WBCs, therefore the Eosinophils percentage is 20% to 21 % and this percentage is more than normal results (4%).

IV. CONCLUSIONS

One novel method for segmentation WBC in addition to identification and counting of Eosinophil cells is suggested in this paper. Special digital image processing algorithm is present for segmentation by using Bi-cubic interpolation technique to resize blood images to 512*512 resolution, as well as RGB and HIS colour space that are used to segment WBC from other blood component. Median filter used to smooth the binary image and removed small object. Also digital image processing provides the help to identifying and counting Eosonophils based on cytoplasm colour of these cells. This medical system is simple to install and apply, therefore the people of remote areas or villages can be installed this system with very necessary level of education. It can decrease the probability of incorrect identification in contrast to manual test. Also the cost of this system is less than other auto recognizer such as automatic blood cell counter (BL500) etc... . The future of this system can be modified to identify other WBCs types, detection Bactria and Semen analysis.

REFERENCES

[1] F. Sadeghian, Z. Seman, A. Ramli, B. H. Abdul Kahar, and MI. Saripan, "A Framework for White Blood Cell Segmentation in Microscopic Blood Images Using Digital Image Processing", *Biological Procedures Online*, vol. 11, no. 1, pp. 196-206, Dec. 2009.

[2] C. Ke, "White blood cell detection using a novel fuzzy Morphological shared-weight Neural Network", ISCSC , IEEE Computer Society, vol. 2, pp. 532-535 , Dec. 2008.

[3] M. Habibzadeh, A. Krzy˙zak, and T. Fevens ,"Comparative study of shape, intensity and texture features and support vector machine for white blood cell classification", Journal of Theoretical and Applied Computer Science, vol. 7,no. 1, pp. 20–35, 2013.

[4] P. Ghosh, D. Bhattacharjee, M. Nasipuri, and D. K. Basu, "Automatic White Blood Cell Measuring Aid for Medical Diagnosis", IEEE, pp. 1-6, July 2011.

[5] L. Putzu, C. Di Ruberto, "White Blood Cells Identification and Classification from Leukemic Blood Image", *International Work-Conference on Bioinformatics and Biomedical Engineering (IWBBIO)*; SPAIN, Ed. COPICENTRO EDITORIAL, pp. 99-106, 18 march 2013.

[6] R. Hoffman et al.; *Hematology: Basic Principles and Practice*, 3rd ed., 2000.

[7] T. A. Salh, and M. Z. Nayef," Improvement of Face Recognition System Based on Linear Discrimination Analysis and Support Vector Machine", University of Technology; Iraq ,Engineering & Technology Journal , **vol.** 31, no. 12 , pp. 2261-2272 , 2013.

[8] E. Chandra , and K. Kanagalakshmi, "Performance Evaluation of Filters in Noise Removal of Fingerprint Image ", *3rd International Conference on Electronics and Computer Technology(ICECT);* Kanyakumari, IEEE, vol. 1, pp. 117 – 121, 8-10 April 2011.

[9] E. Chandra , and K. Kanagalakshmi, "Noise Suppression Scheme using Median Filter in Gray and Binary Images", International Journal of Computer Applications, vol. 26, no. 49, Jul. 2011.

[10] Z. Ju, J. C h e n , J. Zhou ," Image Segmentation Based on The HSI Color Space and An Improved Mean Shift ", *International Conference on Information and Communications Technologies (IETICT 2013); Beijing*, IET, pp. 135-140, 27-29 April 2013.