Journal of Applied Biological Sciences 9 (3): 18-20, 2015
ISSN: 1307-1130, E-ISSN: 2146-0108, www.nobel.gen.tr

A New Blood Cell Recognition Algorithm Based On Directed Vector Method

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Received: August 22, 2015
Accepted: September 30, 2015

Abstract
Nowadays, various methods are used to automatic count and recognize the blood cells in microscopic images. In detection and diagnosis of illnesses, the number of cells in the blood and determination of types of these cells is very important topics. 5 types of white blood cells, a red blood cell and platelet cell are located in human blood. In this paper, a new algorithm based on directed vector method is presented for blood cells recognition in images. In the pre-processing step of this algorithm, some image processing operators are used such as noise removal, thresholding and edge extraction methods. In feature extraction step, 8-way vector chain code and statistical characteristics are used. In classifier step, multilayer perception (MLP) artificial neural network (ANN) is used. The obtained results are satisfactory.
Keywords: Automatic Blood Cell Counting, Multilayer Perception (MLP) Artificial Neural Network (ANN), Directed Vector Method.

INTRODUCTION

Pattern recognition is a scientific area of research that examines the process and the design of systems to identify patterns in the data. Recognition system has emerged as a great challenge for computer vision. The longer term aim is to enable it to achieve near human level recognition for large number of categories under wide variety of conditions [1].

Blood cells are divided two basic group and these are Red blood cells (RBC) and White blood cells (WBC). The blood cells counting, detecting and recognition are very important topics for human and animal health. People who are working in hematology field are interested blood cell recognition and counting. Blood cells recognition and counting are used to diagnosis. To the most known and recognized cells belong: monoblasts, promonocytes, monocytes, myeloblasts, promyelocytes, myelocyte, metamyelocytes, proerythroblasts, basophilic erythroblast, polychromatic erythroblast, pyknotic erythroblast [2,3].

These cells have different size, texture, shape, density and color. These different blood cells are given in Fig. 1.

The image processing techniques have been used for blood cell counting and recognition in the literature. Shape is one of the most important image features due to the fact that shape can effect human perception. Shape features has been extensively applied in RBC recognition to distinguish between normal cells and infected cells [4]. For infected cells, there are also many different shapes, four of which are; Sickle, Echnocyte, Teardrop and Ellipse which relate to four different types of anemia. Many shape representations and retrieval methods exist.

However, most of those methods either do not well represent shape or are difficult to be normalized (making matching hard to do). Fourier descriptors (FD) based method is the one of the best methods for blood cell recognition. It achieved both representation and normalization well [5].

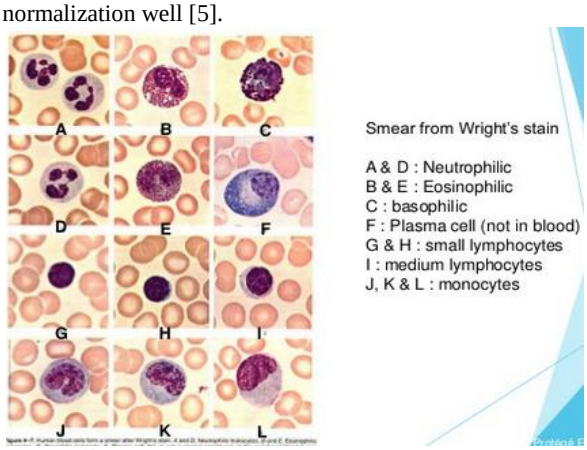

Fig.1. Different type of blood cells images.

Texture analysis is one of the widely used techniques for blood cells recognition. They used texture analysis for feature extraction and they used machine learning algorithms for classification [6].

In this paper we used vector chaining for feature extraction and ANN (Artificial Neural Network) in classification [7-10]. This paper organization is given in below. Proposed method is offered in section 2, experimental results section is presented in section 3 and conclusion is introduced in section 4.

THE PROPOSED METHOD

In this paper, we used chaining coding for blood cells recognition. This method is contour based method. We used noise reduction with median filter. Then, one of the edge detection algorithms is used. Canny edge detection algorithm is used in this study. In feature extraction phase, the proposed method is used chaining coding. In the last step, we used ANN classifier.

Block diagram of the proposed method is given in Fig.2.

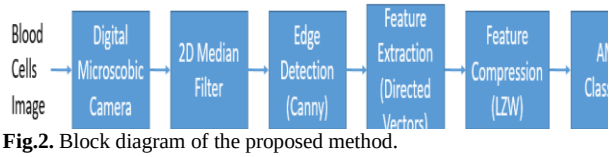

Fig.2. Block diagram of the proposed method.

Steps of the proposed method are given in below.

Step 1: Obtain color blood cell image.

Step 2: Green layer of blood cells images is obtained. Because, this layer is the most appropriate layer of color blood cells image.

Step 3: Apply median filter to green layer of blood cells image.

Step 4: Apply canny edge detector.

Step 5: Apply directed vector coding for feature extraction. Examples of directed vectors are given in Fig.3.

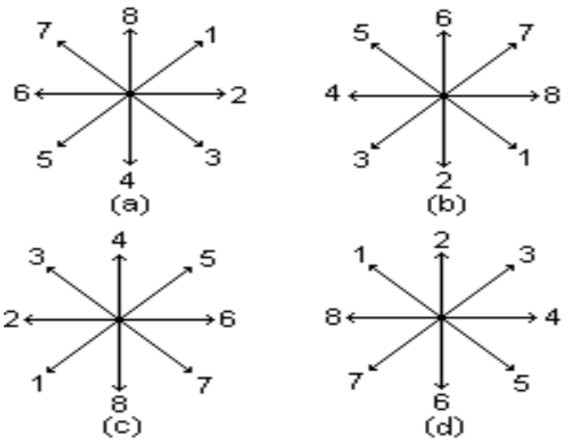

Fig.3. Directed vectors [11].

Step 6: Apply LZW coding for feature reduction.

Step 7: After LZW coding for feature reduction, mean, standard deviation, local homogeneity, cluster shade features are calculated from these reduced features.

The equations of these features can be given as below:

$$\text{mean} = \frac{1}{N^2}\sum_{i,j=1}^{N} t(i,j) \qquad (1)$$

$$\text{standard deviation (sd)} = \sqrt{\frac{1}{N^2}\sum_{i,j=1}^{N}[t(i,j)-mean]^2} \qquad (2)$$

where *t(i,j)* is the transformed value in *(i,j)* for any sub-band (one of L-Li, L-Hi, H-Li, and H Hi) of size *N x N* [11].

$$\text{local homogeneity} = \sum_{i,j=1}^{N}\frac{1}{1+(i-j)^2}Co(i,j) \qquad (3)$$

$$\text{cluster shade} = \sum_{i,j=1}^{N}(i-Px+j-Py)^3 Co(i,j) \qquad (4)$$

Here, *Co(i,j)* is covariance of *(i,j)* image and

$$Px = \sum_{i,j=1}^{N} iCo(i,j) \quad \text{and} \quad Py = \sum_{i,j=1}^{N} jCo(i,j)$$

.

Step 8: Apply NN classifier for determine type of blood cell.

Example of the proposed method is given in Fig.4.

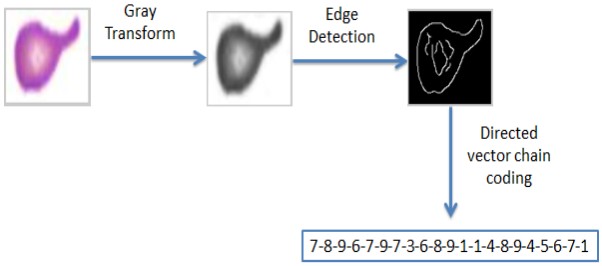

Fig. 4. Example of proposed method.

EXPERIMENTAL RESULTS

In these experimental studies, 120 numbers blood cell images, which have 512 x 512 size and include 7 types of blood cells, were used for data set. This data set was obtained from the Microbiology Laboratory of Firat University Medicine Faculty. The blood cell images contain 7 types of blood cells. These are erythrocytes, leukocytes (eosinophil, basophil, monocyte, lymphocyte, neutrophil) and platelets. Total 840 (120 for each of these 7 types of blood cells) samples were used for these experimental studies. In feature extraction step, After LZW coding for feature reduction, mean, standard deviation, local homogeneity, cluster shade features are calculated from these reduced features. The equations of these features can be ordered in Eqs.(1-4).

The ANN structure and training parameters used in this study are shown in Table 1.

Classifier performance of the proposed method is shown in Table 2.

RESULTS

In this paper, a new algorithm based on directed vector method is presented for blood cells recognition in images. In the pre-processing step of this algorithm, some image processing operators are used such as noise removal, thresholding and edge extraction methods. In feature extraction step, 8-way vector chain code and statistical characteristics are used. In classifier step, multilayer perception (MLP) artificial neural network (ANN) is used. The obtained results are satisfactory. The average performance of the developed method was obtained as 95.99%.

Table 1. Training parameters and the ANN structure used in this study

The number of layer	: 3
The number of neurons in layers	: Input: 4 : Output: 1 : Hidden: 10
Initial weights and deviations	: Nguyen - Widrow method
Activation functions	: Logarithmic sigmoid
Learning rules	: back propagation
Adaptive learning rate	: Initial value: 0.0001 : Increase: 1.05 : Decrease: 0.7
Momentum constant	: 0.98
Sum-squared error	: 1×10^{-8}

Table 2. Correct recognition performance results of proposed directed vector method for different blood cell types.

Blood Cell Type	Accuracy Rate
Erythrocyte	97.50
Neutrophils	98.33
Eosinophils	96.50
Basophils	94.33
Monocytes	93.83
Lymphocyte	95.78
Platelet	95.66
Mean Correct Recognition Rate	95.99

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