Neural Network Classification of Blood Cell Images using Multiperceptron back Propagation

Saylee Deshmukh[1], Gayatri Bhokar[2] ,Sonali Jadhav[3], Gayatri Sadare[4] and Swaranjali Raskar[5]

Abstract- With the technological advancement in the medical field, the need for faster and more accurate analysis tools becomes essential. In this work, the image recognition problem of blood cell is investigated. Two types of white blood cells are classified into granular and non-granular cells using a feed forward back propagation neural network which is further classified. After segmentation, blood cells are obtained from microscopic images, the most 16 significant features of these cells are given as inputs to the neural network.

Keyword- Neural Networks, Image analysis, feature extraction, white blood cell, segmentation

I. INTRODUCTION

The fields of hematology and infectious diseases, classifying different kinds of blood cells can be /used as a tool in diagnosis. By counting certain cells' of relative frequencies and comparing to what is normal, we can conclude about the possible blood diseases. Blood consists of several elements which are white blood cell (WBC), red blood cell (RBCs), platelets, and plasma. The quantity of blood cells plays the important role to ensure the healthiness of a person.

Human blood contains five major types of WBC or what is referred to as leukocytes. The White Blood Cells types, which are depicted in Fig 1, together with their typical relative frequencies are *neutrophils*, *basophils*, *eosinophils*, monocytes, and *lymphocytes*. In a human adult, the normal average number of WBC is about 7000/micro liter, which forms about 1% of the total blood cell in the body. The increase in the number of WBC in the body is referred to as leukocytosis, while the decrease in the number of WBC is called leucopenia, but leukocytosis is most likely to occur as compared with leucopenia [1]. Due to the different morphological features manual classification of such cells is a cumbersome process of the white blood cells, which is time-consuming and susceptible to human error as it is mostly related to the hematologists' experience. This fact actually emphasizes a crucial need for a fast and automated method for identifying the different blood cells. Implementation techniques of automated differential blood cells counting systems are of two kinds [2] One technique is based on the flow cytometer, while the other is based on image processing.

In this work, we have adopted processing of microscopic images of blood cells using neural networks as an efficient decision maker for proper white blood cell type recognition. Neural networks have powerful features in analyzing complex data, and among the wide and variant application areas of neural networks are the system identification and control, image recognition and decision making, speech and pattern recognition as well as financial applications. Artificial neural networks have also been successfully used in medical applications to diagnose.

In this work, the multilayer perceptron back-propagation MLP-BP neural network is used to classify the most known five types of WBC which have been segmented from blood smear microscopic images with the use of most distinguishing features. The adopted algorithmic comprises three stages. The first stage is image segmentation, the second stage is labeling that returns the number and location of each WBC, and the third stage is extracting descriptive features measured from the segmented cells.

II. EXISTING SYSTEM

Based on the significance of blood cell classification in the diagnosis, researchers have proposed many algorithms to classify blood cells. In 2003, Sinha and Ramakrishna classified cells using SVM with a recognition rate of 94.1%. In 2006, Yampri*et al*. [2] used 100 images to perform the same experiments. They implemented the automatic threshold and adaptive contour to segment cells and used the smallest error method to classify them, and the recognition rate was 96% [2]. Yampri*et al*. [2] utilized the KNN algorithm. However, the KNN algorithm does not handle unbalanced samples well. If the sample capacity of a class is large, while the sample capacity of other classes is small, some Issues arise**.**

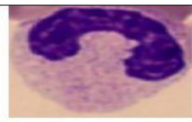
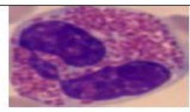
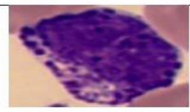
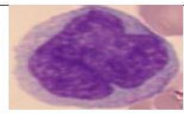
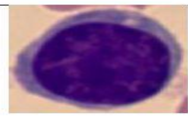
Cell Type	Relative Frequencies	Microscopic Image
NEUTROPHIL	(50-70)%	
EOSINOPHIL	(1-5)%	
BASOPHIL	(0-1)%	
MONOCYTE	(2-10)%	
LYMPHOCYTE	(20-45)%	

Fig.1: WBC types

A. DISADVANTAGES OF EXISTING SYSTEM

Linear vector quantization (LVQ) and k-nearest Classifier which produced 83.33%and 80.76% of Accuracy, respectively. Which is very less compared to neural networks.

III. PROPOSED SYSTEM

A. PRE-PROCESSING AND SEGMENTATION

The algorithm includes three main steps which are segmentation, labeling, and feature extraction, are illustrated in Figure 2. The next image processing step is the White Blood Cells subtype recognition which will be achieved with the help of neural networks.

Steps for segmentation as follows:-

Step 1: Read the color blood slide image to the system
Step 2: Convert the color image into a grayscale image.
Step 3: Enhance the contrast of the grayscale image by Histogram equalization (result A).
Step 4: To adjust image intensity level apply linear contrast stretching to a grayscale image (result B).
Step 5: Obtain the image I1=result A+ result B to brighten all other image components except cell nucleus.
Step 6: Obtain the image I2=I1- result A to highlight the entire image objects along with the cell nucleus.
Step 7: Obtain the image I3=I1+I2 to remove all other Components of blood with minimum effect of distortion over nucleus.
Step 8: To reduce noise, preserve edges and increase the darkness of the nuclei implement the 3-by-3 minimum filter on the image I3.
Step 9: Apply a global threshold Otsu's method on image I3.
Step 10: Using the threshold value in the above step convert I3 to a binary image.
Step 11: To remove small pixel groups use morphological opening.
Step 12: To form objects connect the neighboring pixels.
Step 13: By applying the size test removal of all objects

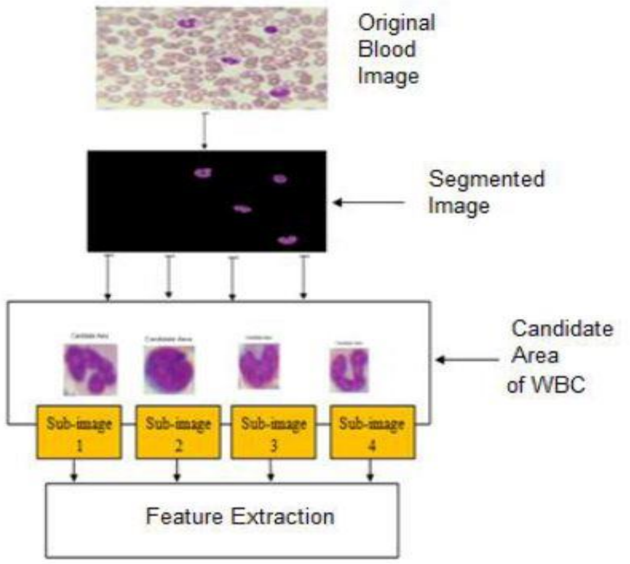


Fig.2: Pre-Processing and Segmentation

B. FEATURE EXTRACTION OF WBC

The choice of features immensely affects the classifier performance. For the robust classification, efficient judgment and better comparison the features must characterize each WBC subtype and must be independent of each other. Indeed, an extensive work has been focused on determining different features that crucially distinguishes each type or groups of types of WBC. These features can be classified into shape features, intensity features, and texture features.

C. Shape Feature

There are many techniques for shape description and recognition. These techniques can be broadly categorized into two types: (1) boundary-based and (2) region-based. The most successful representations for these two categories are Fourier descriptor and moment invariants where moment invariants are for the usage of region-based moments, which are invariant to transformations as the shape feature.

D. Intensity Feature

The features are only based on the absolute values of the intensity measurements in the microscopic image. A histogram describes the occurrence of relative frequency depicting the intensity values of the pixels in an image. The intensity features which will be considered are the first four central moments of this histogram which are mean, standard deviation, skewness, and kurtosis.

E. Neural Network Classification

The features that are considered significant to represent an image of WBC are extracted and accumulated in the vector, which we refer to as the features vector. The features vector is then converted into a set of classes using neural networks as a technique to solve a WBC classification problem. This technique adopts a learning algorithm to identify a model that best fits the relationship between the feature set and class label of the input data. Therefore, a key objective of the learning algorithm is to build a predictive model that accurately predict the class labels of previously unknown records.

The feed-forward back propagation neural network, which is the very popular model in biological and biomedical applications, is used in our work. This type of neural network configuration does not have feedback connections, but errors are propagated back during training using least mean squared error. The back propagation neural network is a multi-layer, feed-forward supervised learning, which requires pairs of input and target vectors.

EQUATIONS

$$\mu_i = \frac{1}{N}\sum_{j=1}^{N} p_{ij}$$

Sayalee Deshmukh Computer, India Email-

sayaleedeshmukh@gmail.com, **Gayatri Bhorkar** Computer, India Email-gayatribhorkar@gmail.com, **Sonali Jadhav** Computer, India Email-sonalijadha7172@gmail.com, **Gayatri Sadare** Computer, India Email-sadaregayatri@gmail.com, **Swaranjali Raskar** Computer, India Email-swaranjali.amcid@gmail.com

IV.FIGURES AND TABLES

These normal ranges can vary by lab. Another common measurement for the volume of blood is cubic millimeter, or mm3. A microliter and cubic millimeter equal the same amount.

The types of cells that make up WBCs usually fall within a normal percentage of your overall WBC count.

Age range	WBC count (per mcL of blood)
newborns	9,000 to 30,000
children under 2	6,200 to 17,000
children over 2 and adults	5,000 to 10,000

The normal percentages of the types of WBCs in your overall count are usually in these ranges, according to the Leukemia & Lymphoma Society (LLS):

Type of WBC	Normal percentage of overall WBC count
neutrophil	55 to 73 percent
lymphocyte	20 to 40 percent
eosinophil	1 to 4 percent
monocyte	2 to 8 percent
basophil	0.5 to 1 percent

Higher or lower numbers of WBCs than normal can be a sign of an underlying condition. Having a higher or lower percentage of a certain type of WBC can also be a sign of an underlying condition. where the ith color channel is defined at the jth image pixel as pij and N is the number of pixels in the image.

This equation is utilized in intensity feature extraction

V. CITATIONS

[1] M. Z. Othman,., and Ali, Alaa, B.," Segmentation and Feature Extraction of Lymphocytes WBC using Microscopic Images", International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181, Vol. 3 Issue 12, December-2014.

This paper presents a proposition for an algorithmic procedure to isolate and count the lymphocytes White Blood Cell (WBC) form microscopic Images. The process involves segmentation of cells, scanning algorithm, feature extraction, and recognition of lymphocyte cells. The scanning algorithm returns the number and location of the candidate area in WBC images.

[2] O. Suhail, Manal, K.," Apply Multi-Layer Perceptrons Neural Network for Off-line signature verification and recognition". International Journal of Computer Science.Vol. 8, Issue 6. Bethlehem.

This paper discusses the new approach of the applying of Multi-layer perceptrons for signature verification and recognition which enables the user to recognize whether a signature is original or a fraud. In this approach, we scan the images into the computer, then modifying their quality through image enhancement and noise reduction, followed by feature extraction and neural network training, and finally verifies the authenticity of the signature. It shows the different stages of the process including image pre-processing, feature extraction and pattern recognition through neural networks

[3] S. Mu-Chun, Chun-Yen Cheng, and Pa-Chun Wang, “A Neural-Network-Based Approach to White Blood Cell Classification”, The Scientific World Journal, Volume 2014, Article ID 796371, 9 pages.

This paper represents a new white blood cell classification system for the recognition of five types of white blood cells. We propose a new segmentation algorithm for the segmentation of white blood cells from smear images. The core idea of the proposed segmentation algorithm is to find a discriminating region of white blood cells on the HSI color space. Pixels with color lying in the discriminating region described by an ellipsoidal region will be regarded as the nucleus and granule of the cytoplasm of a white blood cell. Then, through a further morphological process, we can segment a white blood cell from a smear imageSimulation results showed that the proposed white blood cell classification system was very competitive to some existing systems.

[4] S. Rashmi, and S. Mandar, ” Textural Feature-Based Image Classification Using Artificial Neural Network”, Advances in Computing, Communication, and Control. Communications in Computer and Information Science, vol 125. Springer, 2011.

Textural features can be included for better classification but are inconvenient for conventional methods. Artificial neural networks can handle non-convex decisions. The uses of textural features help to resolve misclassification. This paper describes the design and development of a hierarchical network by incorporating textural features. The effect of inclusion of textual features on classification is also studied

[5] A. Abdul Nasir, Mashor M.Y., and Hassan R.," Classification of Acute Leukemia Cells using Multilayer Perceptron and Simplified Fuzzy ARTMAP Neural Networks", The International Arab Journal of Information Technology, Vol. 10, No. 4, July 2013.

Leukemia is a cancer of the blood that causes more death than any other cancers among children and young adults under the age of 20. This disease can be cured if it is detected and treated at the early stage. Based on this argument, the requirement for fast analysis of blood cells for leukemia is of paramount importance in the healthcare industry. This paper presents the classification of White Blood Cells (WBC) inside the Acute Lymphoblastic Leukaemia (ALL) and acute myelogenous leukemia blood samples by using the Multilayer Perceptron (MLP) and Simplified Fuzzy ARTMAP (SFAM)neural networks

For a conference paper, refer [3]

For a thesis, refer [4]

For a technical report, refer [5]

For a online source, refer [6]

For a patent, refer [7]

For a magazine article, refer [8]

Blood Cell Classification

HOME

Name	Snehal Desai		
Address:	Pune		
AGE	22		
Telephone:	8756451257		
	9856237845		
WBC LEVELS:		EXPECTED RANGE	ACTUAL RANGE
	EOSINOPHILE	100-300	500
	NEUTROPHILE	2500-7000	6000
	MONOCYTE	200 - 600	350
	LYMPHOCYTE	1700 - 3500	2200
	BASOPHILE	40 - 100	80
Report summary:	Eosinophils levels are in not normal range		
Infection Prediction:	Bacterial infection		

VI. CONCLUSION

A conclusion might elaborate on the importance of the work or suggest applications and extensions. Authors are requested to ensure that best efforts are made to retain the appearance of their manuscripts in the given template. Papers not in accordance with these guide lines and manuscripts with number of mistakes will have to be rejected. The editorial committee may make some limited changes in the manuscript if needed.

VII. ACKNOWLEDGEMENT

The success and final outcome of this project seminar required a lot of guidance and assistance from many people. All that we have done is only due to such supervision and assistance and we would not forget to thank them.

We respect and thank our project guide Prof. S. A. Deshmukh, for providing me us an opportunity to do the project work and giving us all support and guidance which made us work enthusiastically on the project. We are extremely thankful to her for providing such a nice support and guidance, although she had busy schedule managing the college affairs.

We heartily thank our Head of Computer Department, Prof D. D. Pukale Sir for his guidance and suggestions during this project work.

We are thankful to and fortunate enough to get constant encouragement, support and guidance from all Teaching staffs of Computer Department. Also, we would like to extend our sincere esteems to all staff in laboratory for their timely support.

VIII. REFERENCES

[1]. M. Z. Othman,., and Ali, Alaa, B.," Segmentation and Feature Extraction of Lymphocytes WBC using Microscopic Images", International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181, Vol. 3 Issue 12, December-2014.

[2]. O. Suhail, Manal, K.," Apply Multi-Layer Perceptrons Neural Network for Off-line signature verification and recognition".International Journal of Computer Science.Vol. 8, Issue 6. Bethlehem.

[3]. S. Mu-Chun, Chun-Yen Cheng, and Pa-Chun Wang, "A Neural-Network-Based Approach to White Blood Cell Classification", The Scientific World Journal, Volume 2014, Article ID 796371, 9 pages.

[4]. S. Rashmi, and S. Mandar, " Textural Feature-Based Image Classification Using Artificial Neural Network", Advances in Computing, Communication, and Control. Communications in Computer and Information Science, vol 125. Springer, 2011.

[5]. M. Darshana. and Asim, B.," Discrete Wavelet Transform Using Matlab", International Journal of Computer Engineering and Technology, Vol. 4, Issue 2, 2013.

[6]. NSC, "Injury Facts Online. Itasca, Ill.: National Safety Council'. Available at: www.nsc.org. Accessed on 17 December 2001.

[7]. Moulton R. K, "Method for on-site cleaning of contaminant filters in livestock housing facilities. U.S. Patent No. 32455986, 1992.

[8]. Wei Yu, Jing Chang, Cheng Yang "Automatic classification of leukocytes using deep neural network".