Detection of Leukemic Blood Cells from Microscopic Images using Local Gabor Binary Pattern and Neural Network

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***Abstract*: A proper diagnostic test is needed for an accurate and final assessment of the disease. Hematology deals with the study of pathological processes of the blood through biochemical or morphological analysis. Morphological test of the peripheral and bone marrow are subjective to shortcomings like slowness, operator experience, tiredness and observer variations. The biochemical test requires expensive routine examination like immunophenotyping and molecular probing. Therefore, a microscopic image analysis is needed for an impressive automated diagnostic for the hematological disorders like malaria, AIDS, psoriasis ad leukemia. Leukemia is a blood cancer which needs to be diagnosed early so that it can be cured faster. This paper specifies the segmentation of leukemic cell using K-means clustering and extracting features based on color and uniform Local-Gabor Binary pattern and then classified using the Levenberg-Marquardt neural network.**

Keywords: Leukemia, K-mean clustering, Neural Network

I. INTRODUCTION

The major diseases in human body are due the disorders in blood. Blood is the most important part of human body, which is a fluid that circulates through the lymphatic system of the body around the heart and blood vessels. The blood consists of White Blood Cells (WBCs), Red Blood Cells (RBCs) and Platelets.

Leukemia is a blood cancer that begins in bone marrow due to the increase in the number of immature WBCs which are called “blast cells”. The four main types of leukemia [1] are:

- Acute Lymphocytic Leukemia(ALL)
- Acute Myeloblastic Leukemia(AML)
- Chronic Lymphocytic Leukemia(CLL)
- Chronic Myeloblastic Leukemia(CML)

They are named according to the type of cells affected (a lymphoid cell or a myeloid cell) and the disease begins with a mature or immature cell. Acute Leukemia is fast-growing and Chronic Leukemia is slow-growing. Microscopic images of stained blood smear are the most widely used for diagnosing leukemia. Accurate detection ad classification of leukemia using image processing techniques is very challenging. It depends on texture, color, size and shape of WBCs image.

The details of the proposed paper are Section 2, includes materials and methods. In Section 3, the literature review. In Section 4, a short description of K-means clustering. In Section 5, working of neural networks. In Section 6, the different feature extractions are listed. In Section 7, proposed methodology explained. In Section 8, results. In Section 9, the results.

II. MATERIALS AND METHODS

A. Datasets

The sources of microscopic images are from ALL-IDB database which consists of ALL-IDB1 having 108 blood images and ALL-IDB2 of 260 blood images in which 130 images are cancerous and 130 images are normal. All images are in .jpg format of size 257x257.[2]

B.Preprocessing

A microscopic blood image provides information about abnormal and normal blood cells which are used for diagnosing leukemic cells. Preprocessing is a step that changes the domain of images to another image according to the proposed method. In the proposed method the input image is taken in RGB format and then converted to L*a*b color space for further processing. The image processing steps are shown in Fig.1.

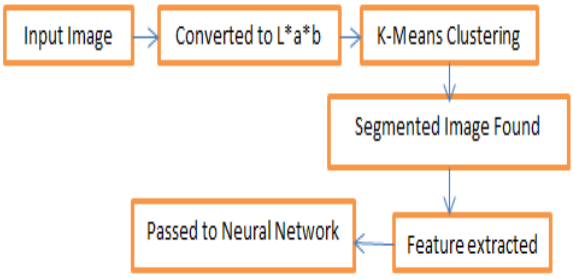

Fig.1 Image Processing steps of proposed method

III. LITERATURE REVIEW

JieSu et al[3] proposes a method using k-means cluster, then builds a cell image representing model by Hidden-Markov Random Field(HMRF), uses Expectation Maximization(EM) probability until an optimal value and

compares the segmentation results with several other classes of cells. Lorenzo Putzu et al[4] converts the images from RGB to CMYK, performs Histogram equalization, Zack algorithm used. Shape, color and texture features are extracted. SVM is used.

SaifS.Al-jaboriy et al[5] automatic leukocyte cell segmentation based on machine learning. Blast cells are extracted using 4-moment statistical features and artificial neural network. Chitra P et al[6] Uses contrast enhancement, local binary pattern detection and Fuzzy C mean clustering technique. A fuzzy two based color segmentation strategy is employed for separating leukocytes from other blood components.

S.Mohapatra et al. [7] has proposed color based clustering, fractal geometry, contour signature and texture based techniques for nucleus feature extraction using SVM.

IV. K-MEANS CLUSTERING [8]

An unsupervised classification of data pattern into homogenous groups or clusters is called clustering. K-means which is a center based clustering algorithm is used in large databases and high dimensional databases. K-means divides an image as per distance. The steps are:

- K-clustering center values are initially selected.
- From each cluster center to each sample calculate the distance to get the nearest centers.
- For each cluster, new clustering centers are connected with the mean samples.

A disadvantage of this method is:

- To estimate k-clustering number is difficult.
- Very expensive due to the iterations.
- It is a partitioning method based on distance.

V. NEURAL NETWORK

Artificial Neural network (ANN) is compared to the functions of the human brain. Machine Learning(ML) algorithms requires a lot in decision making and ANN has performed well in the purpose of medical field. The Figure.1 below shows the flow of working of ANN algorithm. Back propagation is mainly applied to train multilayer Forward NN.

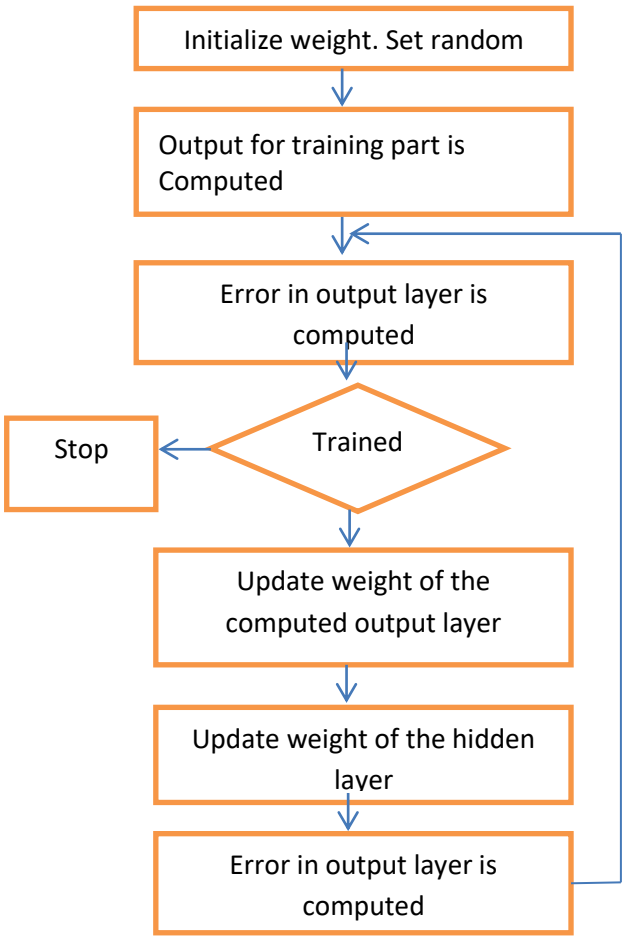

Fig. 2 Working of Neural Network

VI. FEATURE EXTRACTION(FE)

Feature Extraction is used to extract and identify the features that are obtained from segmented parts or from the whole image. We have to extract the relevant features to perform the task and to get accurate information. The features extraction are based on

- Shape features
- Texture features
- Statistical features
- Geometrical features
- Color features

In the proposed paper we are selecting color moments and a combined feature of uniform local binary pattern and Gabor features.

VII. PROPOSED METHODOLOGY

The steps for the proposed method are given as below:

Step 1: Start.

Step 2: Select input image.

Step 3: The input image is segmented using K-means segmentation.

- The image in RGB is converted to L*a*b color space. (L stands for Lightness, a*b stands for color dimensions).
- From L*a*b, a*b is extracted.
- K-means is performed to partition image pixels into k clusters (k = 2), using the Squared Euclidean distance metric and replicates = 3, which is the number of times to repeat clustering using new initial cluster centroid positions.
- The area of each object in each cluster is found.
- Cluster with minimum area is selected.
- Holes are filled.
- Final segmented image is received.

Step 5: Uniform Local-Gabor Binary Pattern is applied to the segmented image using the following steps:

- Set wavelength to 4, orientation to 90.
- Apply Gabor filter to the tuned frequency and orientation.
- Extract Uniform Local Binary Pattern from the magnitude of Gabor filter.
- 59 features are extracted.

Step 6: Color moments are extracted from RGB channel (Red, Green, Blue), HSV channel (Hue, Saturation, Value) and YCbCr channel (Luminance, Chroma:Blue, Chroma:Red).

- The variables computed from color moments are (Mean, Skewness, Variance) are computed per channel.
- Total of 27 features are extracted from 9 color channels (9x3=27).

Step 7: Combine the extracted Uniform Local-Gabor Binary Pattern features and Color moments features (59 features from (step 5))+27 features from (step 6))=86 features).

Step 8: The combined 86 features is passed as input to neural network with training: validation: testing ratio 70:15:15 using Levenberg-Marquardt (LM)[10] learning method, number of hidden neurons = 20 and number of epochs = 500.

Step 9: The class with maximum probability is selected as output.

VIII. RESULTS

The microscopic images are a combination of cancerous and normal images. An image in RGB format is selected as input image. (Fig.3). This RGB image is converted to L*a*b color space where a*b channel is extracted. (Fig.4). Using K-means clustering the object is divided into two clusters. (Fig.5). Clusters with minimum area is found and the holes are filled. (Fig.6).Finally, segmented image is received. (Fig.7).

To the segmented image uniform Local-Gabor binary pattern feature extraction is performed with wavelength to 4 and orientation to 90 (Fig. 8) from where 59 features are extracted. The color moments (27 features) are extracted from this RGB image from where 9 channels are extracted as(R, G, B, H, S, V, Y, Cb, Cr) (Fig.9) using 3 variables (skewness, Mean, Variance).

Total 86 features are passed to Neural Network (Fig.10) with training 70%, testing 15%, and validation 15% using LM and finally a result cancer detected or normal is obtained.(Fig.11).

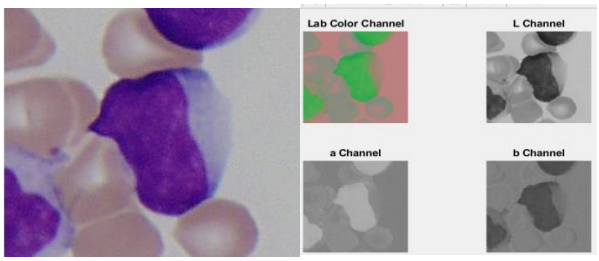

Fig.3 Input ImageFig. 4 a*b channel selected

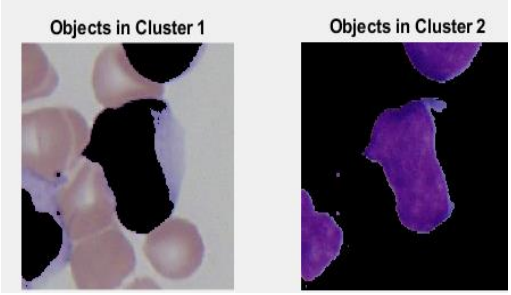

Fig.5 Object in each cluster is found

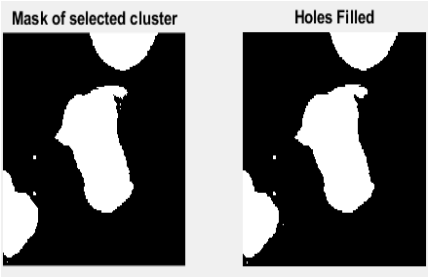

Fig.6 Holes are filled

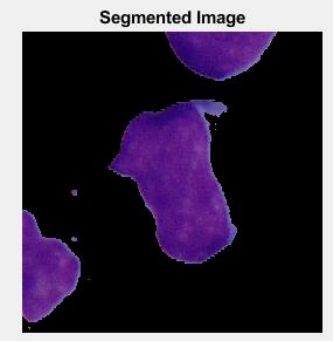

Fig. 7 Segmented image

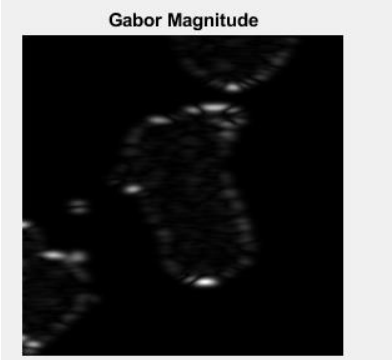

Fig.8 Gabor filter applied

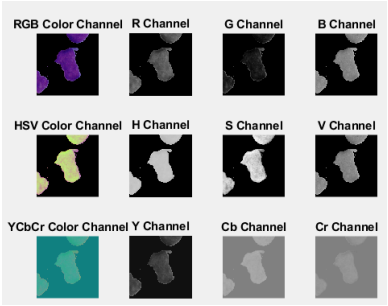

Fig 9.Color moments extracted

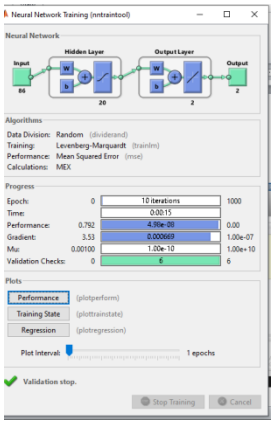

Fig.10 Neural Network

Combining color moments (27 features) and uniform Local-Gabor Binary Pattern (59) (total 86 features) are passed through a neural network LM and finally a result that cancer is detected or normal is obtained.

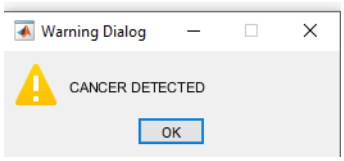

Fig.11 Result

The Table.1shows that the proposed method has more accuracy compared to other models.

TABLE 1. Classification accuracy using different classifier models

Model	***Accuracy***
KNN	94.2308
SVM	94.6154
Naive Bayes	84.6154
Linear	81.5385
Proposed Method	**97.3077**

IX. CONCLUSION

This paper gives importance of feature extraction in digital image processing. For the detection of leukemia several feature extraction are performed. This paper highlights features of Local Gabor binary pattern and color features. The classification is done through Levenberg-Marquardt learning method which produces an accuracy of 97.30%. As future work to improve efficiency we can apply our proposed method to deep neural networks.

REFERENCES

[1]. ALL-IDB. Acute Lymphoblastic Leukemia Image Database for Image Processing. http://homes.di.unimi.it/scotti/all/
[2]. M.E.Celebi, H.A.Kingravi, and P.AVela, " A comparative study of efficient initialization methods for the k-means clustering algorithm," Expert Systems with Applications.,Vol.40(2013) 200-210.
[3]. J.Su., S.Liu., J.Song ," A segmentation method based on HMRF for the aided diagnosis of Acute Myeloid Luekemia", Computer Methods and Programs in Biomedicine,152,115-123, 2017.
[4]. Lorenzo Putzu, Giovanni Caocci, Cecilia Di Ruberto., "Leucocyte Classification for Leukaemia Detection Using Image Processing Techniques" Artificial Intelligence in Medicine, 2015
[5]. Saif S. Al-jaboriy., Nilam Nur Amir Sjarif., SuriayatiChuprat., Wafaa Mustafa Abduallah., "Acute Lymphoblastic Leukemia Segmentation Using Local Pixel Information", Pattern Recognition Letters (2019)
[6]. Chitra P,, Ebenezer Jebarani M R., Kavipriya P., Srilatha K., Sumathi M., Lakshmi S., "Detection of AML in Blood Microscopic Images using Local Binary Pattern and Supervised Classifier",. Research J. Pharm. and Tech. 2019; 12(4):1717-1720
[7]. SubrajeetMohpatra, Dipti Patra and SanghamitraSatpathy., "Unsupervised Blood Microscopic Image Segmentation and Leukemia Detection Using Color Based Clustering", International Journal of Computer Information System and Industrial Management Applications. ISSN 2150-7988 Volume 4, pp.477-485, 2012
[8]. M.E.Celebi, H.A.Kingravi, and P.AVela, " A comparative study of efficient initialization methods for the k-means clustering algorithm," Expert Systems with Applications.,Vol.40(2013) 200-210
[9]. Sudip Mandal, Indrojit Banerjee., "Cancer Classification Using Neural Network", International Journal of Emerging Engineering Research and Technology Volume 3, Issue 7, July 2015, PP 172-178
[10]. Hao Yu., Bogdan M.Wilamowski., "Levenberg–Marquardt Training", Intelligent Systems,2010