Analysis of Acute Lymphoblastic Leukemia Cells using Digital Image Processing

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Abstract— Acute Lymphoblastic Leukemia is type of blood cancer. This type of cancer mostly occurs in children of age 3 to 7. ALL caused by excessive production of immature lymphocytes. Early detection of ALL is important for faster treatment. The present system used for ALL detection is mainly based on visual inspection. This process is tiring and error prone. The proposed system is based on automatic image analysis of microscopic images of bone marrow. It identifies lymphocytes using digital image processing. For this identification K-mean clustering has been used. By using k-mean clustering nuclei of lymphocyte is obtained. The features of nuclei are extracted i.e. texture, geometry, etc. which are further used for classification. SVM is used for classification of cancerous and noncancerous cell. So lymphoblast cell which is cancerous cell can be detected easily. This will help in faster detection of ALL with less efforts and with minimum errors. So ALL cell detection using digital image processing and SVM classification will be useful for haematologist for faster and accurate result. It is not only low cost but also efficient solution that uses image analysis for quantitative examination of bone marrow stained blood microscopic images for leukemia detection.

Key words: Acute Lymphoblastic leukemia, Lymphocytes, Lymphoblasts, K-mean clustering, SVM

I. INTRODUCTION

A. *Formation of Blood:*

The process formation of blood cell takes place in the bone marrow.

B. *Basic of Blood:*

1) Erythrocyte or Red blood cells-Used to carry oxygen to tissues and carbon dioxide back to the lungs.
2) Leukocyte or White blood cells-These cells defends the organism from infection. They have several types.
3) Thrombocyte or Platelets – These cells used to control bleeding with the help of blood clotting.
4) Plasma –It is fluid in blood which contains dissolved ions which are necessary for cell function. It consists of hydrogen, magnesium sodium, potassium, chloride, iron.

C. *What is Leukemia?*

Leukemia is kind of blood cancer. It usually begins in bone marrow. It generates high numbers of abnormal white blood cells. These white blood cells also called as leukocytes are not fully matured and called as blast cells.

D. *Types of Leukemia:*

leukemia can be divided into 4 types that are:

1) Acute Lymphoblastic Leukemia:

Acute lymphoblastic leukemia, which also called as acute lymphoid leukemia or acute lymphocytic leukemia (ALL). It is an acute form of blood cancer, which can be characterized by the excessive production as well as accumulation of cancerous, immature lymphocytes known as lymphoblast. If person having ALL, lymphoblast are over generated in the bone marrow and continuously multiply. This overproduction of lymphoblasts causes not only damage but also death by affecting the production of lymphocytes in the bone marrow. It can also spread in other orgasm. ALL commonly occurs in childhood, at 2–5 years of age and another peak in old age.

E. *ALL Morphologic Classification*

The French-American-British (FAB) Cooperative Working Group have defined three main types of lymphoblasts. In which first type is L1 lymphoblasts which are small cells with a high nucleus-to-cytoplasm ratio. In which pale blue cytoplasm is restricted to a small portion of the perimeter of the cell and is scanty. These kind of cells has indistinct nucleoli and nuclear membranes which vary from round to clefted. Second type is L2 lymphoblasts which are larger and often in a more heterogeneous shape and it has lower nucleus-to-cytoplasm ratio. In this kind of lymphoblasts prominent nucleoli and nuclear membranes that may be of Reni form or may be irregular. Third type is L3 lymphoblasts which are heterogeneous group of cells. These cells are similar to Burkitt-like leukemia and it can be characterized by deeply basophilic cytoplasm and prominent cytoplasmic vacuolization.

Approximately 85% of children having ALL may have predominant L1 type of morphology, 14% may have L2 type of morphology and remaining 1% may have L3 type. L2 type is more commonly occurs in adults. While L3 lymphoblasts represent an immunopheno typically distinct population of mature B cells. In which there is no correlation between the various stages of pre-B cell differentiation or immunopheno type and L1 or L2 morphology.

1) Acute Myeloid Leukemia (AML)

AML is fast developing form of leukemia cancer of blood and bone marrow. It occurs when the bone marrow started to make blast of cells which are not yet completely matured. In AML, the bone marrow may also make abnormal red blood cells as well as platelets. AML normally occurs in children.

2) Chronic Lymphocytic Leukemia (CLL)

CLL is typically slow growing leukemia cancer which beings in lymphocytes in the bone marrow and further extended into blood. It may also spread in organs and lymph nodes such as the spleen and lever. It normally occur in older.

3) Chronic myeloid leukemia (CML)

CML of leukemia is grows slowly and begins in blood-forming cells in bone marrow and after some time it spread to the blood and that cause disease which spreads to the blood. CML normally occurs after 45 years of age.

F. *Conventional Method and Its Limitations:*

There are following methods for detection of leukemia. First is physical exam in which doctor is going to look for physical

signs of leukemia blood cancer such as swelling of your lymph nodes, pale skin from anemia, enlargement of your liver as well as spleen. Further doctor can determine abnormal levels of white blood cells or platelets with the help of blood test by looking at a sample of your blood which may suggest leukemia. Third is bone marrow test in which doctor may carry out the procedure of removing a sample of bone marrow from your hipbone. This sample of bone marrow may be removed using a long, thin needle. Then sample is sent to a laboratory to detect leukemia cells. Specialized tests of your leukemia cells may reveal some features that can be used to determine the treatment options of leukemia cancer. Currently for diagnosis of leukemia, the cytogenetics and immunophenotyping methods are being used.

Limitation of these method is that they are dependent on operator's experience and his capabilities. So result is error prone. These methods are dependent on visual inspection and time consuming. These tests are extremely complex and subjective. These tests are much expensive and subject to non-standardized result and reports. The accuracy rate of traditional method is quite less and required too much efforts to get higher rate of accuracy. So to overcome these limitations of visual inspection automatic blood analysis using Digital Image Processing has being introduced here which is cost effective and robust method which also improves results.

II. METHODOLOGY

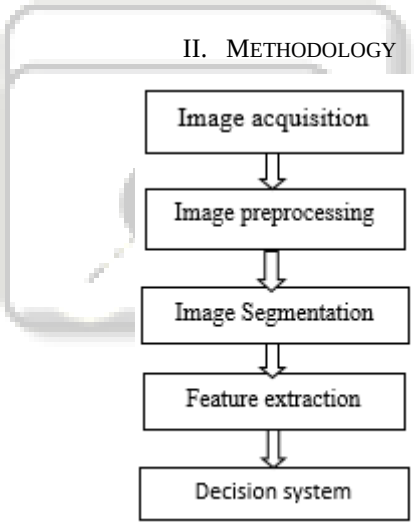

Fig. 1: Block diagram

A. Image Acquisition:

The microscopic images of blood sample have taken from internet. Digital images of Blood samples of bone marrow are collected in the form of Bitmap or JPEG format from distinct sources.

B. Image Pre-Processing:

Image pre-processing is used as image thresholding techniques in which the noise in an image is removed to make it suitable for particular application.

C. Image Segmentation:

Image segmentation is executed by using k mean clustering algorithm to extract the nuclei of leukocytes. The K-means clustering algorithm is a simple method for estimating the mean (vectors) of a set of K-groups.

K-mean clustering aims to partition n observations into k clusters. After that each observation related to the cluster with the closest mean. This can be serves as a prototype of the cluster. Here 4 clusters have been generated based on color using Matlab. These cluster are as given: first is of Red Blood Cells, second is of WBC's nuclei, third is of WBC's Cytoplasm and last is for Background.

D. Feature Extraction

Feature extraction is important to recognizing blast in cell. Here features of nuclei of leukocytes are extracted. There are mainly two types of features.

E. Geometrical Features:

This type is based on shape of nuclei. It includes following

1) Area: area of nuclei is calculated using non zero pixels.
2) Perimeter: It is calculated in between successive boundary pixels of image region.
3) Solidity: it is important parameter in recognizing blast and calculated as ratio of actual area to convex hull area.
4) Form Factor: It is dependent on surface irregularities and given as Form factor=4*pi*area/perimeter^2
5) Eccentricity: It is measure how much deviation of shape of nuclei from being circular.
6) Elongation: The ratio of maximum distance and minimum distance from center of gravity to the nucleus boundary is Elongation. Elongation is used to measure abnormal bulging of nucleus.

Elongation=Rmax/Rmin.

1) Texture Feature:

In this type of features following measurements are performed.

1) Homogeneity: It is used to measure uniform quality throughout.
2) Energy: It is measure of uniformity.
3) Correlation: It represent correlation between two neighboring pixels.
4) Entropy: It is a measure of randomness or disorder.

F. Decision System

A set of features is extracted from image which is used for further classification. Classification is done in two types of cells one with cancer i.e. lymphoblast and one with normal WBC i.e. Lymphocyte. SVM i.e. Support Vector Machine is used as a classifier to achieve this purpose. SVM is related to statistical learning theory. It is powerful tool for data classification. SVM is based on hyper plane classifier.

III. CONCLUSION

The main goal of this paper is to help in detection of Acute Lymphoblastic Leukemia. This system is useful for Lymphoblastic Cell Detection. Segmentation based on K-mean Clustering is used for extraction of nuclei and cytoplasm of Lymphocytes. The feature extracted from lymphocytes nuclei like Area, Contour Signature, Homogeneity, etc. which are further given to SVM classifier for classification of Lymphocytes and Lymphoblasts.

REFERENCES

[1] Subrajeet Mohapatra, Dipti Patra, Sanghamitra Satpathi presented "Image Analysis of Blood Microscopic Images for Acute Leukemia Detection" on 2010 International

Conference on Industrial Electronics, Control and Robotics ©2010 IEEE.

[2] Fabio Scotti presented ”Automatic Morphological Analysis for Acute Leukemia Identification In Peripheral blood Microscope Images” at IEEE Internatonal Conference on Computational Intelligence for Measurement System and Application on July 2005

[3] Malhar Bhatt1, Shashi Prabha presented ”Detection Of Abnormal Blood Cells Using Image Processing Technique” International Journal of Electrical and Electronics Engineers ISSN- 2321-2055 (E) IJEEE, Volume 07, Issue 01, Jan- June 2015.

[4] Xitao Zheng,Yongwei Zhang ,Jun Shi, Yehua Yu presented “Analysis of leukemia Development Based on Marrow Cell Images” on 4th International Congress on Image and Signal Processing ©2011 IEEE.

[5] Stanislaw osowski, robert siroi´c, tomasz markiewicz, and krzysztof siwek presented “application of support vector machine and genetic algorithm for improved blood cell recognition” on IEEE transactions on instrumentation and measurement, vol. 58, no. 7, July 2009

[6] Adnan Khashman presented “IBCIS: Intelligent blood cell identification system National Natural Science” at Foundation of China and Chinese Academy of Science, Published by “Elsevier Limited and Science in China Press” @2008.

[7] Tapas Kanungo, David m. Mount, Nathan S. Netanyahu, Christine D. Piatko, Ruth Silverman, and Angela y. Wu, presented “An Efficient K-mean clustering Algorithm: Analysis and implementation” at IEEE transactions on pattern analysis and machine intelligence, vol. 24, no. 7,july2002

