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Analysis of Microscopic Images of Blood Cells for Detection of Leukemia

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Abstract: Leukemia is a malignant progressive disease in which the bone marrow produces a increased number of immature leucocytes. The need for microscopic color imaging, segmentation, clustering, classification arises when microscopy study of human blood was done by Hematologist. This allows the identification of patients who suffers from Leukemia. In earlier time, before automation in clinical laboratories, the Hematologist visually inspect the microscopic images of blood smear. This process seems to be time consuming and tiring. In the visual inspection, the automatic image processing system is urgently needed and can overcome its related constraints . The development of the integrated system for the use of the clinical sector remains most challenging aspect of medical imaging. The method of visual inspection of microscopic images of blood cells to detect the blood disorder and other related ailments was performed. By the identification of various abnormalities in blood, the classification of blood disorders can be made with higher accuracy. The cancer was one of the most feared human disease . The proposed system relies on the microscopic images of blood smear to detect Leukemia. Analyzing through images is very important as from images, diseases can be diagnosed and cured at earlier stage. This proposed work is implemented using MATLAB R2014a.

Keywords: Leukemia, Hematopoiesis, Staining, Erosion, Dilation, MATLAB

I. Introduction

The most important part of any human body is blood as it keeps one alive. It performs many important functions such as to transfer oxygen, carbon dioxide, mineral and etc. to maintain metabolism in the body. The three major components of blood are RBC, WBC and Platelets. Insufficient amount of the blood could affect the metabolism greatly which could be very dangerous if early treatment is not taken. One of the common blood disorders is Leukemia. One of the common type of cancer found in children was Leukemia. All cancers begin in body cells, and leukemia is a cancer that begins in blood cells. Generally, cells grow and multiply to form new cells as the body needs them. As the cells grow, they become older at one extent and the die. They are compensated by the formation of the new cells. Sometimes, this cycle does not work correctly. In cancer, new cells are formed when the body does not need them, and old cells do not die when they should.

Leukemia involves the abnormalities in blood-forming tissues of the bone marrow, spleen and lymph nodes. It is characterized by an uncontrolled production of immature blood cells.

The bone marrow is the site where lymphocytes and other blood cells are made. The bone marrow(Cradle of blood corpuscles) is a spongy tissue found in the mid region of large bones of the body. The figure (1) shows the arrangement of hematopoiesis. The bone marrow produces three types of blood cells: RBCs contain hemoglobin and carry oxygen and other materials to the tissues throughout the body; Platelets help to form clots; WBCs help fight off infections in the body. The bone marrow of the leukemia patients does not work properly. Hence a abnormal, immature cells, called leukemia cells are produced by bone marrow. Leukemia cells are mostly referred to as "blasts". In the bone marrow, a crowd around the blood forming cells was created by the immature cancer cells. If a bone marrow is not able to make enough RBCs to carry oxygen, the child may develop anemia, and feel very tired. If sufficient platelets are not produced, the blood will not clot properly, and the patient may bleed easily. When WBCs are not plentiful enough, the body cannot fight off germs and the person may develop a frequent infection. Leukemia can be either acute or chronic in type.

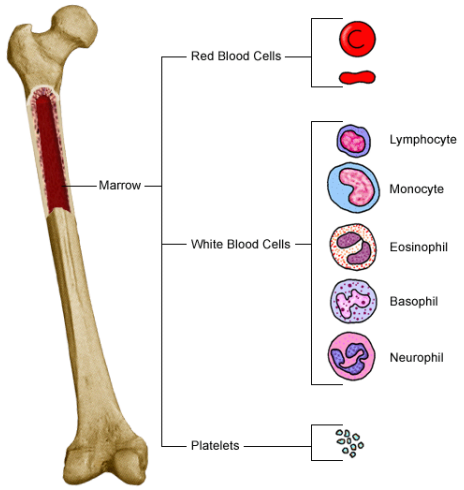


Figure (1) Hematopoeisis

II. Diagnostic Methods of Leukemia

(i) Medical history and physical examination

The record of present symptoms, and problems a person has had in the past. The medical history of a person's family also helps in diagnose leukemia.

(ii) Complete blood count (CBC)

Blood is taken and checked under the microscope for the number of RBCs, WBCs and platelets.

(iii) Bone marrow aspiration

Bone marrow is removed with the help of a needle from breastbone. The removed sample is observed under a microscope to look for abnormal cells.

(iv) Cytogenetic analysis

Cytogenetic test takes blood or bone marrow to help identify individual chromosomes. It shows abnormalities in chromosomes, which help to diagnosis and identify the type of leukemia. Results are usually available within 3 weeks.

(v) Immunohistochemistry

Blood sample of cells are treated with special antibodies in immunohistochemistry. Under the microscope the change in color can be seen. It helps in determining the types of cells that are present.

III. Methodology

In this work, an image analysis approach for automated detection, preprocessing- smoothing, enhancement, segmentation, feature extraction- morphological and calorimetric and then detection and classification of particular cells, especially the cancer cells from normal cells is done.

This paper describes a primary study of developing a automated diagnosis of leukemia using microscopic blood sample images. It will use features in microscopic images and examine changes in texture, geometry, color and statistical analysis. The variation in these extracted features will be used as a input to the classifier.

The proposed work of detecting leukemia in microscopic images by image processing consist of two phases.

Phase-I:
(I) Image Acquisition:

Microscopic images of blood cells from slides will be obtained from nearby hospital with effective resolution and magnification.

(Ii) Preprocessing:

The acquired image was corrupted with noise due to excessive staining in clinical laboratory and noise during acquisition of images. The region of interest (ROI) appear as blurred image region due to illumination or shadowing effect.

Phase-II:
(III) Image Segmentation And
Feature Extraction

Algorithm:
Step -1: Conversion of RGB image to gray scale image.
rgb2gray( );

Step - 2: Find the circles in the image whose radii are approximately equal to given radius. The object polarity to dark in imfindcircles to search for dark circles. Sensitivity to control the internal threshold.
imfindcircles( );

Step - 3: Flush the figure and draw only the circles specified by the inputs.
viscircles( );

Step - 4: Find the length of the largest array dimension.
length( );

Step - 5: Extract the primary colors in the image
red=rgb(:,:,1);green= rgb(:,:,2); blue= rgb(:,:,3);

Step - 6: Find the components of below condition
Red=25 to 123; Green= less than 135; Blue=167 to 201

Step-7: Perform morphological reconstruction to flood fill some edge point with background value. Repeat until the non-filled background edge pixel repeats.
imfill( );

Step - 8: Apply morphological operations like erosion & dilation in the image
bwmorph( );

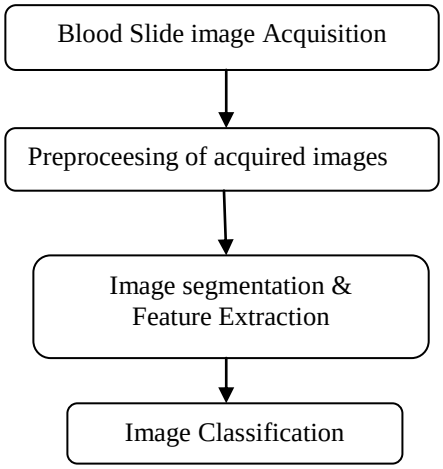
Step - 9: Convert grayscale to binary image.
im2bw( );

Step - 10: Label the connected components in the binary image.
bwlabel( );

Step - 11: Find the number of cancer cells.
(Num/Cell) * 100

Step - 12: Detection of cancer stage.
If **cancer<25** indicates the initial stage of leukemia.

Work Flow



IV. Results and Discussion

This work involves detecting the types of leukemia using microscopic blood sample images. The features in microscopic images by examining changes on texture, geometry, colors and statistical analysis are used to built the system as a classifier input. The system should be efficient, reliable, less processing time, smaller error, high accuracy, cheaper cost and must be robust towards varieties that exist in individual, sample collection protocols, time and etc. People are beneficial in predicting, solving and treating blood diseases immediately for a particular patient with the help of information extracted from microscopic images of blood sample.

The following figure (2) shows the output of classification by extraction of features from blood cell image. The image taken was the initial stage of cancer which becomes malignant and cause death if not treated. This is justified from the figures (3) and (4) showing the linguistic output of classification done for the image.

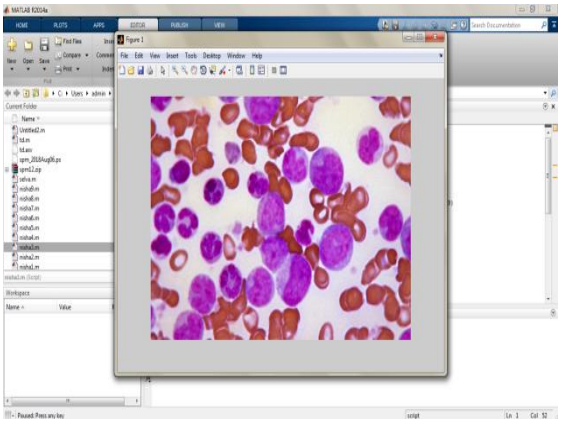


Figure (2) Output of processed image for classification

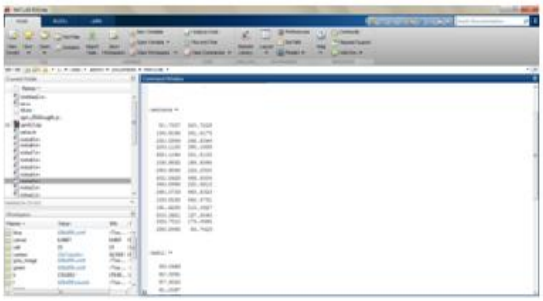


Figure (3) Statement of output as available in Command window of MATLAB

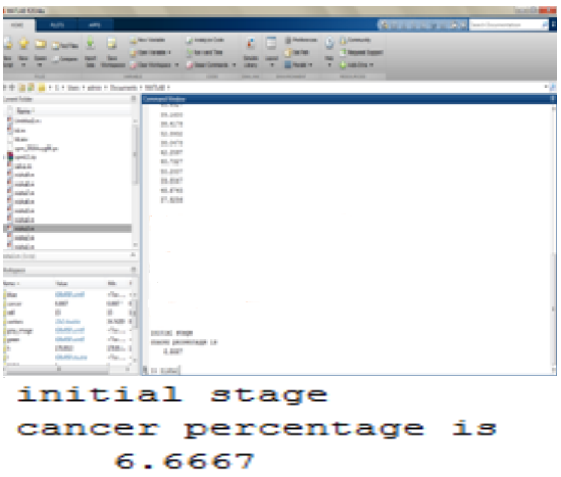


Figure (4) Interpretation from image analysis

centers =

51.7207	320.7228	134.8193	331.8178
232.5859	248.6343	224.1100	395.1939
885.1094	331.8105	106.9532	189.9345
293.9058	226.2500	402.5628	499.5004
394.8994	230.4813	295.0729	483.8323
109.8235	442.4731	91.6255	515.1827
803.3621	137.9043	533.7010	179.0945
	288.8495	34.7429	

radii =

39.0669	40.3591	37.3025	41.0087	45.4927
39.1600	38.4178	52.3932	38.0478	42.2597
40.7327	50.2007	39.8547	48.6745	37.9256

h =

178.0013

Table (1) Parametric Interpretation from image analysis

Thus, an automated method to detect the leukemia was developed. It provides the accurate results with high efficiency. It reduces the time taken by the hematologist to predict the percentage of cancer in blood cells.

This proposed work uses a validated protocol that give an accurate detection of abnormal proliferation of blood cells in pathological conditions and their monitoring at different stages, and support future developments for the definition of reliable biomarkers for bone marrow degenarative diseases and other pathologies relating to blood connectivity networks.

V. Future Work

This proposed work of automated method for diagnosis of leukemia using morphological image processing can be extended to detect the acute myeloid leukemia(AML), chronic myeloid leukemia(CML), acute lymphocytic leukemia(ALL), chronic lymphocytic leukemia(CLL).

VI. References

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