Counting of RBCs using circular Hough transform with median filtering

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***Abstract*— precise value of blood cell count plays very important role in the disease diagnosis field. Increment or decrement in the count of blood cell causes many diseases to occur in the human body like leukemia and anemia. Conventional method involves the manual counting of the blood cells, it is very time consuming and inaccurate. LASER type hematology counters are very expensive and it may damage the cells. A fast and cost effective automated counter using digital image processing is proposed in this paper. It consists of the analysis and processing of microscopic image of the blood smear. The salt n pepper noise in the blood smear image is removed by median filtering and the blood cell count is obtained by circular Hough transform. The whole work has been done on the MATLAB 8.3 platform.**

Keywords*— *Biomedical Signal processing ,Red blood cells detection,Counting,Image Segmentation,Gray thresholding,Hough Transform,MATLAB

I. INTRODUCTION

Human blood has various functions such as transportation of gases, immunity, temperature regulation etc. Blood consist of 55% by plasma and 45% by cells called formed elements. There are three types of cells such as red blood corpuscles (RBC), white blood corpuscles (WBC) and platelets. The five types of WBCs are monocyte, eosinophil basophil, lymphocytes and neutrophil. The immunity is the important function of wbcs and platelets are responsible for blood clotting. By means of the hemoglobin contained in the erythrocytes, it carries oxygen to the tissues and collects the carbon dioxide (CO2). It also conveys nutritive substances (e.g. amino acids, sugars, Mineral salts).

The analysis of individual blood components gives valuable information about the status of human body and can be used for the diagnosis and can be used for the diagnosis of various disorders. There are conventional and automatic methods for the counting of blood cells. The conventional method is the manual counting of blood cells by the microscopic inspection. It is time consuming and produces a less accurate result. The current age popular haematological analyzing devices cannot identify morphological abnormalities in blood corpuscles with 100% precision as the detection part may subject to human error. LASER type haematology counters are very expensive and it may damage the cells.

Many digital images are being captured and stored such as medical images by hospitals and medical institutions every day. Current research is doing on blood counting application in the image segmentation. An image can be considered as a matrix of light intensity levels that can be manipulated using computer algorithms in MATLAB.

Red blood is measured by the amount of hemoglobin. We suffered fatigue and short of breath when the level of hemoglobin is too low due to insufficient oxygen supply. The effect of high red blood cells in our blood can be indication of an undetected heart or lung problems. Therefore, RBC count is very important in diagnosis of many dieses.

In our project, the aim to count the total number of red blood cells in a microscopic image of blood smears using MATLAB. Our work is an implementation of automated counting for blood cell using the image processing techniques. Median filtering is used to remove noise which is added at the time of capturing the microscopic blood images. The circular Hough transform is a specialization of Hough transform and is used for the detection of circle. The RBCs are of biconcave shape, circular Hough transform can be used to detect and count them.

The whole work has been done on MATLAB 8.3 platform. Finally, the count is normalized to get it per cubic milliliter, which is the normal practice by a medical practitioner.

A. Types Of Blood Cells

The three blood cells are RBCs (erythrocytes), WBCs (Leukocytes) and the platelets (Thrombocytes). RBCs have biconcave shape and are red in color due to the presence of heamoglobin.4-6 million RBCs are present in 1 cubic milli meter of blood. RBCs are of size 6-8 μm and have a life span of 4 months. The main function of RBC is the transport of gases. The WBCs and the platelets have the functions immunity and blood clotting respectively and are colorless.

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II. Proposed Methodology

In this project, our aim is to calculate the count of RBCs from the microscopic blood smear image. The block diagram and the flow chart of the method is shown in figure 1 and figure 2 respectively.

A. Image Acquisition

The digital microscope is interfaced to a computer and the microscopic images are obtained as digital images. The image used for the project is shown below. The input image is in RGB format. For post processing, this image is to be converted in to gray scale format. After converting image in to gray scale, salt n pepper noise is added in the resultant image.

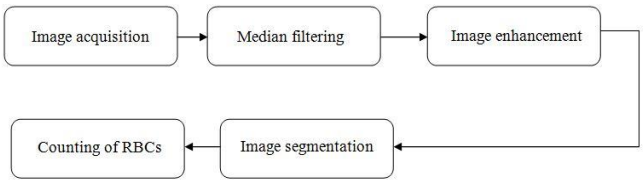

Fig. 1. The Block diagram for the proposed method

B. Median Filtering

Median filtering is used to remove noise which is added at the time of capturing the microscopic blood images. This noise can be the dust particles that are present on the blood slide while preparing the slides. Median filtering is a common image enhancement technique for removing salt and pepper noise. Because this filtering is less sensitive than linear techniques to extreme changes in pixel values, it can remove salt and pepper noise without significantly reducing the sharpness of an image.

C. Image Enhancement

The input image has to be enhanced to obtain better segmentation, this improves the quality of the image. After filtering, the next step is the histogram equalization of imported image. We have used contrast-limited adaptive histogram equalization (CLAHE) which operates on small data regions (tiles), rather than the entire image.

D. Image Segmentation

Gray thresholding is done using a graythresh function in matlab. This function uses Ostu's method, which chooses the threshold to minimize the intra class variance of the Black and white pixels. The global threshold value is then used to convert an intensity image to a binary image with the function im2bw. The next step is to fill the holes present in the binary images.

E. Circular Hough Transform

The circle Hough Transform (CHT) is a feature extraction technique for detecting circles. It is a specialization of Hough Transform. The purpose of the technique is to find circles in imperfect image inputs. The circle candidates are produced by "voting" in the Hough parameter space and then select the local maxima in a so-called accumulator matrix.

In a two dimensional space, a circle can by described by:

$$(x-a)^2+(y-b)^2=r^2$$

Where (a, b) is the center of the circle, and r is the radius. If a 2D point (x, y) is fixed, then the parameters can be found according to the equation given above. The parameter space would be three dimensional, (a, b, r). And all the parameters that satisfying (x, y) would lie on the surface of an inverted right-angled cone whose apex is at (x, y, 0).

Hough based approach for object detection is flexible as the primary voting elements are not restricted to edge pixels, but can include interest points, image patches or image regions. Another attractive property is the simplicity of the learning procedure. In our project, the RBCs are detected and counted by this circular Hough transform.

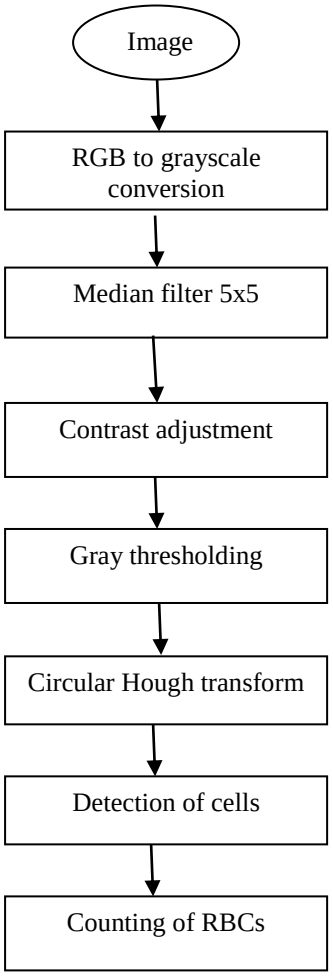

Fig. 2. The flow chart for the proposed system

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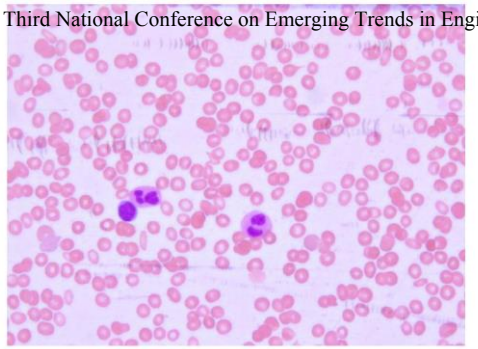

Fig. 3. The microscopic blood smear image

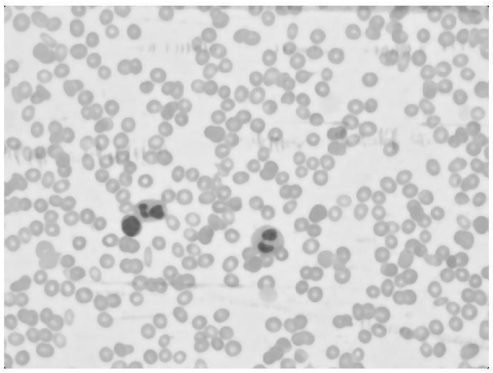

Fig. 4. Median filtered gray scale image

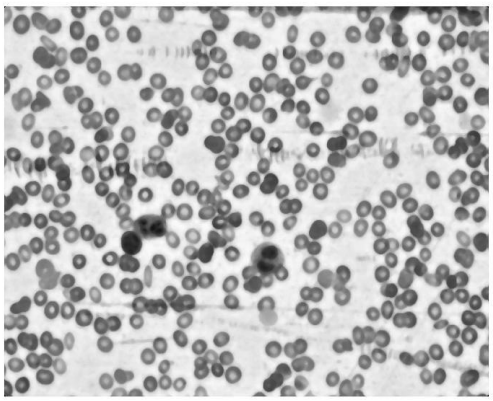

Fig. 5. Enhanced histogram equalized image

III. RESULTS AND DISCUSSION

The RBCs in the blood smear image are detected and counted by the circular Hough transform. However, blood count in medical terms means the number of blood cells (rbc or wbc or platelets) in a cubic millimeter (cumm) of blood volume. So, we have computed the blood count in cumm with the formula given below,

$$rbc\_cumm = \left(rbc\_cht / ((a/(m*m)* ft)) * df\right)$$

rbc_cumm=actual RBC count in 1 cumm
rbc_cht=RBC count obtained by circular Hough transform
a=input image area
m=magnification ratio
ft=film thickness
df=dilution factor

For the image used in our project, the CHT counted 334 RBCs. The film thickness, magnification ratio and dilution factor are 0.001m, 200 and 10 respectively. The image area is computed in MATLAB. The actual RBC count in 1 cumm is obtained as 5.78 million.

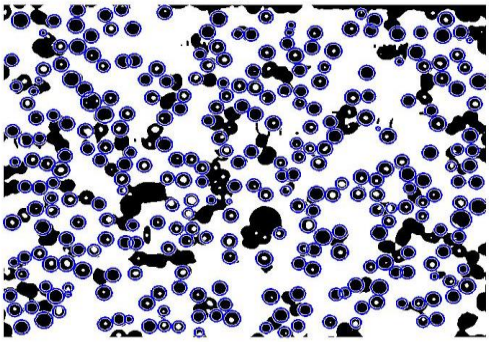

Fig. 6. RBCs detected by circular Hough transform

IV. CONCLUSION

The manual counting of blood cells is time consuming. Our image processing method to calculate the blood cell count helps to do it faster within a fraction of few seconds. The accuracy of the algorithm depends on the camera used, but our method is more accurate than the manual counting. This project can be extended to detect the various abnormalities of red blood cells and white blood cells such as Sickle cell anemia, leukemia using efficient image processing algorithms.

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