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A Smart Sensing And Quantification Of Platelets, Red Blood Cells (RBC), White Blood Cells (WBC) And Classification Of WBC'S Using Microscopic Blood Image

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ABSTRACT- *The counting and analysis of blood cells allow the evaluation and diagnosis of a vast number of diseases. Many research problems are related to the analysis of microscopy images, such as complete blood count (CBC) tests and the analysis of blood smears, which is considered the first step in detecting and diagnosing malaria, leukemia, and anemia, etc. In particular, the analysis of white blood cells (WBCs) is a topic of great interest to hematologists. The manual counting of white blood cells (WBCs) , red blood cells (RBCs) and platelets in microscopic view is an extremely tedious, time consuming, and inaccurate process. Another method for CBC counting uses the automatic hematology analyzer, this machine is very costly. So it is not possible all the hospital's clinical laboratory implement such an expensive machine to count the blood cell in their laboratory. Nowadays the morphological analysis of blood cells is performed manually by skilled operators. This involves numerous drawbacks, such as slowness of the analysis and a nonstandard accuracy, dependent on the operator skills. In literature there are only few examples of automated systems in order to analyze the white blood cells, most of which only partial. This paper introduces an efficient and cost effective computer vision system for automatic red blood cell , white blood cell and platelets counting using image based analysis. Automatic analysis will allow hematologist experts to perform faster and more accurately. This system can be deployed in the remote area as a supporting aid for telemedicine technology. Analyzing through images is very important as from images; diseases can be detected and diagnosed at an earlier stage. Further actions like controlling, monitoring and prevention of diseases can be done. Also the result obtained shows a good accuracy rate as compared to other techniques for automatic segmentation.*

Keywords— Biomedical image processing, Automatic detection, counting RBCs, WBCs, Platelets, segmentation, white blood cell analysis, visual display of WBCs.

1, INTRODUCTION

The analysis of microscopy images is extremely important in both the medical and the computer science fields. Many research problems are related to the analysis of microscopy images, such as complete blood count (CBC) tests and the analysis of blood smears, which is considered the first step in detecting and diagnosing malaria, leukemia, and anemia. Additionally, during a complete physical exam a series of tests are performed. One of these tests is the CBC, which is used to evaluate the composition and concentration of all cellular blood components. The CBC determines red blood cell (RBC) counts, white blood cell (WBC) counts, platelet counts, hemoglobin (HB) measurements, and mean red blood cell volumes.

CBC tests and the analysis of blood smear images help to evaluate, diagnose, and monitor various health conditions. For blood disorders, such as anemia, which is based on HB level, the production and destruction of red blood cells are evaluated.

1.1 RBC- Red blood cell disorder such as anemia, other red cell indices such as (mean cell volume) MCV, mean cell hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), RBC, and red blood cell distribution width (RDW or RCDW) are evaluated to narrow down on the causes of anemia. If the red cell indices are suggested of iron deficiency anemia (IDA), further tests to confirm the IDA will be done. In normal blood, red blood cell (RBC) counts range from 4.2 to 5.9 million cells per square centimeter[15]. High RBC counts can be indicative of serious medical conditions, such as heart, lung, or kidney disease. Primary or secondary polycythemia in polycythemia HB is also raised; a bone marrow disorder also causes high RBC counts

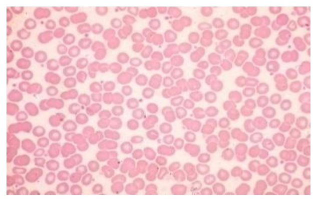


Fig.1 Red blood cell (microscopic blood image)

1.2 WBC- White blood cells(WBCs) are classified into five major categories as shown in Fig 2, like Lymphocyte, Monocytes, Neutrophils, Eosinophil and basophil . Neutrophils, basophils, and eosinophils have a multi-lobed nucleus. These are differentiated based on the color of the cytoplasm, size and the color of the nucleus. The white blood cell count provides information about various illnesses and also helps to monitor the patients recovery after initiation of treatment. One measure, the differential blood count, indicates the type of blood cells which are most affected. Normal WBC counts range from 4,500 to 10,000 WBCs per micro liter of blood depending on the sex and age of the individual with a composition of

I.) Neutrophils: 50 – 70%; II.) Lymphocytes: 25– 35%; III.) Basophils: 0.4 – 1%; IV.) Eosinophils: 1 – 3%; V.) Monocytes: 4 – 6%;

High WBC counts (above 30000 cells per micro liter) indicate an infection, systemic illness, inflammation, allergy, leukemia, or burn-induced tissue injury. If leukemia is suspected, analysis of blood smear is done to look for morphology of the leukemic cells and followed by bone marrow examinations.

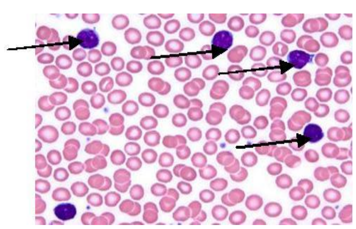


Fig.2 White blood cell (microscopic blood image)

1.3 Platelet - It also called "thrombocytes", are blood cells whose function is to stop bleeding. Platelets have no nucleus. Platelets are found only in mammals. The ratio of platelets to red blood cells in a healthy adult is 1:10 to 1:20The normal platelet count is 150,000-350,000 per micro liter of blood, but since platelets are so small, they make up just a tiny fraction of the blood volume. Platelets are produced in the bone marrow, the same as the red cells and most of the white blood cells. In patients with low platelet count such as in patients with dengue infection, their platelet count is monitored closely and the value is within critical level, the patient might need platelet transfusion. Generally, any abnormal blood smear reading indicates an infection or disease.

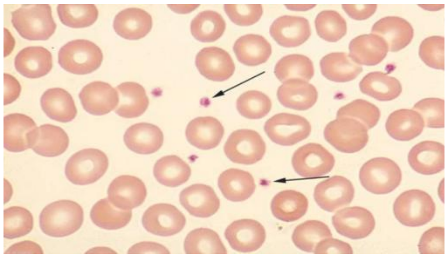


Fig. 3 Platelets (Microscopic blood image)

An accurate segmentation and counting mechanism that gathers information about the distribution of microscopic particles may help diagnose abnormalities during clinical analysis. Our objective in this paper is to develop and validate an algorithm that segments and automatically counts red and white blood cells in microscopy images. In this paper, we propose an automated of RBC counting in microscopic image using circular Hough transform (CHT). The peripheral blood smear slides are obtained from the hospital is capture using a camera that had been attached to the eyepiece of the microscope.

In the following sections of this paper, we will summarize related work on the segmentation and counting of Platelets, RBCs and WBCs , present the methodology used , discuss the results and experiments and review the conclusions.

2,RELATED WORK

2.1 Thresholding Based Method

The WBCs and RBCs are counted by using the gray thresholding algorithm by Pooja R. Patil et al. Otsu's method is used for binarization of image. Labeling algorithm is applied to count the connected objects. Form factor calculation is done and we get the total RBC count.

2.2 Watershed Transform Based Method

Hemant Tulsani et al. presented a method for counting of blood cells. The image processing techniques used for counting are spatial filtering, morphological operations and segmentation using watershed transformation.

2.3 Cell Structure and Intensity Based Method

S. Kareem et al. introduced angular ring ratio method for counting of RBCs in thin blood films. After that peak intensities of the ratio transformed image are calculated. Next, mapping the peaks on to the corresponding coordinates, which is actually the centre of each RBC is done.

3, PROPOSED METHODOLOGY

This paper introduces an automatic Platelets, RBCs , WBCs counting and classifies the types of WBC's using computer vision which helps to perform the counts accurately using image based analysis from which the blood smear image taken by the digital camera attached with the microscopic setup. There are several steps involved in the process of estimating the platelets, Red blood cells and White Blood cell and classification.

3.1 Framework for RBCs detection and counting

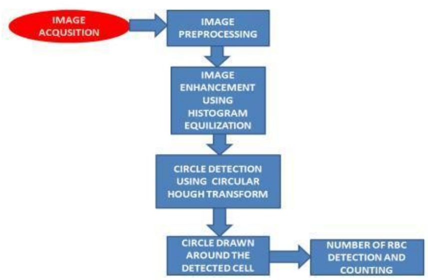


Fig. 4. Block diagram of RBCs detection and counting

(a) Image Acquisition:

The first step in the process is image acquisition- that is, to acquire a digital image which is shown in Fig.6a. Usually it is microscopic image that can be obtained from online medical library or hospital blood sample images. These images are in RGB color format.

(b) Image Preprocessing:

Image pre-processing is a technique of adjusting images suitable for the next step of computational process. It is done in such a way that image quality improved for the success of the other processes see Fig.6b .Original blood cells images are in color. But for post processing, this image is to be converted into grayscale format. After converting image in to grayscale, salt in pepper noise is added in resultant image. Acquired images have low contrast as all blood elements colors close to background color. Also noise is included due to clustered white blood cells. To overcome or reduce such effects contrast enhancement is done.

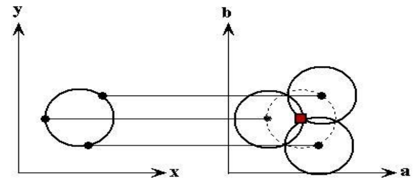
(c) Image Enhancement

After pre-processing, image enhancement is done. It is carried out for the improvement of image's contrast and brightness characteristics as well as to reduce noise in the image or sharpen the details as shown in Fig 6c . These techniques include histogram equalization. Image contrast is to detect and extract the RBC from the images.

(d) Circle detection(using CHT)

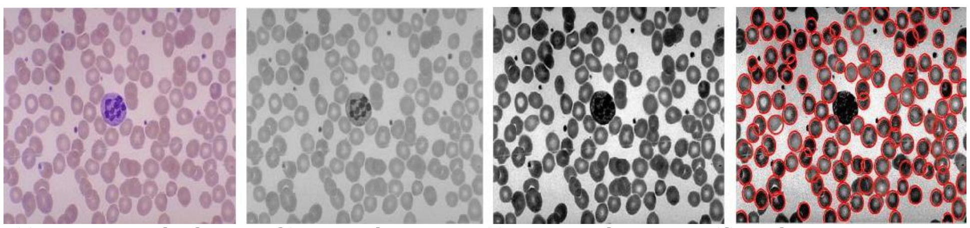
An approach we used for automatic RBC and platelets counting is using Circular Hough transform technique. CHT is a feature extraction techniques used in image analysis to detect the images in a circular shape. In contrast to a linear HT, a CHT relies on 3 parameters, which requires a larger computation time and memory for storage, increasing the complexity of extracting information from our image. It contains two major steps viz. finding out minimum and maximum radius of RBC and Hough transform. With the help of known radius, circular

Hough transform is applied to count RBCs in peripheral blood smear image. Fig 6d shows that CHT is applied to the contrast image to analyze the RBC based on the minimum and maximum radius of RBC and circle is drawn around the detected cell and total number of RBCs is counted



(a) Geometric space (b) Parametric space

Fig.5. Each point in geometric space (left) generates a circle in parameter space (right).



(a)Microscopic Blood (b)Gray Scale (c)Intensity Adjust (d) Circle Detection

Fig.6 . RBCs detection and counting Images

3.2 Framework for WBCs detection and counting

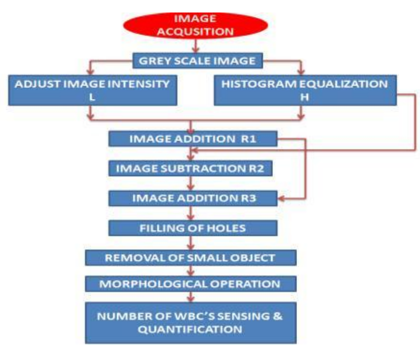


Fig.7. Block diagram of WBCs detection and counting

(a) *Image Acquisition and Preprocessing*

The digital microscope is interfaced to a computer and the microscopic images are obtained as digital images which is shown in Fig 6a.

The images are converted into gray scale images so that the nucleus part of the cell will appear as the darkest part of the image which is shown in Fig.6b.

(b)Image Enhancement

First one copy of the image will be enhanced with a linear contrast stretching (is referred to as L) and another copy will be enhanced with histogram equalization (is referred to as H). The result from L is added to the resultant image from H and subsequently called R1 .By performing the image addition, all the resultant pixels exceeding the intensity value of 225 is truncated to 255 which brighten most of the details in the image except the nucleus.

$$R1\ (i\ ,j)=L\ (\ i,\ j)\ +\ H\ (\ i\ ,\ j) \qquad (1)$$

The result (R1) is then subtracted from the histogram equalized image (H) to form R2 .This operation highlights all the objects and its borders in the image including the cell nucleus.

$$R2\ (i,j) = R1(\ i\ ,\ j\ ) - H\ (i\ ,\ j) \qquad (2)$$

The last arithmetic operation is to add both of the results R1 and R2 together to produce R3 . This operation removes almost all the other blood components while retaining the nucleus with minimum effect of distortion on the nucleus part of the white blood cell. The last arithmetic operation is to add both of the results R1 and R2 together to produce R3 as shown in Fig.8a.

$$R3\ (\ i,\ j\ )= R1(i\ ,\ j)+\ R2\ (i\ ,\ j) \qquad (3)$$

(c) Filling Holes

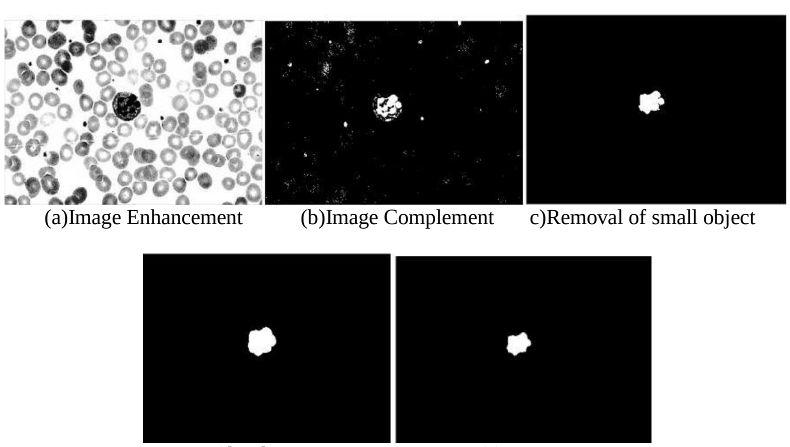
Holes presented in the binary image are filled so that the blood cells are segmented properly as shown in Fig.8c.

(d) Image segmentation

In the segmentation process, morphological technique is major used because the mathematical morphology offers a powerful tool for segmenting images and useful to describe the region shape, such as boundaries, skeletons and texture.

Morphological operation**-** Morphology is a wide set of image processing operations that process images based on shapes[2]. Morphological operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of pixels in the output image is based on a comparison of the corresponding pixels in the input image with its neighbors[1]. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image see Fig 8d & 8e.

*(e) Image Labeling***-** Labels are the connected objects. The objects can have a value of either 4 or8, where 4 specifies 4-connected objects and 8 specifies 8-connected objects. Finally the total number of WBCs is counted using labeling.



(a)Image Enhancement (b)Image Complement c)Removal of small object

(d)Dilation (e)Erosion

Fig.8 WBCs detection and counting Images

3.3 Framework for Platelets detection and counting

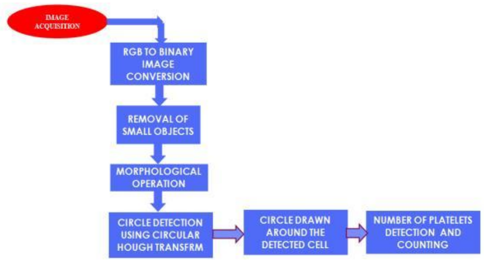
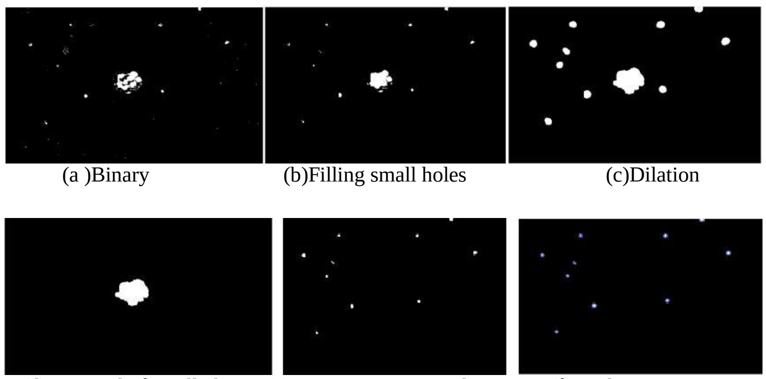


Fig.9. Block diagram of Platelets detection and counting



(a)Binary (b)Filling small holes (c)Dilation

(d)Removal of small object (e) XOR Operation and Erosion (f)Circle Detection

Fig.10. Platelets detection and counting

Images 3.4 Smart visual display of WBCs types

Since there are five different types of WBC as mentioned earlier. In manual counting, types of WBC can be obtained by seeing through microscope. To overcome such an extremely tedious process ,a smart visual display has been proposed where the clinical laboratory technician can easily find out the types of WBC's presents in human body. The below fig.11 shows a smart visual display of WBC present in microscopic blood image of Fig. 6a. with a clear view displayed. So that the types of WBCs presents in an image can be easily detected and counted without any stress.

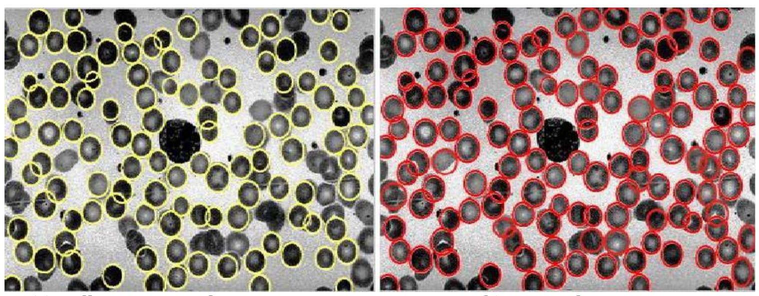
Fig.11 smart visual display of Neutrophil (one type of WBC)

4, EXPERIMENTAL RESULTS AND DISCUSSION

The algorithm proposed is implemented using Matlab Simulation software and the results are obtained[12]. Fig 4 shows the output of figure Fig.6a.

Fig.11 Quantification of RBCs, WBCs and Platelets

On comparison with Cell Structure and Intensity based method, our method shows that many number of cells and over lapped RBCs were detected and results in good accuracy.



(a) Cell Structure and Intensity Based Method (b)Proposed system

Fig.12. Comparison of Cell structure and intensity based method with our proposed method in detection of RBCs

V. CONCULSION AND FUTUREWORK

In this paper one novel approach for detection and counting of different types of white blood cells is proposed. This system is cheaper than other auto recognizer like cello meter, automatic blood cell counter (BL500) etc. This system is easy to install and use. Therefore, it can be installed by people of remote places with very basic level of education. It can reduce the probability of wrong diagnosis in comparison to manual counting. In this work we have proposed an innovative method for the completely automatic identification of thrombocytes

,erythrocytes, leukocytes and classification of leukocytes by microscopic images, in order to provide an automated procedure as support medical activity, in recognition of acute lymphocytic leukemia. The results obtained shows that the proposed method is able to identify in a robust way of WBCs present in the image, being able to properly classify all leukocytes suffering from disease and offering a good level of overall accuracy. As a next phase we are trying to develop by using Microscopic video and automate other microscope-based pathological investigations like detection of bacteria or protozoa. The accuracy of the algorithm depends on camera used, size of objects, whether or not objects touching and illumination conditions.

REFERENCES

[1] Gonzalez RG, RE Woods and SL Eddins, "Digital Image Processing", Pearson Education, Inc. NJ.2007.

[2] Bernd Jahne. "Digital Image Processing", Springer Publications, Berlin, 2011.

[3] Jain A. K., "Fundamentals of Digital Image Processing". Pearson Education, 1st Indian edition, 2003.

[4] Bacus J. W. and Weens J. H., "An automated method of differential red blood cell classification with application to the diagnosis of anemia", J HistochemCytochem, 25: 614, 1977.

[5] Ross N. E., Pritchard C. J., Rubin D. M., Duse A. G. "Automated image processing method for the diagnosis and classification of malaria on thin blood smears", International federation for Medical & Biomedical engineering, March 2006.

[6] Patra D. and Mohapatra S., "Automated Cell Nucleus Segmentation and Acute Leukemia Detection in Blood Microscopic Images", NIT Rourkela. 2010.

[7] Price-Jones C. "The diameter of red cells in pernicious anameia and in anameia following haemorrhage". J PatholBacteriol, 1992.

[8] Malone, BS, Werlin, SL. "Cholecystectomy and cholelithiasis in sickle cell anemia". Am J Dis Child; pp. 142:799, 1988.

[9] Al-Salem AH."Indications and complications of splenectomy for children with sickle cell disease", J PediatrSurg, Nov 2006.

[10] Aguilar C, Vichinsky E, Neumayr L. "Bone and Joint Disease in Sickle Cell Disease", HematolOncolClin North Am.; 19(5):929-4, Oct 2005.

[11] Timothy A.Davis, "MATLAB Primer, Eight Edition ," 2011.

[12] "Gonzalez, "Digital Image Processing Using Matlab," 2010.".Biomedical Engineering International conference, Oct. 2013. pp. 1-4

[13] Jayme Garcia ArnalBarbedo, "Method for Counting Microorganisms and Colonies in Microscopic Images," 12th Int. Conf.Computer Science and Its Applications, June 2012. pp. 84-87.

[14] Michael R. Pinsky, Laurent Brochard and JordiMancebo. "Applied Physiology in Intensive Care Medicine".Springer.229-238, 2007.

[15] Medicine Health –http://www.medicinehealth.com/leu kemia/article.html.