Disease detection with RBC &WBC cell structure using image processing

Shruti Bagde[1], Mahesh Meshram[1], Sarika Bujade[1], Akshay Kadu[1],Dr P.D. Khandait[2]

Student, Electronics, K D K C E, Nagpur, Maharashtra, India [1]

Professor, Electronics, K D K C E, Nagpur, Maharashtra, India [2]

***Abstract*— Blood cell analysis is very much important for all human beings, because there are WBCs, RBCs, and Platelets in our blood, White blood cell count gives the vital information about our blood and diseases related to blood that help diagnosis many of the patient's sickness. We will also study the different parameters like number of cells, number of WBCs and also calculate the time for our code to be executed. One of major challenges in computer vision is to determining the location, shape, or quantity of instances of a particular object. Our project is SOFTWARE based where we are using image processing technique in which we detect and count the number of RBCs and WBCs in the blood sample image and detect the diseases by comparing it with the pre-installed database stored in our system.**

Keywords— WBCs, RBCs, Hough transform, k-means clustering, thresh-holding, image processing.

I. INTRODUCTION

The human blood consists of the RBCs, WBCs, Platelets and Plasma. The complete blood count defines the state of health. Blood is a health indicator therefore segmentation and identification of blood cells is very important. Complete Blood Count (CBC) includes counting of all the cells which determines person's health. The RBC and WBC count is very important to diagnose various diseases such as anemia, leukemia, tissue damage, etc. Old conventional method use in the hospital, laboratories involves manual counting of blood cells using device called Hemocytometer and microscope. But this method is extremely monotonous, laborious, time consuming, and leads to the inaccurate results due to human errors. Also there are some expensive machines like Analyzer, which are not affordable by every laboratory. The objective of our project is to develop an image processing based system or software that can automatically detect and count the number of RBCs and WBCs in the blood sample image and detect the particular diseases by comparing it with pre-installed database in our system.

Image Acquisition, Pre-Processing, Image Enhancement, Image Segmentation, Image Post-Processing and Counting algorithm these are six steps involved in an image processing algorithm.

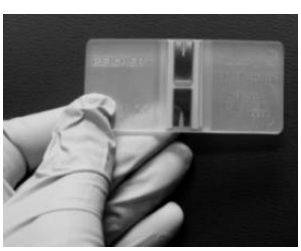
II. BLOOD CELL DISCRIPTION

Blood circulatory system is one of the most important systems in human's body. The function of this system is to transport blood throughout the body. This system consists of blood vessels which are arteries, veins, and capillaries, heart that act as pumping system, and blood that act as the medium for the system. Blood transportation is very important in order to supply oxygen to our body, carries carbon dioxide for gaseous exchange, minerals, nutrients, and ensure healthiness. Blood cell composed of White Blood Cells (WBCs), Red Blood Cells (RBCs), platelets, and plasma. There are five types of WBC which are Monocyte, Lymphocyte, Neutrophil, Basophil, and Eusinophil. Each component in the blood cells plays their own role in maintaining living activities and health. The number of each element plays important role to ensure healthiness. Lack or extreme amount of blood cells, and the shape of RBC's in the body can cause disease such as leukemia or anemia, and other medical problem. WBCs number is important to conclude human's health state. This is due to the number or quantity of this cell determined the individual health condition and indicates diseases which might occur. WBCs involve directly in human body defend system.

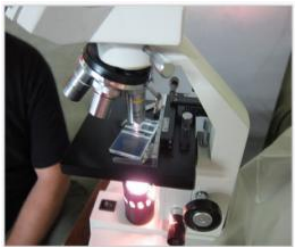
Blood cell images taking from microscopic can be analyzed to count the number of target cells by manual counting and automatic counting. Manual counting can be very detail but might not accurate due to human error. Meanwhile, computerized technique using software was developed to improve the quality of analysis. However, some problem might occur when system failed to count WBC number precisely due to cell overlapping with other cells. This is due to the technique used was based on the cell size and shape. Incomplete shape of cell in image also will cause problem to count the cell accurately. Research need to be done to overcome the problem by using other technique, or improving existing technique.

III. CURRENT METHODS FOR BLOOD CELL COUNTING

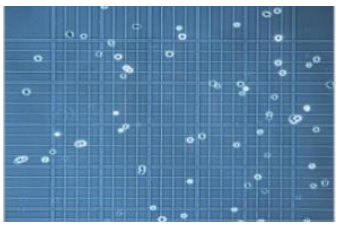
A. Manual Method



(a)



(b)



(c)

Fig 1(a) Haemocytometer (b) Haemocytometer in microscope(c) View of haemocytometer slide through the microscope

The conventional device used to count blood cells is the Haemocytometer. It consists of a thick glass microscope slide with a rectangular indentation creating a chamber of certain dimensions. This chamber is etched with a grid of perpendicular lines. It is possible to count the chamber of cells in a specific volume of fluid, and calculate the concentration of cells in the fluid. To count blood cell, physician must view haemocytometer through a microscope and count blood cells using hand tally counter. Drawbacks of the manual method

- Manual counting task is time-consuming and laborious.
- Counting overlapping blood cells is a major problem.
- Difficult to get consistent results from visual inspection.

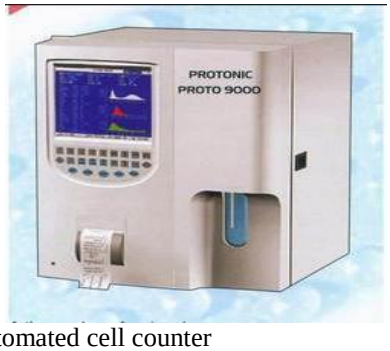


Fig 2: Automated cell counter

B. Automated method

Complete blood count is performed by an automated analyser. The blood is well mixed (though not shaken) and placed on a rack in the analyser. This instrument has many different components to analyse different elements in the blood. The cell counting component counts the numbers and types of different cells within the blood. The results are printed out or sent to a computer for review.

Drawbacks of automated method

- Automated analyser is Costly
- Cannot detect irregularities or variation in the shape and size of the cells.

IV. PROPOSED METHOD

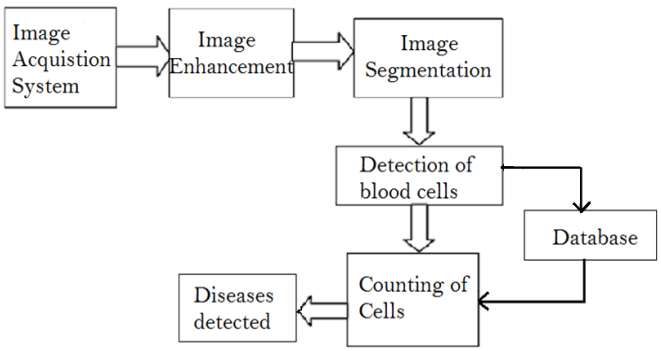


Fig 3. General block diagram

Figure showing a block diagram of Diseases detector with rbc and wbc cell structure by using image processing. This block diagram is divided into six steps i.e. Image Acquisition, Pre-Processing, Image Enhancement, Image Segmentation, Image Post-Processing and Counting algorithm. In Image acquisition step, it acquires digital images of blood samples in either .jpeg or. pang format. These images are in RGB colour plane. Microscopic image that are obtained from hospitals, laboratories using digital microscopes or digital camera placed at the eye piece of a microscope. Image Enhancement is a technique of

adjusting images, improving the quality, contrast and brightness characteristics of an image. The histogram thresholding is used to distinguish the nucleus of the RBCs & WBCs from the rest of the cells in the image . It also removes noise from the image. Image segmentation involves selecting only the area of interest in the image. Here only the blood cells are selected, because they are the areas of interest. When circular Hough transform is applied, not much of the image segmentation is needed because the applied transform looks only for the circular objects in the image. A segmentation can be used for object recognition, boundary estimation within motion or stereo systems, image compression, image editing or image database look up. In Detection of blood cells, Hough transform technique is applied to the contrast adjusted image. This technique searches for the blood cells in the image and detects them.The function draws circles around the detected cells. Even the overlapped cells are detected,

Counting algorithm is applied to measure number of RBCs and WBCs. Counting the number of cells drawn gives the total number of blood cells in the image. This project may be used for detecting diseases like:

1. Aplastic Anemia
2. Microcytic Anemia.
3. Iron deficiency Anemia
4. Sickel cell Anemia
5. Thalessimia
6. Spherocytosis

It may also detect the imbalance of Blood cell counts which may cause diseases related to heart, kidney etc.

A. Image Acquisition System

Image acquisition acquires digital images of blood samples in either .jpeg or .png format. These images are in RGB color plane. These are microscopic image that are obtained from hospitals or from laboratories using digital microscopes or using a digital camera placed at the eye piece of a microscope. Images are also available on online medical library[4]. To examine the RBCs and WBCs stained blood images may be captured with the help of thin glass slides and Digital microscope [5]. Giesma stained thin blood film image should be taken so that platelets, RBCs and WBCs can be easily distinguished. In [6]to differentiate RBCs from WBCs and Platelets, RBCs are less stained as compare to WBCs and platelets leaving a bright patch with intensity value similar to background value. These images are digital images in either .jpeg or .png format and are in RGB color plane.

B.ImageEnhancement

Enhancement techniques improves the quality, contrast and brightness characteristics of an image, also sharpen its details. Histogram plotting, histogram equalization, image negation, image subtraction and filtering techniques, etc. are basic Image enhancement techniques

In [9] Hue saturation is used for an image. The histogram thresholding is used to distinguish the nucleus of the leukocyte or WBCs from the rest of the cells in the image [12]. To get enhanced image, pre-processing is done to get enhanced image with contrast-Limited Adaptive Histogram Equalization is used by Haider Adnan Khan et al. [13]. As the green color plane contains more information about the image is compare to blue and red color plane. Green color plane is extracted. To enhance the image, its contrast is adjusted by plotting its histogram [3]. In [3] canny edge detection and connected component labelling is used as image enhancement techniques. The goal of edge detection is to extract the important features like line,corners, curves etc. from the edge of animas.

C. Image Segmentation

The segmentation is used to separate object from the background. Different segmentation methods are segmentation by using Histogram Thresholding, Otsu Adaptive Thresholding [2], Global Thresholding [3], Hough Transform [1] and Watershed transform algorithm [17], as well as by K-Means Clustering, nucleus segmentation by Gram-Schmidt Orthogonalization and a snake algorithm. The Circular Hough Transform detects some unnecessary circles due to overlapping, therefore removing one of the overlapping circles and then taking average of the count of both the method provides very accurate results [1], [10], [11]. Circular Hough transform is a frequently used method for detecting circles in an image, it often suffers from degradation in performance, especially in terms of speed, because of the large amount of edges given by complex background or texture [18], [19]. Naveed Abbas [20] et al.modified Hough Transform, it was proposed to improve the detection of low-contrast circular objects.

Some researchers use segmentation to classify abnormalities in the cells. In analysis of WBC, to segment the nucleus some techniques used are Gradient Vector Flow (GVF), snake algorithm and Zack Thresholding [12]. Also a Fuzzy approach is proposed for classified pixels to Region of Interest (ROI) [13]. Fuzzy C- Means (FCM) Clustering is used for sub image component [14]. The same work by using sub image component for feature space clustering is done [15]. To classify WBC automatically another advance work also is done in term of calculating area, major axis length over minor axis length, perimeter, circularity and ratio of areas between nucleus and cytoplasm [16].

D. Detection of blood cells

Detection of blood cells includes Feature extraction and morphological operations.

Morphology includes dilation, erosion, granulometry and morphological filtering. Closing operation is used to fill the holes and gaps and opening operation is used to smoothen an image [7], [9]. Different types of structuring of elements are there for dilation and erosion. In [6] the concentric ring is used for dilation and a disk for erosion. Morphological operations eventually removes platelets and other stained parasites. In [21] author used morphological area closing to lower pixel value image and dilation and area closing to higher pixel value image.

Feature extraction extracts features that contain quantitative information about objects of interest. Shape features are: geometric parameters like areas, cell perimeter, and ratio of nucleus to overall cell area, boundary of the nucleus and circularity factor [12]. Texture features are entropy, homogeneity and contrast. Color features includes color histogram, mean and standard deviation of the color components in CIE-Lab domain [8]. Circular Hough Transform (CHT) is technique used in image analysis to detect the objects in circular form [10].Classifiers likeNearest Neighbor (NN), K-Nearest Neighbor (KNN), W-KNN, Bayes, Support Vector Machine (SVM), Neural Network (NNet) [22], Artificial Neural Networks (ANNs) [7],[23] and Local Linear Map (LLM), Fuzzy Cellular Neural Networks are included in feature extraction and are often used to classify blood cells.

Before doing labelling, borders are removed. Cells containing borders contain less information. Therefore, borders has to be removed to reduce complexity [8], [11] used „imclear" function to clear the borders in an image.

E. BLOOD CELL COUNTING

Counting algorithm is applied to measure number of RBCs and WBCs. The most popular method used for counting is connected component labeling. Counting of RBCs and WBCs is done by finding number of connected components in segmented image [14]. It labels the connected objects in an image [2], [3], [9]. P. S. Hiremath et al. [12] used these labels

for the subsequent feature extraction procedure. CHT is also a popular method for counting RBCs in an image. CHT counts number of circular objects i.e. RBCs in an image [3], [9] [10].

V. CONCLUSION

This paper is based on detection of diseases & counting blood cells from different blood sample images, it is important for every human being to know about their blood cells. Our implemented algorithms are k-means clustering algorithm and Hough transform. These two methods include extraction of cells, count of cells and time calculation for getting output. This will develops an approach used to count white blood cells in blood image without the use of microscope, because using the microscope is very much costlier process. Image processing based method of cell counting is fast, cost effective and produces accurate results. MATLAB software is used for the analysis. This method is very beneficial for people by detecting the desired disease, at earlier stage. So that they can have their proper treatment .

Acknowledgment

With profound feeling of immense gratitude and affection, i would like to thank my guide Dr. P. D. Khandait, Dept. of Electronics Engineering for his continuous support, motivation, enthusiasm and guidance. His encouragement, supervision with constructive criticism and confidence enabled me to complete this research.

References

1. Pawan Agrawal and PradiptiVarma “Automated Detection and Counting of Red Blood Cell using Image Processing Techniques”,International Journal of scientificresearch and management, Vol. 3, Issue 4, pp. 2692-2695, 2015.
2. Pooja R. Patil, G. S. Sable and Gauri Anandgaonkar, “Counting of WBCs and RBCs from Blood Images Using Gray Thresholding”, International Journal of Research in Engineering and Technology, Vol. 03, Issue: 04, April2014.
3. Thejashwini M and M C Padma “Counting of RBCs And WBCs using Image Processing Techniques”, International Journal on Recent and Innovation Trends in Computing and Communication, Vol. 3 Issue: 5, May 2015.
4. Amruta Pandit, Shrikrishna Kolhar and Pragati Patil “Survey on Automatic RBC Detection and Counting”, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 4, Issue: 1,January 2015.
5. Naveen Jambhekar, “Red Blood Cells Classification using Image Processing”, Science Research Report 1(3): pp. 151-154, November 2011 .
6. S. Kareem, R.C.S Morling and I. Kale, “A Novel Method to Count the Red Blood Cells in Thin Blood Films”, IEEE International Symposium on circuits and systems, pp. 1021 – 1024, May – June 2011.
7. Madhuri G. Bhamare and D. S. Patil, "Automatic Blood Cell Analysis by Using Digital Image Processing: A Preliminary Study", International Journal of Engineering Research & Technology, Vol. 2,Issue: 9, September2013.
8. Mojtaba Taherisadr Mona Nasirzonouzi, BehzadBaradaran and Alireza Mehdizade, “New Approach to Red Blood Cell Classification Using Morphological Image Processing”, Shiraz E-Medical Journal, Vol. 14, January 2013.
9. Sumeet Chaurasiya and G Usha Rani, “Automatic Red Blood Cell Counting using Watershed Segmentation”, International Journal of Computer Science and Information Technologies, Vol. 5, pp. 4834-4838, 2014.
10. . Mausumi Maitra, Rahul Kumar Gupta and Manali Mukherjee, “Detection and Counting of Red Blood Cells in Blood Cell Images using Hough Transform”, International Journal of Computer Applications, Vol. 53, September 2012. .
11. Siti Madihah Mazalan, Nasrul Humaimi Mahmood and MohdAzhar Abdul Razak, “Automated Red Blood Cells Counting in Peripheral Blood Smear Image Using Circular Hough Transform”, First IEEE International Conference on Artificial Intelligence, Modelling & Simulation, pp. 320 – 324, 2013.
12. . P. S. Hiremath , Parashuram Bannigidadand Sai Geeta, “Automated Identification and Classification of White Blood Cells (Leukocytes) in Digital Microscopic Images”, ”, International Journal of Computer Applications, Special Issue on ―Recent Trends in Image Processing and Pattern Recognition I , 2010.
13. Nasution, AMT and EK Suryaningtyas, “Comparison of Red Blood Cells Counting using two Algorithms: Connected Component Labeling and Back projection of Artificial Neural Network”, IPGC 2008, IEEE, 2008.
14. K.S. Kim, P.K. Kim and J.J. Song, “Analysing Blood Cell Image to Distinguish Its Abnormalities”, 8Th ACM international conference on Multimedia, 2000.
15. Adnan Khashman and Esam Al-zgoul, “Image segmentation of blood cell in Leukemia patients”, Recent Advances in Computer Engineering and Applications, N. CYPRUS, 2009.

16. S. S. Savkare and S. P. Narote, “Automatic Classification of Normal and Infected Blood Cells for Parasitemia Detection”, International Journal of Computer Science and Network Security, Vol. 11, February 2011.
17. Saransh Saxena and Naveen Yadav, “Segmentation using Morphological Watershed Transformation for Counting Blood Cells”, International Journal of Computer Applications & Information Technology, Vol. 2, Issue: 3, Apr-May 2013.
18. Monika Mogra, ArunBansel, Vivek Srivastava, “Comparative Analysis of Extraction and Detection of RBCs and WBCs Using Hough Transform and k- Means Clustering Algorithm”, International Journal of Engineering Research and General Science Vol. 2, Issue: 5, pp. 670 – 674, August-September 2014.
19. Minal D. Joshi, Atul H. Karode, and S. R. Suralkar,"White Blood Cells Segmentation and Classification to Detect Acute Leukemia" , International Journal of Emerging Trends & Technology in Computer Science, Vol. 2, May – June 2013.
20. Naveed Abbas and Dzulkifli Mohamad, "Microscopic RGB color images enhancement for blood cells segmentation in ycbcr color space for k-means clustering", Journal of Theoretical and Applied Information Technology, Vol. 55,september 2013.
21. Venkata lakshmi. B and Thilagavathi. K, “Automatic Red Blood Cell Counting Using Hough Transform”, Proceedings of IEEE Conference on Information and Communication Technologies, pp.268-270, 2013.
22. Fabio Scotti, “Automatic Morphological Analysis for Acute Leukemia Identification in Peripheral Blood Microscope Images, ICoCIMSA 2005 – IEEE, 2005.
23. Seyed Hamid Rezatofigh, KosarKhaksari, and Hamid Soltanian Zadeh, “Automatic recognition of five types of white blood cells in peripheral blood”, 7th International Conference, ICIAR 2010, Póvoa de Varzim, Portugal, June 2010.