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Identification of Blood Group and Blood Cells Through Image Processing

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Abstract **- In a human body, blood plays a major role in delivering oxygen and providing nourishment. So, it's very important to have a proper analysis of blood cells and the blood group of a person. Blood is classified into different groups based on the antigen and antibodies present on it. Blood transfusions can be done only between people of same blood group type. If not, it can be fatal. So, it is very important to know the blood group of oneself. Blood cells contain different components such Red Blood Cells (RBC), White Blood Cells (WBC) etc. The number of RBC and WBC in a human body plays a major role in indicating the health condition. Currently, Lab technicians conduct these tests manually which is time consuming and need a lot of human intervention. There may be a chance of human errors. So, to overcome these problems related to cost, time errors, a software-based methodology is proposed that process the images obtained from the laboratories through image processing techniques and gives the blood group type and blood cells count. A preprocessed dataset has portions for training and validation. Disease detection based on machine learning is also equipped. The system takes very less time for execution and gives high accuracy.**

Keywords **– Image Processing, Median Filter, Histogram Equalization, ANN**

I. INTRODUCTION

Blood group types were first discovered in 1901 by Austrian Karl Landsteiner. There are different systems to determine the blood type of a person out of which ABO blood group system and RH d blood group system are most widely used. This process of testing and identifying the blood group type of a person in called blood typing. The results obtained in blood typing must be very accurate. In case of blood transfusing, there might be a chance of incompatibility if other type of blood is used, which may lead t intravenous clumping and can be fatal. Generally, these tests are carried out manually by the technicians in the laboratories which require a lot of human effort and may there may be a chance of having wrong results as human are tend to make errors. Therefore, there is a scope for determining blood group through a software by using image processing techniques. In biomedical engineering, blood cells analysis is of high importance in determining any deficiencies in the body if present. The main purpose of the blood cells analysis is to identify different blood components, particularly Red Blood Cells and White Blood Cells and to count them. This count helps in determining the persons health condition. Any abnormal reading of any of these cells can give the sign of disease or infection.

Conventional methods are carried manually by lab technicians which requires long time for analysis. Also, these tests need sophisticated equipment which are costly and can't be afforded by developing countries or in rural areas. When there are huge number of samples to be processed, a lot of human intervention and skill is required which limits the accuracy and speed. So an alternative software based system that is cost effective and efficient can be designed that can automatically detect and count the cells in a blood cell image.

The main objective of our proposed system is to identify the blood group type of a person from his blood sample image, detect the number of WBC and RBC present in microscopic image of Blood, and to find whether the cell is diseased or not based on the WBC structure.

II.LITERATURE SURVEY

Siti Madihah Mazalan, Nasrul Humaimi Mahmood and Mohd Azhar Abdul Razak [1] used pre-processing techniques like color conversion and binary conversion. For differentiating the RBC from blood smear image, thresholding and then image contrasting is done. Further the colored image is converted to grayscale image and image quality is increased through contrast enhancement. This is further converted to binary image making it easy for further processing.

Chunni Dai and Jingao Liu [2] did not use any pre-processing techniques, they studied and worked on hyperspectral blood cell images. The images are obtained by molecular hyperspectral imaging system from the

leukemia blood smear images. For extracting the features of blood cells, they used spectral feature extraction.

J. Theerapattanakul, J. Plodpai and C. Pintavirooj [3] used binary conversion as basic signal pre-processing technique for segmenting white blood cells. By thresholding they converted the WBC image into binary image. WBC nucleus location is detected by looking up for binary value '1' in the background.

Fabio Scotti [4] used contrast enhancing and low pass filtering (Gaussian filter) as a pre-processing step for blood cell image analysis. By using gray scaling technique, the background from the original image identified and removed. Gaussian low pass filter is used on image as the background consists of low spatial frequencies than blood cells and thus the background can be reconstructed. Also, high spatial frequency noise is generated while calculating mean image. So, gaussian low pass filter is again applied on mean image and the obtained a low contrast image. So, contrast stretching is used and segmented the WBC cells.

Mostafa mohamad and Behrouz Far [5] used green plane components as gray scale image from RGB Color image. For preprocessing, contrast stretching and histogram equalization are used to adjust intensity levels and to improve contrast respectively, by which image can be identified easily. Further the image is converted to binary image and post-processed. The proposed model gave an accuracy of 80% in detection of blood cells

III.PROPOSED METHOLOGY

A. Software and hardware requirements used

MATLAB software of version 9.4.0 R2018a has been used.

Hardware required:

1. A Dell laptop of 64bit OS.
2. Mobile phone camera.

In our system, for blood group detection we need to capture images of blood images through mobile phone.

And we have collected images dataset for blood cells count from online sources such as Kaggle.

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B. Database collection

For RBC and WBC count, the dataset is collected from online sources, which has microscopic image of a blood sample. For blood group identification, Blood samples taken on a glass slide is captured with a mobile camera ensuring the background is clear. These digital images are used in training and testing the model.

To examine blood group, 40 blood sample images were used. And for RBC and WBC count detection the system is trained over 300 images of microscopic blood cell. Figure 1 and 2 show the database images collected.

Figure 1: Dataset images for Blood Group detection

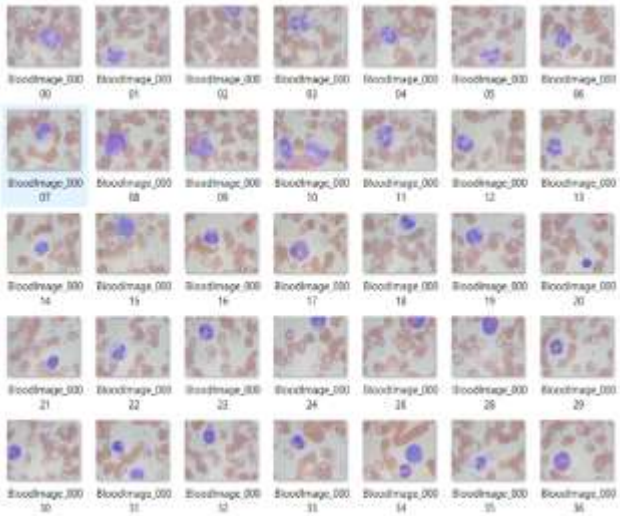

Figure 2: Dataset images for Blood cells count

C. Model Architecture

The System is designed through image processing and machine learning. The process of performing required operations on a digital form image is called image processing. The model generally considers the digital images as a 2d signals when preprocessed. It includes various operations such as enhancement, histogram equalization, morphological operations etc. in order to extract some required features that are associated with it.

The proposed system has 3 important functions: Identification of Blood group, RBC and WBC detection and Count, abnormality detection based on WBC Structure. Initially the system asks to upload an image, and further performs some image processing techniques. A basic image processing block diagram is shown below.

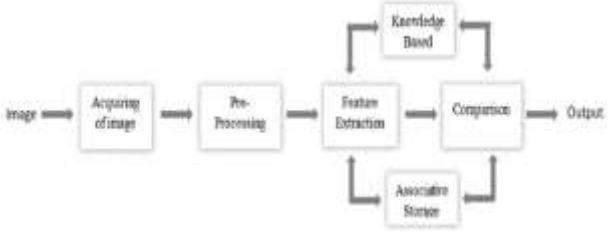

Figure 3: Basic Block Diagram of Image Processing

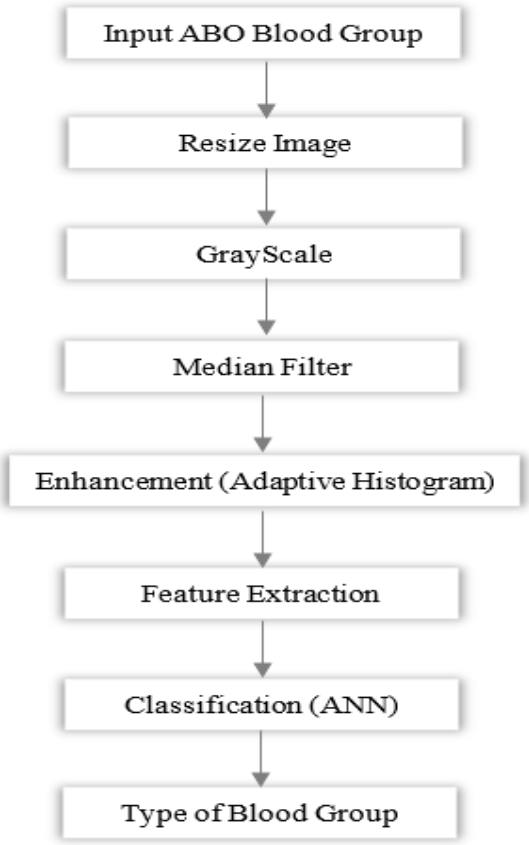

Figure 4. Block Diagram of Blood Group Identification

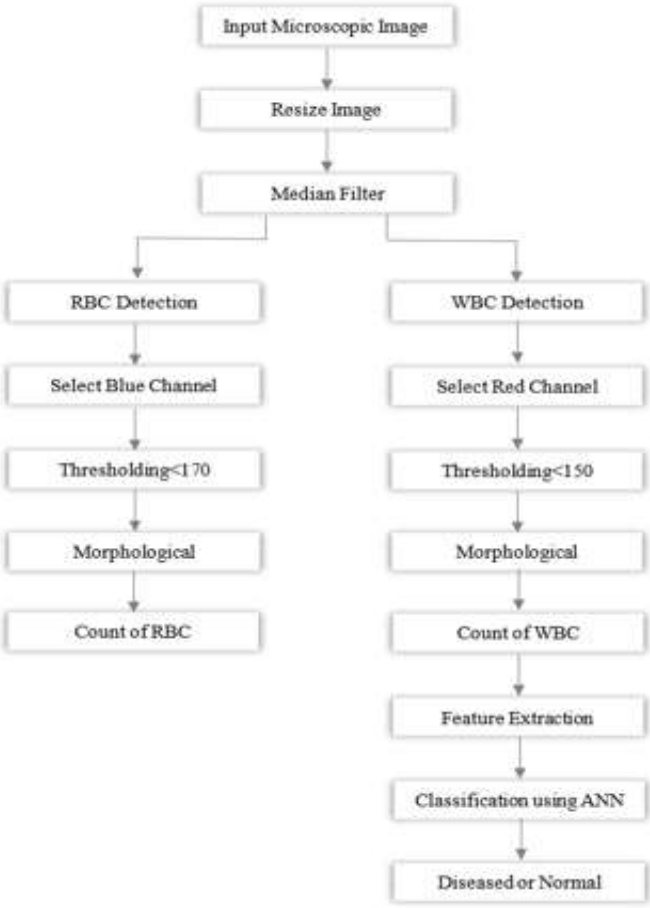

Figure 5. Block Diagram of RBC and WBC Detection

- **Gray Scale:** In digital image processing, generally the colored images is first converted into gray scale image. It is a Black and white or gray monochrome image. In gray scale image, each pixel is considered as a sample and this sample represents the intensity of light of that particular image. In other words, the gray scale image holds the information about intensity levels of the image. If the intensity is low, the contrast ranges to black. And while the intensity increases, the contrast range moves from black to white.

- **Median Filter:** Median Filter is a filter that is used in digital signal and image processing. It is a non-linear filter, generally used to reduce noise. In digital processing, it is generally used as a pre-processing step. Median filter plays a major role in improving the results of the further processing steps. It also preserves edges while removing noise, which is why it is most widely used

- **RGB plane:** Every image is a combination of different colour planes. RGB plane is one such plane, where the image is split into 3 primary-coloured planes, namely, Red, Green, Blue over stacked one upon other, resulting in a original colour image. Below is an example for the colour plane splitting into RGB plane. In the left you find the isolated colour channels in original colours and to the right are their grayscale equivalent images

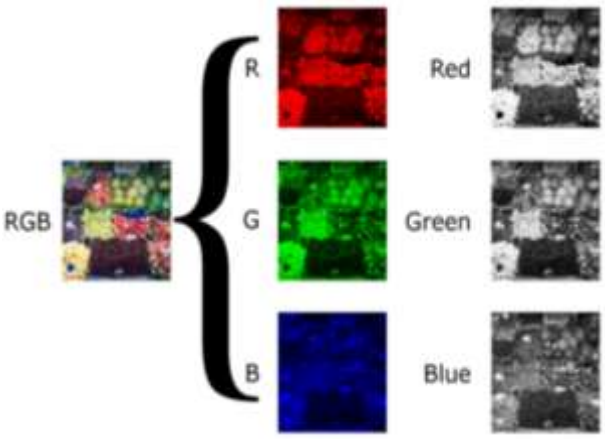

Figure 6. RGB Plane and their gray equivalents

- **Histogram Equalization:** Histogram is a graphical representation that gives information about the grayscale and contrast of an image. Image becomes darker if the histogram of image is moved to the left end of the x axis and when it is inclines towards right, it becomes brighter. If the histogram is narrow at the centre of intensity plot, its image possesses low contract, and when evenly distributes over x axis, the contrast increases.IT is a data structure that stores frequencies of the pixel's values of the image.
  In image processing, improvement of contrast of an image is very important, which can be achieved by histogram equalization. In this

process, the image histogram is distributed over intensity axis uniformly with an appropriate intensity transformation function.IT can be done by computing the histogram and normalizing into probability distribution.

- **Feature extraction**: It is achieved through GLCM. The Gray Level Co-occurrence Matrix (GLCM) is an image processing technique used for analysis of different texture features and calculations. It gives information about various combinations of gray levels that co-occur in a image.IT is used in measurement of variations in the pixel's intensity.

- There are different GLCM texture features such as listed below.

a) **Energy**: In GLCM, energy gives the summation of the squared elements.

$$\text{Energy} = \sqrt{ASM}$$

Where ASM is the Angular Second Moment and is given by

$$\text{ASM} = \sum_{i,j=0}^{N-1} P_{i,j}^2$$

b) **Homogeneity:** It is a measure of the closeness that is distributed among int elements between the GLCM and its diagonal.

$$\text{Homogeneity} = \sum_{i,j=0}^{N-1} \frac{P_{i,j}}{1+(i-j)^2}$$

c) **Entropy**: Provides the randomness in neighbourhood values of intensity that is used to characterize the input image texture

$$\text{Entropy} = \sum_{i,j=0}^{N-1} P_{i,j}(-\ln P_{i,j})$$

d) **Contrast:** Used to measure the local variations that occur in GLCM

$$\text{Contrast} = \sum_{i,j=0}^{N-1} P_{i,j}(i-j)^2$$

e) **Correlation:** For a specific pixel pair values in GLCM, Correlation is used to measure the occurrence of joint probability

$$\text{Correlation} = \sum_{i,j=0}^{N-1} P_{i,j}\left[\frac{(i-\mu_i)(j-\mu_j)}{\sqrt{(\sigma_i^2)(\sigma_j^2)}}\right]$$

where

$$\mu_i = \sum_{i,j=0}^{N-1} i(P_{i,j})$$

$$\mu_j = \sum_{i,j=0}^{N-1} j(P_{i,j})$$

$$\sigma_i^2 = \sum_{i,j=0}^{N-1} P_{i,j}(i-\mu_i)^2$$

$$\sigma_j^2 = \sum_{i,j=0}^{N-1} P_{i,j}(j-\mu_j)^2$$

P_{ij} = Element i, j of the normalized symmetrical GLCM.

N= Number of gray levels in the image as specified by Number of levels in under Quantization on the GLCM texture page

μ = GLCM mean

σ^2 = Variance.

- **Artificial Neural Network:** For training the proposed system model, (Artificial Neural Network) ANN is used. It is a parallel computational model that has many processing units to receive input, process the inputs based on predefined activation function and gives appropriate output. A neuron or a perceptron is the basic unit of ANN. It is a processing element which computes all the operations, and all the neurons are interconnected. It consists of input layer, Hidden layer and output layer. Based on the requirement, any number of hidden layers can be equipped.

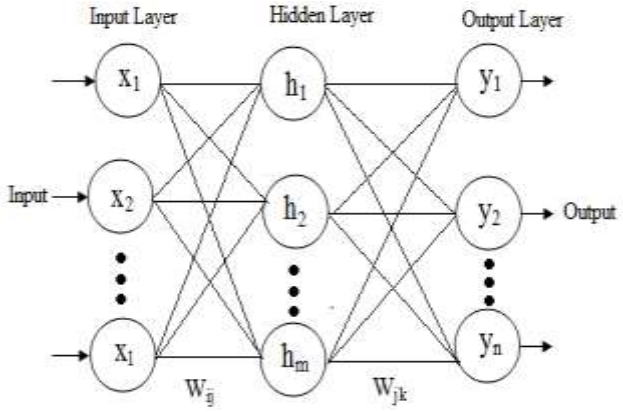

Figure 7. Feed Forward Neural Network

Here all the input nodes, hidden layer nodes, output layer nodes are represented by 'x', 'h' and 'y' respectively. Weights are assigned between layers, 'Wij' represents the weights between input layer and hidden layer and 'Wjk' represents the weights between hidden layer and output layer.

(a) Input Layer: The input layer is responsible for taking the inputs and forwarding it to hidden layer by assigning corresponding weights. Usually, the training data is given as input.

(b) Hidden layer: Hidden layer is mainly responsible for the determining the accuracy of the entire network. The accuracy is dependent on the number of nodes in this layer. Based on the requirement, any number of hidden layers can be implemented.

(c) Output layer: It is responsible for giving the output based on the pre-processing done at previous layer. The number of nodes in the output is dependent on the number of data parameters we required at target. Based on the topologies the ANN are classified into Feed

forward and feedback networks. In Feed forward neural networks, for training the data, a supervised learning method, back propagation is used. Initially the network has random weights assigned between layers and a processed to get output. When error is generated, the weights are modified by using this error and computed.
The procedure of back propagation algorithm is given as follows.

a) Input training dataset is given to the input layer.
xi = (x1, x2, ... xl)

b) Net input to hidden layer unit

$$net_{ih=\sum_{i=1}^{m} W_{ij} x_i}$$

c) output of hidden layer unit

$$h_{oh} = \int (net_{ih})$$

d) net input to output unit

$$net_{io=\sum_{j=1}^{l} W_{ij} h_{oh}}$$

In our model the inputs are 13 i.t the feature that are needed to be extracted namely, contrast corellation, skewness, homogenity, energy, entropy etc. and 24 hidden layers are used

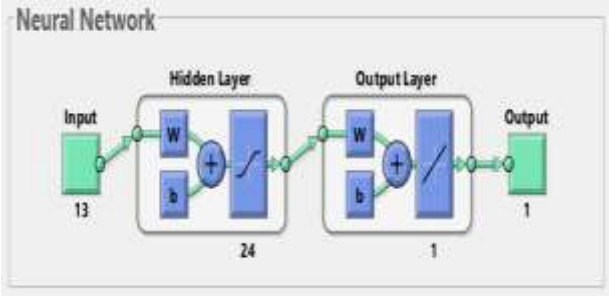

Figure 8. Neural Network

Confusion Matrix obtained for cell Diseased identification is shown in figure 9.

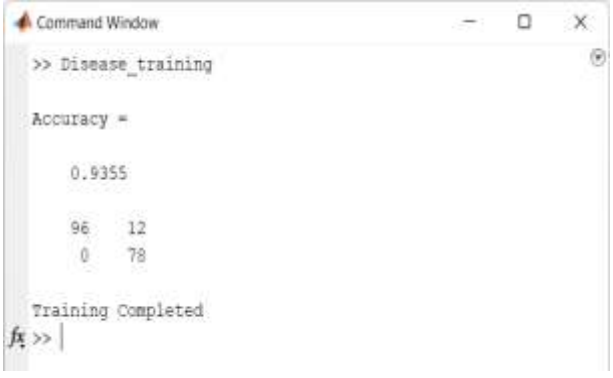

Figure 9. Confusion Matrix for Diseased Identification

Confusion Matrix obtained for Blood Group identification is shown in figure 10:

Figure 10. Confusion Matrix for Blood Group Detection

IV. RESULTS AND PERFORMANCE:

Initially, A GUI window opens asking to select an image for WBC and RBC count as shown in Figure 11.

Figure 11. Image Selection for RBC and WBC count

On selecting the image from the blood cells images, the image is processed into gray scale image, median Filtered image, Binary and Morphological images as shown in figure 12.
On being processed, it classifies the RBC and WBC areas. Based on the structure of WBC cell, it determines whether the cell is normal or diseased.

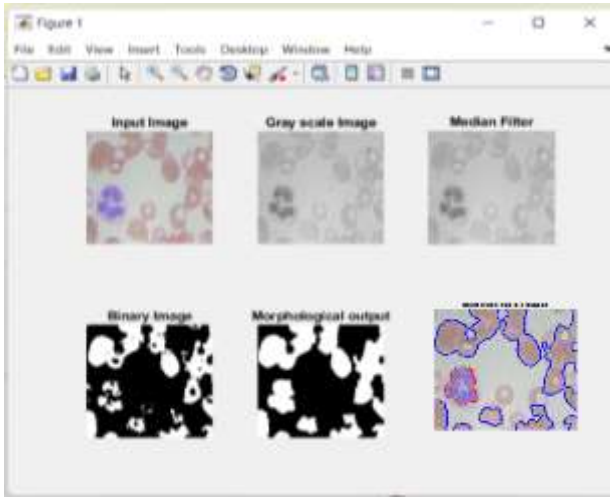

Figure 12. Output Images of RBC and WBC Detection

Then another GUI window appears asking to select an image for Blood group Classification as shown in figure 13. On Selecting the image, based on the training model, it determines the group of the blood.

Figure 13. Image Selection for Blood Group Detection

The Selected image is used for Blood group Detection and it is processed into gray scale and median diltered images as shown in figure 14.

Figure 14. Output Images of Blood group Detection

Finally the rbc count,predicted count of RBC cells in the whole body, wbc count, blood group type, and the cell condition is displayed as shown in figure 15.

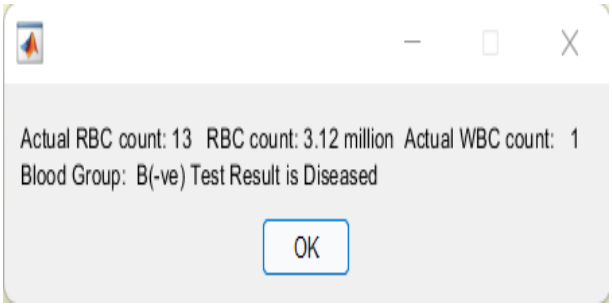

Figure 15. Final Result

The Performance Plot obtained for cell Diseased identification is shown as in figure 16.

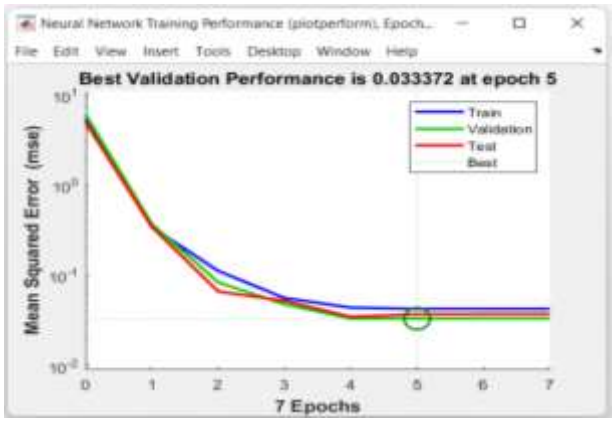

Figure 16. Performance Pot for Diseased Detection

The Performance Plot obtained for Blood Group identification is as follows:

Figure 17. Performance Pot for Blood Group Detection

Blood group	*No. of samples collected*	*No. of samples recognized correctly*	*Recognition rate*
A positive	27	26	96.29
B positive	43	42	97.67
A negative	10	10	100
B negative	26	25	96.15
AB positive	30	30	100
AB negative	30	30	100
O positive	24	24	100

Figure 18. Blood Group Detect Recognition Rate

On taking the average accuracy of the model, it is found that the system shows an accuracy of 98.5%.

V. CONCLUSION:

A software-based automated system using image processing Mechanisms has been developed for identifying and classifying the blood group, detecting and counting Blood cells. The proposed system provides accuracy above 87%. It is simple, cost effective, and yields very fast results. It works effectively for blood group identification and the cells count automatically with very less human intervention.

VI. FUTURE SCOPE:

The RBC count is obtained only for the microscopic image and the total RBC cells in the body is predicted. Whereas for WBC only the number of cells present in microscopic image is detected. Later in future, by working upon finding the density, depth of the blood from the image, we can be able to acquire the WBC count for whole human body of a person.
Also based on the count classification and the structure there is a scope to find out different types of diseased like leukemia, anemia etc.

VII. REFERENCES:

[1] J. M. Sharif, M. F. Miswan, M. A. Nagdi, Md Sah Hj Salman, "Red Blood Cell Segmentation Using Masking and Watershed Algorithm: A Preliminary Study", IEEE International Conference on Biomedical Engineering, 2012

[2] Raymond Joseph Meimban; Alexa Ray Fernando; Armil Monsura; Jonrey Rañada; J.C Apduhan," Blood Cells Counting using Python OpenCV" : 2018 14th IEEE International Conference on Signal Processing (ICSP)

[3] Pradipta Maji, Ankita Mandal, Madhura Ganguly, Sanjay Shaha, "An Automated Method for Counting and Characterising Red Blood Cells using Mathematical Morphology", IEEE,2015.

[4] G Elizabeth Rani.; Harini Mohan; Bendela Kusuma; P Shiridi Kumar; Ardhala Mounika Jenny; Nukala Akshith" Automatic Evaluations of Human Blood Using Deep Learning Concepts, **:** 2021 6th International Conference on Signal Processing, Computing and Control (ISPCC),IEEE,2021

[5] 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, 2014

[6] Pawan Agrawal and Pradipti Varma, "Automated Detection and Counting of Red Blood Cell using Image Processing Techniques", International Jornal of scientific research and management, vol. 3, pp. 2692-2695, 2015.

[7] Akshaya P. Sahastrabuddhe, "Counting of RBC and WBC using Image Processing: A review", International Journal of Research in Engineering and Technology, vol. 05 2016

[8] Fabio Scotti, ―Automatic Morphological Analysis for Acute Leukaemia Identification in Peripheral Blood Microscope Images‖, ICoCIMSA 2005 – IEEE, 2005

[9] H. Berge, D. Taylor, S. Krishnan, and T. S. Douglas, "Improved red blood cell counting in thin blood smears," in Proceedings of the 8th IEEE International Symposium on Biomedical Imaging: From Nano to Macro (ISBI '11), pp. 204–207, Chicago, Ill, USA, April 2011.

[10] Thejashwini M and M C Padma , "Counting of and WBC's Using Image Processing Technique", International Journal on Recent and Innovation Trends in Computing and Communication, vol. 3 , no. 5, pp.2948 – 2953 , 2015

[11] Ravindran G., Pandiyan P., Pravin M.,"Determination andClassification of Blood Types using Image Processing Techniques ",*International Journal of Computer Applications (0975 – 8887),* Volume 157– No 1, January 2017.

[12] Tejaswini.H.V, M.S. Mallikarjuna Swamy, "Determination and classification of blood types using image processing techniques" ITSI Transactions on Electrical and Electronics Engineering (ITSI-TEEE)", Volume-2, Issue-2-2014, pp.29-33.

[13] M.R.Brown, P.Crim, "Organizing the antibody identification process" Clin Lab Sci, Vol.20, 2007, Pp.122-126.

[14] A. S. Prasad, K. S. Latha, and S. K. Rao, "Separation and counting of blood cells using geometrical features and distance transformed watershed," International Journal of Engineering and Innovative Technology (IJEIT), vol. 3,no. 2, 2013.

[15] A. Dada, D. Beck, G. Schmitz. (2007). "Automation and Data Processing in Blood Banking Using the Ortho AutoVue® Innova System". Transfusion Medicine Hemotherapy, vol. 34, pp. 341-346. Available: Kargerwww.karger.comltmh

[16] P.Maji, A.Mandal and M.Ganguly and S.Saha (2015), An Automated method for counting and characterising Red Blood Cells using mathematical morphology - IEEE International Conference on Advances in Pattern Recognition (ICAPR), Pg:1 – 6.