Review on Detection and Counting of Red Blood Cells

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Abstract— Blood is the identifier of person's health. Blood contents are normally white blood cells, red blood cells and blood platelets. All these three indicates the person's health according to their range in blood. Hence at primary level of diagnosing the complete blood cell count is very important. And to analyze this count there are two methods which basically used everywhere in laboratories that are manual counting under microscope and hemo cytometer. Manual counting the blood cell under microscope is very stressful and sometimes give inaccurate count. Another methodology to count the blood cells is using Hemo Cytometer. It is very expensive and quite possible to make it available in every laboratory. So the techniques here will provide the count in real time and cost effective.

Key words: Image processing, MATLAB, Hough Transform, Gray level thresholding, Fuzzy C means, k means clustering

I. INTRODUCTION

Nowadays image processing is used in variety of applications from automated industries to medical etc. Generally pixels are grouped in an image and the labeling technique is used to identify the structuring element. In medical applications the various tumors of cancers can be diagnosed by structuring element features.

Red blood cells are scientifically known as erythrocytes. With the circularity systems of body red blood cells are known to provide Oxygen (O2) to body tissues. From the Lungs and Gills the Oxygen is taken by red blood cells and it is released to tissues. Red blood cells are enriched with hemoglobin and iron containing biomolecules that can bind Oxygen so they provide the red color to blood cells. Red blood cells in human body and their diameter ranges from 6.2 to 8.2um approximately. Its maximum thickest point ranges from 2 to 2.5 and the minimum thick point in the centre is from 0.8 to 1um. Blood diseases related to red blood cells include Anemia- iron deficiency anemia, sickle cell disease, aplastic anemia, pure red cell aplasia and Hemolysis, Polycythemia.

Today the blood cell counting in laboratory is done by two methods. First is traditional method that is testing he blood under microscope. And another method is use of Hemo cytometer. The traditional method means testing the blood under microscope can be known as manual method. By using this method the cells are classified and then counted. Hence the method becomes slower, quite time consuming and sometimes stressful. This delays the diagnosing procedure because of manual interpretations. Accuracy of result can be affected because of human tiredness. So the human errors are added into the result. Another methodology to count the red blood cells is Automated Hemotology Center. This includes the Hemo cytometer to count the blood cells. This gives the efficient result. But the fact, machineries are very expensive and are not affordable to every laboratory to make it available in country.

As a need to provide automated, cost-effective and efficient alternative to detection and counting of RBCs image processing techniques are effective. If we offer a computer vision system then it will be faster and real time.

II. METHODOLOGY

The red blood cells means Ethrocytes are small as compared with other cells. And they are in reddish color. They are identified from their size, color and shape. Normally the healthy red blood cell is in disc shaped. Quantity of red blood cells is higher than any other cell in blood. So the red blood cells can be detected from their above features. There are different methods to identify the red blood cell from blood.

A. Hough Transform Method

In [1] discussed the method to diagnose a patient using telecommunication technology. This is very useful to diagnose the patient lives in rural and critical area where rare facilities of diagnostic. In acquisition stage the setup of camera is used to capture images of blood sample. The setup of camera is microscopic. In preprocessing step image is converted to saturation. Then segmentation is carried out from the histogram. Thresholding point is set and segmentation is done. Morphological operations are carried to separate the red blood cells from the white blood cells and platelets. White blood cells are masked and remained only red blood cells. Then again morphological operations are done to separate out overlapping red blood cells. In this paper the white blood cells also detected along with red blood cells from nucleus and features of white blood cells. And red blood cells are detected using hough transform. Method described in paper provides result faster than manual counting method.

In paper [2] the images are captured using optical laboratory microscope connected with canon power shot G5 camera. In a preprocessing stage for better noise removal median filter is used to overcome the shot noise also salt and pepper noise. Small platelets also removed by median filter. Then the image is cleared for red blood cells and white blood cells identification. Then the image is converted to gray scale. Green component and blue components are subtracted from the image. The image then purely consists with red blood cells. The cells are then located by using Hough Transform method. For more accuracy the overlapping circles are removed from results. The true accuracy they have described is 94.64%.

In paper [3] discussed the application of sickle cells detection using hough transformation method. The method discussed in the paper separates the overlapping cells which is almost not possible with hemotology analyzer. First the original image is converted to grayscale the purpose of conversion is to retain only intensity information. The histogram of image carried out from that the contrast is adjusted to perform the thresholding. Then Heywood's circularity parameter is calculated. The value of it is 1 for

circle and differs with shape of object. Parameter also called as form factor. With a form factor value the sickle cells are detected. The true accuracy specified by them is 91%.

B. K Means Clustering

Clustering as well as classification techniques are discussed in paper [4]. This algorithm is applied when there are varieties of shapes or features of objects at input. The key technique discussed in paper is k means clustering. The main reason for using this algorithm is for real time response application. Clustering technique carried out the clubbing of objects. Similar objects according to features are clubbed into one cluster and remaining clubbed into remaining cluster. Clustering techniques have two subtypes. One is Hard clustering and Hierarchical clustering is second one. The research described by considering Hard clustering. In this method first the value of k is selected as per desired clusters. Then from the value of k is determined the centre value can be got. Then similar shapes or features data is set into cluster as per k number. Again new k value is calculated by considering old k value. This calculation is performed for maximum number of count to reach. This algorithm is very fast, complexity also less and no wider memory is required. Accuracy achieved by using k means clustering is 83%.

In paper [5] described k means clustering by different approach. In input preparation phase instead of thick blood smear images the thin red blood cells images are selected. De noising step is carefully avoided to save object properties and remain unchanged. Then conversion from RGB to YCbCr is carried out. Additionally separate channels are formed. Every time the separate histogram is taken for separate channels. After taking histogram for channel equalization of it is done. Then all channels are merged to get a single image.

C. Watershed Technique

In [6] discussed a paper in which Watershed technique is described. WBC counting is taken in the paper but the same approach can be used for RBC counting. In watershed technique the intensity values are described in terms of Hills and Valleys for high intensity and low intensity. Every separate low intensity value fill up by various color of water. That means the valleys are labeled by a different color. As the flow of water increased then valley start to form a path of colors. But when valley sizes are going to increase then valleys get mix and result into mixture of two colors. So need to locate barrier between two boundaries of color. First the object region needs to specify by one color and locate it by one color. And non object region background is labeled by different color.

In paper [7] two phases are described first is image segmentation and next is counting methods. In segmentation process the importance of mathematical morphology in the application of segmentations of image is discussed. Mathematical morphology offers good feature description like boundary, texture etc. After image preprocessing the thresholding of an image is carried out. 1 specifies the object in image and 0 is specified as background. The same kind of technique is discussed in paper to overcome noise and to image enhancement. Image is subdivide in two form, one it is converted into HSV form and in second only green component of image are extracted. The reason behind the division is better RBC detection. Morphological operations are taken on image to distinguish the overlapping cells. After the erosion gradient magnitude is applied together so the watershed algorithm is formed by together masking. After all the procces the divided images are superimposed on each other to get original one. The accuracy depend on the camera type and quality used and size of RBCs captured.

D. Connected Component Labeling

In [8] discussed that the cells are healthy then its boundaries are easily determined because they are separated and if the cells are unhealthy and infected then its edges or boundaries are not cleared or sharp. Firstly they have adjusted contrast to distinguish it from background. It is optimized to both cells first the healthy that is normal and second for infected. Then the image converted into gray levels. The Sobel edge detector technique used to carry out boundaries of cells. To clearly define the outlines of cells the morphological operation dilation is optimized. The gaps between the cells are filled and then smoothing operation is performed. The image then eroded. And the components are counted using connected component labeling. True accuracy obtained through their research is 70%.

E. Fuzzy C Means

In paper [9] stated the Fuzzy C means approach. In image preprocessing step the bitmap image or JPEG format image is selected. Normal enhancement and de-noising steps are carried out in this step. In image segmentation step only object specifying area is selected. According to pixel labeling the object in image can be identified. Feature extraction is carried out using thresholding method. Feature extraction is performed by identifying the properties of cells according to their radius, diameter and color. Fuzzy logic then applied after completion of features extraction. Fuzzy logic works on basis of partially true conditions rather than completely true as well as completely false. It continually checks and compares the parameter value of cell and locates the cells. It is appreciable job of neural network. Then cells can be highlighted according to features value and then counted. Accurately detection ability to cells is more than above prescribed methods. But the decision making time and memory requirement is quite more in this case.

F. Gray Level Thresholding

In paper [10] discussed blood cell counting using grey level thresholding. Blood cells classification is carried out in 4 steps as image pre-processing, image segmentation, image post processing and blood cell classification. In image pre-processing step the image is first taken by the microscopic setup or from medical library. Next the image is transferred in RGB format. Median filtering is done to reduce the salt and pepper noise from image. Then in image segmentation method thresholding performed using Otsu's method. Intra class variation is reduced using Otsu's method. The hole filling done after segmentation. So the cells are recognized properly. Borders do not contain sufficient information so removed hence automatically complexity is reduced. Connected component labeling is performed for 4 and 8 connected objects. Then WBC AND RBCs are classified by applying formula described in paper. Accuracy is 94.58% as suggested in paper.

III. CONCLUSION

Conventional methods use manual counting, and counting time for blood cells is more as compared with all above methods. Hemotologist manually identify blood cells under microscope and then classify that cell as red and white BC. The procedure for counting is quite slow and adds sometimes human error into result due to tiredness. The proposed work will be restricted for counting of only RBC's in blood sample. All the above methodologies described are functioned on images which are taken under microscope using setup, detection and counting performed using MATLAB. As a need to provide automated, cost-effective and efficient alternative to detection and counting of RBCs image processing techniques are effective. Hough transform is popular method for detecting lines, curves and various shapes of object in image. Using circular hough transform for detection of RBCs provided more accurately. Using a Fuzzy c logic the detection of cells is done accurately. But to achieve more accuracy the number of sample training images should have to increase. Connected component labeling, Watershed algorithm and Gray level thresholding provide better segmentation for detecting RBCs. From the methodologies discussed the count of RBCs is achieved faster and in real time.

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