IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661, p-ISSN: 2278-8727, Volume 20, Issue 3, Ver. III (May. - June. 2018), PP 53-60
www.iosrjournals.org

Detection of Abnormal RBCs using Signatures

Snehal Bhogan[1],Meghana Pai Kane[2], Sheetal Inas D'souza[3], Prachi Kamat[4], Meeth Nagda[5]

[1,2]*(Asst. Prof., Computer Engineering Department, AITD, Goa University, India)*
[3,4,5]*((B.E Student, Computer Engineering Department, AITD, Goa University, India))*

Abstract : *Image processing techniques are mostly useful in medical science for detecting various diseases , infections , tumors , cells abnormalities , and various cancers . To detect a particular disease and curing it on time is very important in todays world for saving life . Mostly when patient is serious, and the waiting time of patients reports is more in case of blood test . The time taken for generation of any blood report is minimum 1 hour and this can be risk. The system which is being used currently by the doctors for identification of the blood samples is costly and even generation of the reports takes time which leads to loss of patients life . Also , the pathological tests expensive , which are sometimes not affortable by the patient. This paper basically tells us the technique to detect the normal and abnormal red blood cells in comparitively less time. The proposed technique also shows different categories of abnormal red blood cells based on the Signature Method.*

Keywords – *Dilation, Edge, Erosion, Foam factor ,Fourier Descriptors, Gradient, Intensity ,Opening, pixel.*

I. INTRODUCTION

The blood consist of various components such as Leukocytes (WBCs), Erythrocytes (RBCs) and Thrombocytes (platelets). The Erythrocytes remove carbon dioxide from the body, transporting it to the lungs for to exhale. It contains a red pigment called Haemoglobin that carries oxygen from the lungs to the rest of the body and nutritive substances such as. amino acids, sugars etc to various tissues. In case of diseases having high mortality rates, the waiting time of patients for their reports such as blood test, MRI is quiet high using the microscopy method. The time for generating any report takes roughly around 2 to 6 days, depending upon the queue. In such cases the time has to be reduced significantly, so that the patient can get the necessary treatment as soon as possible.

The current system used by the pathologists for identification of blood parameters is time consuming, which sometimes lead to the loss of patient's life. Also these tests are expensive and hence not affordable by all the patient. To overcome theses, an automated system is required which generates the blood reports in a very less time with minimum cost. The proposed system would be cost effective and will generate the test reports in minimum time.

Previously in [1] area and perimeter of a cell was computed using Form Factor of the cell and this approach was used for detection of the abnormal RBC. The proposed system involves various steps in detecting the abnormal RBC. The steps are image acquisition,image segmentation , image segmentation , detection of abnormal RBC and detecting the type of abnormal RBC.

II. LITERATURE SURVEY

Paper [1] shows the method used for detecting Abnormal Blood Cells is Form Factor. In this method, Area and Perimeter of the Cell are computed using which the Form Factor of the cell are estimated. Detection of Abnormal Blood Cells are done based on these Form Factor ranges. It also includes counting and segregating of the Cells. Firstly the image is acquired and green plane is extracted because it contains more information about the image. Then the image is enhanced by adjusting the contrast using histogram. Getting area and perimeter Form Factor is calculated and the abnormal cells are detected and counted.

In paper [2], Enhancement was done in Morphological Operation by introducing Regular Morphological transform to reduce the redundancies present in original method. The different approaches for obtaining morphological skeleton are observed and compared to check which is better. The result conforms that the reduced regulated transform has minimal points as compared to the regulated skeleton transform.

Corner detection, Signature, and Chain code method are used to achieve a good shape recognition and performance of each are analyzed [3]. Image is acquired and pre-processed to remove noise using different filters such as low-pass filter, median filter and the converted to grayscale. Then the boundary of object extracted and morphological operation to separate the object boundaries or to fill the holes. Then the corners are detected using determinant method and feature are extracted to recognize the object using signature method.

Paper [4], focuses on detection and counting of WBCs, done using digital image processing. The acquired image is preprocessed to enhanced the contrast and convert the image to grayscale. Image is segmented using otsu thresholding. Morphological operation are used to eliminate noise and ragged edges. Different feature extraction techniques are used to detect abnormal cells and count of cells.

Paper [5], focuses on detection and counting of Dacrocyte, Schistocyte And Elliptocyte Cells for detecting Iron deficiency. Fourier basic region descriptors are used in Feature extraction and Classification is done using SVM And KNN methods. The data set is preprocessed using histogram equalization to enhanced the contrast. Segmentation is achieved by Otsu Binarization and the marginal cells are removed. Then localization ,cell extraction and classification is performed.

This paper investigates automated diagnosis of Red blood cells and Classifies the different shapes of Red blood cells using Artificial Neural Network [6]. The image is recorded and converted to grayscale images for easy processing and given to the artificial neural network. Then the RBC and WBC cells are detected and counted. In this segmentation is done using histogram.

The main objective of this paper is the study of different methodologies of cell counting [7]. Counting of RBCs and WBCs is done by finding number of connected componenets in segmented image. Also Circular Hough Transform method is used for Counting of the cells. The acquired image is pre-processed to remove noise using median filter and Hue saturation is used for enhancing the image. Segmentation is perform using Gradient Vector Flow (GVF) ,snake algorithm and Zack Thresholding. Image post-processing include feature extraction and morphological operations. Counting algorithm is applied to count the number of cells.

In paper [8], An algorithm is developed, which uses tree data structure to track down all the connected components of binary image. The novel algorithm is called SAGAP to find connected components in a binary image of vehicle license plate.

In paper [9], All steps in Canny Edge Detection method are explained in detail. The varies steps in performing Canny algorithm i.e gaussian ,sobal ,non-maximum suppression and hysteresis were explained in detail.

The main objective of this paper is to differentiate between real and fake currency notes [10]. This is done by extracting dominant color, dimension, latent image and Identification mark mentioned by RBI guidelines. Classification id done using Minimum Distance Classifier technique. The system focuses more on security features present in currency notes and using those security features recognize the Indian Currency.

In paper [11], Fast Fourier Transform is used on Centroid distance function to obtain the Fourier descriptor information used for analyzing different cell shapes for detecting tumor cells. The polar rectangle and histogram is applied to original image and not the normalized coefficients of the FFT. Implement method of classification and clustering on cancer cell images and be able to classify cancer cells.

III. EXISTING SYSTEM

In [1] it speaks about image processing technique for detecting normal and abnormal cells. In this paper, the use of foam factor is mentioned, which calculates the area and perimeter of a cell. Once the foam factor is calculated based on the foam factor values, it can detect whether the cell is normal or abnormal. If the cell is abnormal then classify the abnormality of that cell. The abnormalities of the blood cells are getting segregated based on form factors.

IV. PROPOSED SYSTEM

The major drawback of the existing system was that if the resolution of the image changes then even the foam factor value of the cell will change and because of this the system may detect a normal cell as abnormal cell or it may detect abnormal cell as a normal cell.

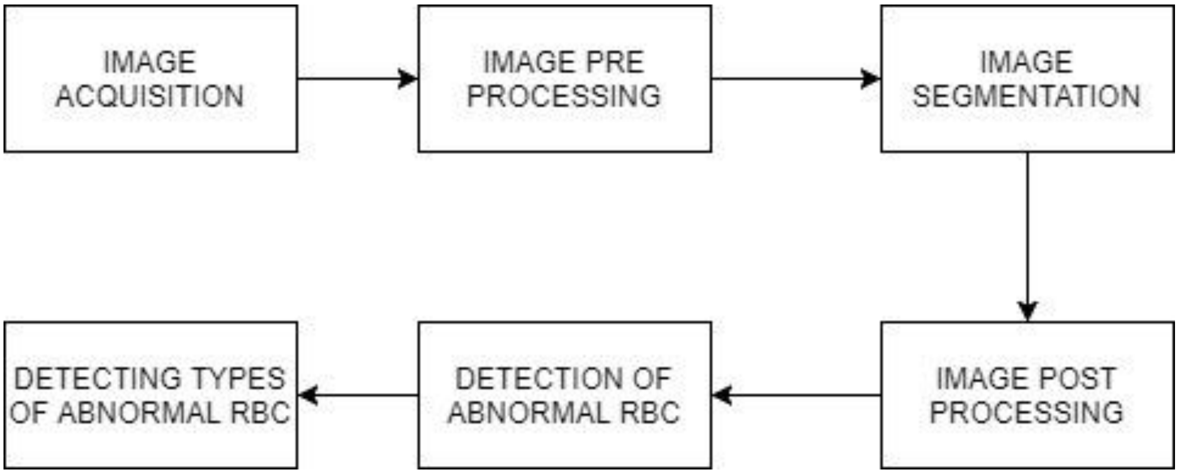

Fig 1: Steps in order to detect abnormal and normal RBC.

The Proposed system has various steps involved in order to detect the abnormal RBC. The steps are image acquisition, image preprocessing, image segmentation, image post processing, detection of abnormal RBC and detecting the type of abnormal RBC.

The steps have been explained from fig 1 as follows:

4.1. Image Acquisition
In this step we take the digital images of blood samples which are either in png or jpeg format. These images are microscopic images. These images are in Red,green,Blue colour plane.

4.2. Image Pre-Processing
Adjusting images by improving the quality of image for next process is Image Pre-Processing. Here, the image is converted to grayscale and Median Filter is used to remove noise.

4.2.1. RGB to grayscale
All grayscale algorithm utilizes the same basic three step process
1.Get the 3-pixel values that is green, red and blue.
2.Use math to turn those pixel numbers into single grayscale value.
3.Replace original value with new value.

Using Luminance formula convert the RGB Image to Grayscale
Gray= (red*0.299 +blue*0.114+ green*0.587)

4.2.2. Noise Removal
Median Filter is widely used nonlinear method to remove noise as it is very effective at preserving edges. This filter is effective in removing ‘salt and pepper’ type noise which occur due to a random bit error in a communication channel.

4.3. Image Segmentation
The segmentation is used to separate object from the background. Segmentation and data extraction is performed by Edge detection. The goal is to extract the important features like line, corners, curves etc. From the edge of cells [9].

4.3.1. Edge detection
It extracts useful structural information from objects and reduce the amount of data processesed.Steps are:

4.3.1.1. Gradients Magnitude
A Sobel filter has two kernels (of size 3x3), in x-direction (detects horizontal lines) and y-direction (detects vertical lines).

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

Both kernals are applied seperatly seperatly on the image to get the Gradients Magnitude .

G = sqrt(GX^2 + GY^2)

OR

G=|GX|+|GY|

4.3.1.2. Gradient Direction

Next step is to find the Gradient direction (in degree). This will be done using the following:
theta= atan (GY/GX)
If GY == 0 and GX == 0,
then theta = 0
else
GY != 0 and GX == 0, then theta = 90

4.3.1.3. Non-Maximum Suppression

Non-Maximum Suppression remove unwanted pixels which may not be part of edge, All the pixels are checked whether it is a local maximum in its neighborhood in the direction of gradient.

4.3.1.4. Double Thresholding

Non-maximum suppression removes most of the false edges, however some edge pixels remain that are caused by noise. To eliminate this, double thresholding is applied which consist of two threshold values, tlow and thigh.

4.3.1.5. Edge Tracking

Strong edges which are certain are included in final image. Weak edges are included if and only if they are connected to strong edges.

4.3.2 Morphological Operations

Morphological image processing is a study of shape or morphology of feature in an image. Morphological operation does not rely on the numerical values but infect they rely on ordering of the and therefore they are used on binary images.

4.3.2.1. Opening Operation

Opening operation is erosion followed by dilation. Opening can open up a gap between objects connected by a thin bridge of pixels. Any regions that are lost by erosion are restored to their original size by the dilation.

4.3.2.1.1 Erosion

The erosion of a binary image A by structuring element B is defined by :

$$A \ominus B = \{z \in E | B_z \subseteq A\},$$

Where Bz is the translation of B by the vector z i.e

$$, B_z = \{b + z | b \in B\}, \forall z \in E.$$

4.3.2.1.2 Dialation

Dilation has the opposite effect to erosion – it adds a layer of pixels to both the inner and outer boundaries of regions The dilation of *A* by *B* is defined by:

$$A \oplus B = \bigcup_{b \in B} A_b,$$

where A_b is the translation of *A* by *b*.

4.4. Image Post-processing

Image post processing includes Feature extraction. In image processing, feature extraction takes initial set of measured data and generate derived values intended to be informative and non-redundant, facilitating the subsequent learning and generalization steps, leading to better human interpretations.When the input data for an algorithm is too large to processes and it is suspected to be redundant then it can be transformed into a reduced set of features. Feature Selection is determine subset of initial features. The features contain the relevant information from the input data, so that thebe used to perform desired task instead of the complete initial data.

4.1 Feature Extraction

The region of interest in an image is found by using sequential algorithm called "Sagap" by finding connected component in binary image. The algorithm "Sagap" means "Fishing net" in Itbayaten language. We are interested in netting all white pixel that make connected component.

4.1.1 Sagap Method

Sagap [8] is sequential algorithm to find connected components in a binary image to get region of interest. Algorithms give great results in terms of accuracy and faster executiontime. The regions of interest if extracted accurately from a binary image can be used further for pattern recognition and analysis.

4.5. Detection Of Abnormal RBC

4.5.1. Signature Method

Input image will be segmented binary image of object whose shape to be detected . Object is then traced using Boundary tracing Algorithm to obtain boundary coordinates. Shape signature is any 1D function that represent 2D area. [11]

In Shape signature 2D area or boundary is represented using 1D function.Using the Centroid distance we find the g_x ,g_y.

$$g_x = \left| \sum_{i=0}^{i=N-1} \frac{(x_i+x_{i+1})(x_i y_{i+1} - x_{i+1} y_i)}{6A} \right|$$

$$g_y = \left| \sum_{i=0}^{i=N-1} \frac{(y_i+y_{i+1})(x_i y_{i+1} - x_{i+1} y_i)}{6A} \right|$$

Here, the area of the shape, A, is given by the following equation:

$$A = \left(\frac{1}{2}\right) \left| \sum_{i=0}^{i=N-1} (x_i y_{i+1} - x_{i+1} y_i) \right|$$

Expressed by the distance of the boundary points from the centroid (gx ,gy) of a shape:

$$r(t) = \sqrt{(x(t) - g_x)^2 + (y(t) - g_y)^2}$$

The discrete Fourier Transform of r(t) is given by:

$$a_n = \frac{\sum_{t=0}^{t=N-1} \left(r(t) * e^{\left(\frac{-j2\pi nt}{N}\right)} \right)}{N}$$

For n = 0,1,2,3, ... , N-1

The shape representations must be invariant to translation, rotation and scale. Invariance to Translation is achieved at beginning by shifting shape to the origin. Invariance to Rotation is achieved by taking only magnitude of FD. Magnitude of complex number $a+jb$ is given by

$|z|=\sqrt{(a2+b2)}$

4.5.2. Form Factor

Foam Factors[1] are dimensionless quantities used to analyze a particular image which intern describes the shape of an object. Form Factor is pre-defined for each and every type of cell.

1. Normal RBC : 1
2. Sickle Cell : >0.5
3. Tear Drop(Dacrocyte) : ranges between 0.4 to 0.6
4. Macrocyte : ranges between 0.3 to 0.5

It is given by an equation:-

$$\text{Form Factor} = \frac{4*pi*a}{p*p}$$

Where pi=22/7, a=area and p=perimeter

4.6. Detecting the type of abnormal RBC

Based on the Fourier descriptor compared in the database System tell you whether the RBC is normal or Abnormal. Then the system specifies the type of abnormal RBC based on the Fourier descriptor.

V. RESULTS AND DISCUSSIONS

5.1. Input Image

Fig 2: Taking the input image of red blood cell.

5.2. Converting to Grayscale

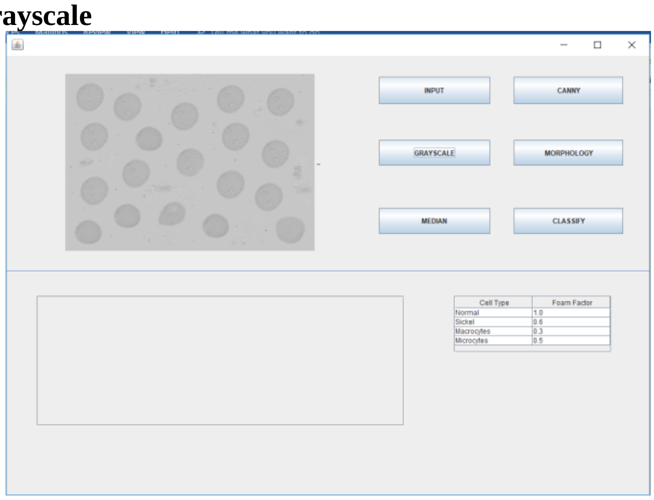

Fig 3: Converting the input image to grayscale.

5.3. Noise Removal (Median Filter)

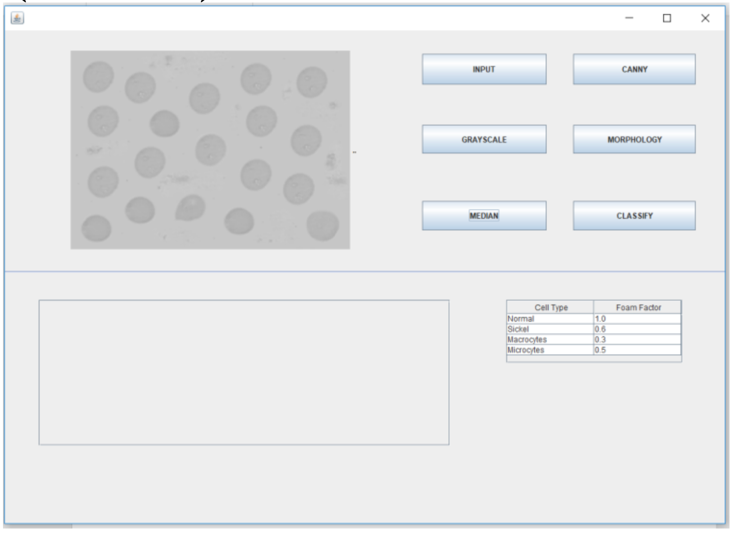

Fig 4:Applying median filter on grayscale image to remove salt and pepper noise.

5.4 . Edge Detection (canny Edge detection)

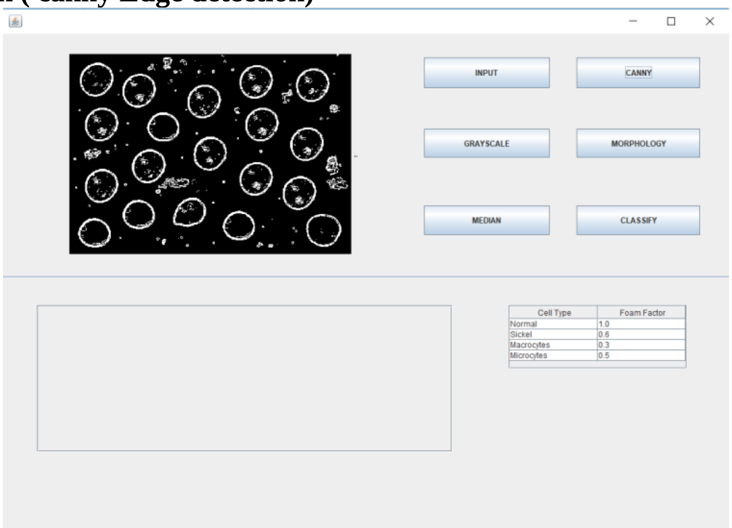

Fig 5: Detecting edges of cells using canny edge detection.

5.5 . Morphological Operation (Opening operation)

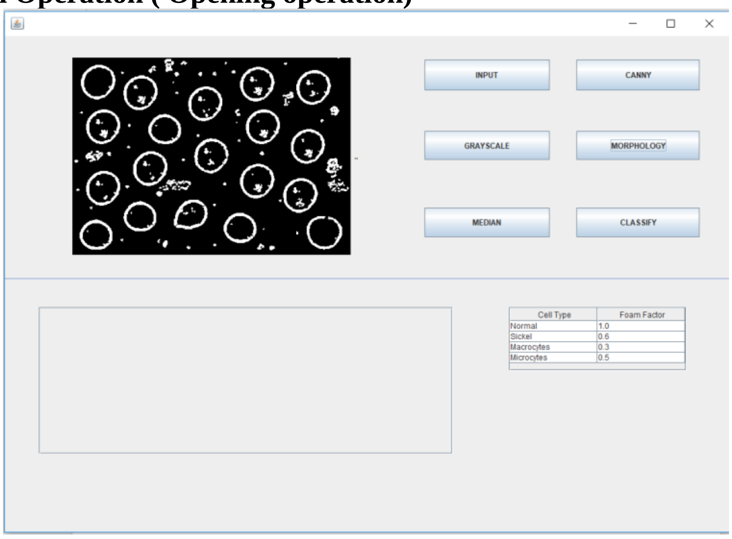

Fig 6: Applying morphological operation fill up the regions in the cell.

5.6 . Detection of normal cells and abnormal cells.

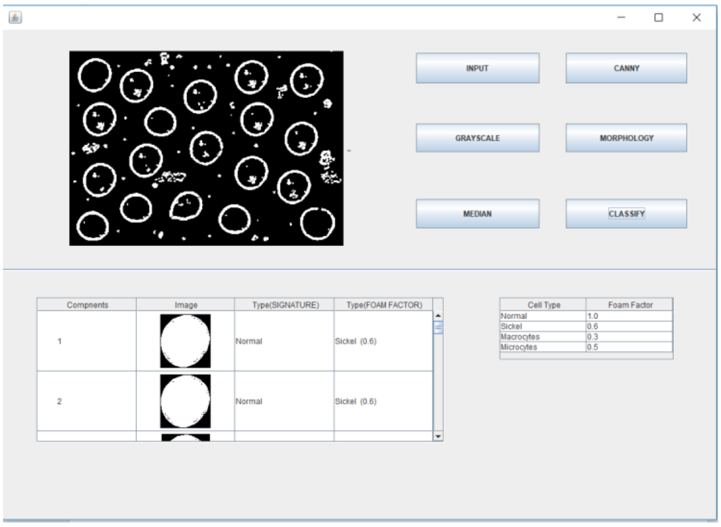

Fig 7: Detecting and classifying the cells as abnormal and normal.

VI. CONCLUSION

The system which was proposed for abnormal RBC detection using foam factor has various drawbacks like the foam factor is predefined may sometimes not match the foam factor which computed manually or it may lie close to the predefined value.

Error in calculating the perimeter of a complex image can result in wrong calculation of form factor and because of this the form factor calculated may lie in some other range.

The proposed system helps in detecting the normal cells and also various categories of abnormal cells based on the signature method. The proposed system specifies if the cell which is detected is either normal or abnormal and if abnormal then it tells the type of abnormality, so it's a faster way to detect the type of abnormal RBC which will be beneficial by pathologies to cure the disease, this system will also be cost saving.

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