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Review on Image Segmentation Techniques for Red Blood cell Identification

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Abstract — This review paper highlights the methodology followed for analysing the medical image by extracting the red blood cells from it. The image of blood cell sample is captured through microscope which consists of number of cells. Different techniques for segmentation of image such as edge detection, thresholding, Morphological processing etc. are used for the area evaluation of red blood cells for its efficient analysis. The main objective is to adopt the proposed methodology for discovering the red blood cells in the microscopic image.

Keywords — Red blood cells (RBCs), thresholding, edge detection, Morphological processing, Hough transforms

I. INTRODUCTION

Image segmentation and red blood cell identification is an important task in the analysis of medical images. The state of a person's health is determined by discovering the contents of cells in particular red and white from the blood cell sample of the person. The main problem occurs when large amounts of blood samples are required to be processed by the Medical Laboratory Technicians. This requires adequate time and skill to process the blood samples and thus limits the speed and accuracy of processing the sample. Thus a need arises to follow a step-step approach for the identification of red blood cells from a provided blood cell microscopic image. Section I contains the introduction, Section II contain the methodology, Section III concludes research work with future directions.

II. METHODOLOGY

For correct diagnosis of red blood cells in medical images, the image must be segmented properly. Many methods have been developed for better image segmentation.

The approach followed for red blood cell identification is illustrated below:

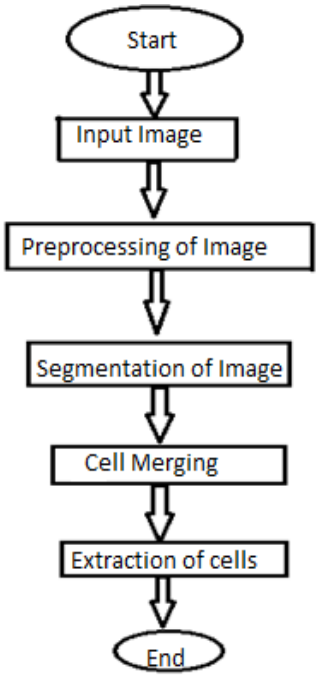
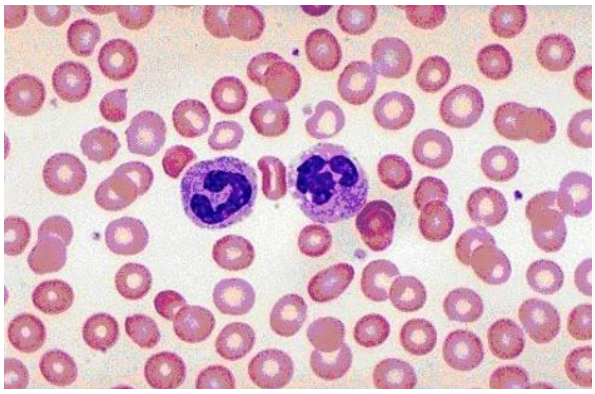


Figure 2 Methodology adopted

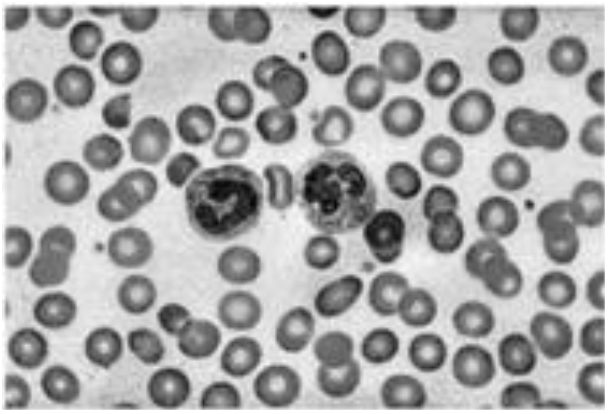
1. **Pre-processing of Image**

The blood cell microscopic image may contain noise due to scanning. Therefore for analysing the image correctly smoothness of image is needed. Image can be smoothed by pre-processing it. Pre-processing of image removes the different types of noise from the image. Noise can be removed by using different filters such as average filter, mean filter, median filter [1] etc.

Original image and the result of pre-processing is shown:



a) Original image



b) Pre-processed image

Figure 3 a) Original image b) Pre-processed image

2. Segmentation of Image

Segmentation of image is done to identify the red blood cells from the background. Segmentation partitions an entire image into multiple areas. This technique aims to make an image more meaningful for easy analysis. Segmentation of image results in a set of areas that cover the entire image. The cells covering the particular area are similar to each other according to its color, texture ,intensity, etc.

a) Thresholding:

It is one of the simplest method of segmenting an image. This technique generates binary images[2] from grayscale. In this method of segmentation, if the intensity of individual cell in the image is less than a threshold value then it is considered as background otherwise it would be considered as foreground. It is further of two types:

- Global Thresholding
  The thresholding technique is applied on the entire image.
- Local Thresholding

Sub images of an original image is made and then the above thresholding technique is applied to the individual sub image.

The result of thresholding technique is shown:

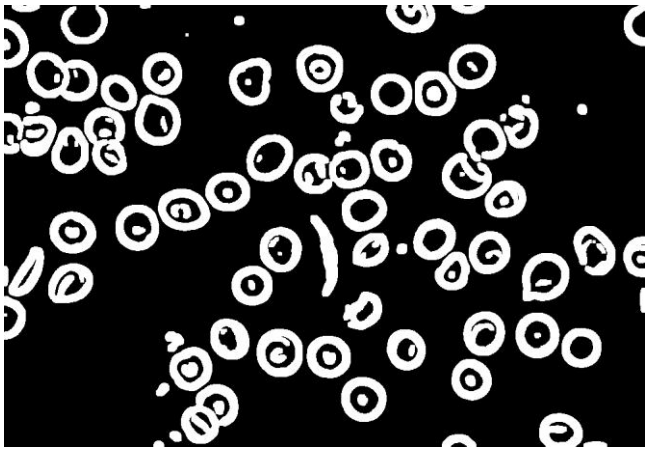


Figure. 4 Thresholded image

b) Edge Detection:

Boundaries are characterized by edges and are fundamentally important in the segmentation of image. Edge detection is the process of finding sharp discontinuities in an image. It removes useless data [3] and at the same time saves the important characteristics of an image. Edge detection methods may be classified into two categories:

- Gradient edge detection
  In this method maximum and minimum values are looked in the first derivative of the image for edge detection.
- Laplacian edge detection
  In this method zero crossings are searched in the second derivative of the image for edge detection.

Various edge detectors:

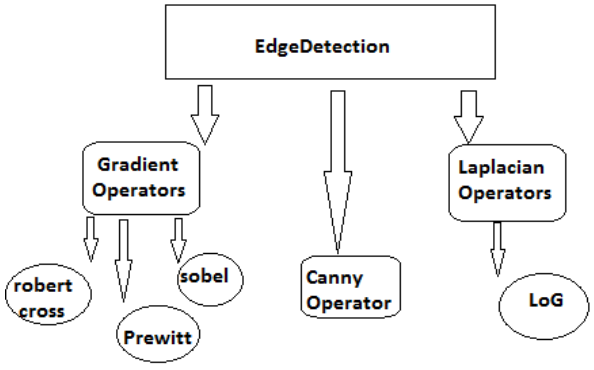


Figure. 5 Operators for edge detection

Sobel Operator

This operator uses a pair of 3×3 kernels .One kernel is the rotation of other by 90°.Kernels are shown :

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

Gx

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

Gy

The magnitude of gradient is given by:

$$|G| = \sqrt{Gx^2 + Gy^2}$$

The orientation angle of the edge is given by:

$$\theta = \arctan(Gy/Gx)$$

Robert's cross operator

This operator uses a pair of 2×2 kernels. One kernel is the rotation of other by 90°. Kernels are shown:

+1	0
0	-1

Gx

0	+1
-1	0

Gy

The orientation angle of the edge is given by:

$$\theta = \arctan(Gy/Gx) - 3\pi/4$$

Prewitt's operator

This operator discovers [4] horizontal and vertical edges.

$$h_1 = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix} \quad h_3 = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

LoG operator

The Laplacian L(x,y) of an image with pixel intensity values I(x,y) is given by:

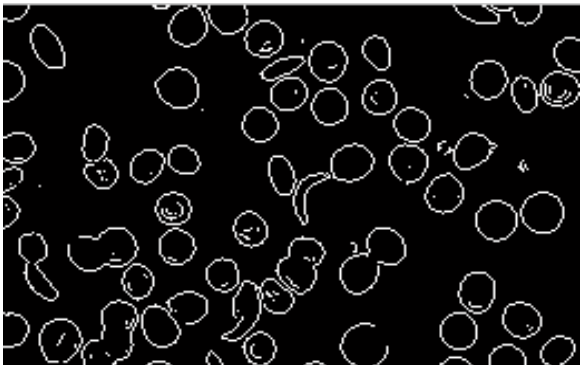
$$L(x, y) = \frac{\partial^2 I}{\partial x^2} + \frac{\partial^2 I}{\partial y^2}$$

Canny operator

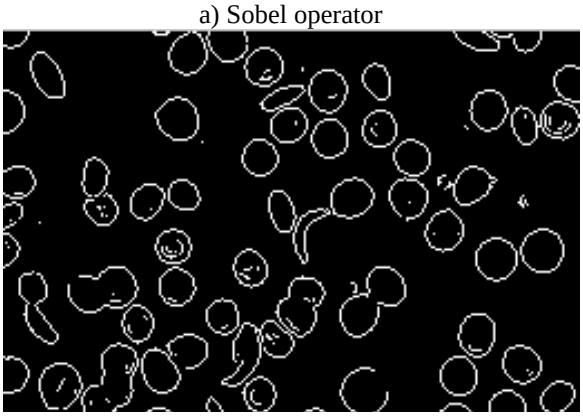
It is the optimum edge detector. It has following advantages:

a) Easy Localization
b) No multiple responses
c) Low error rate

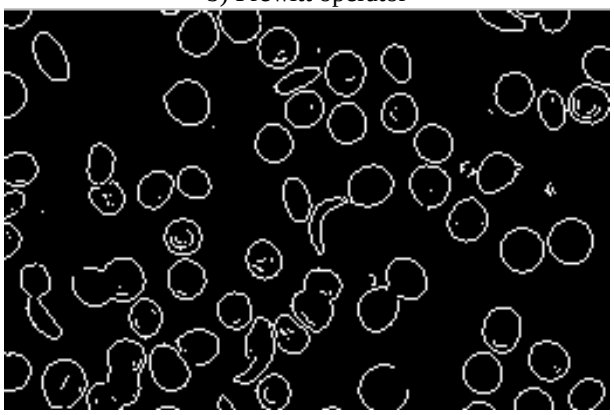
Edge detection using various operators is shown:



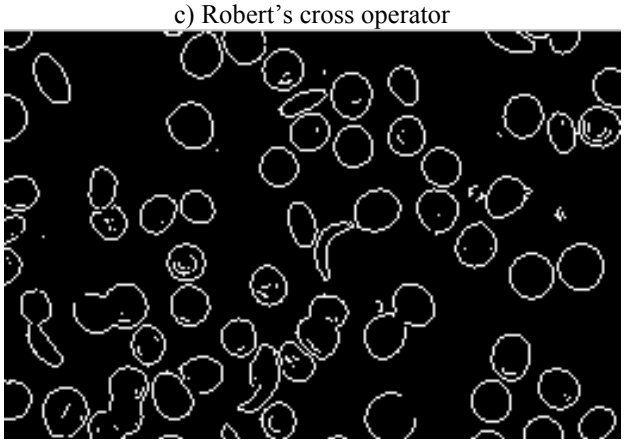
a) Sobel operator



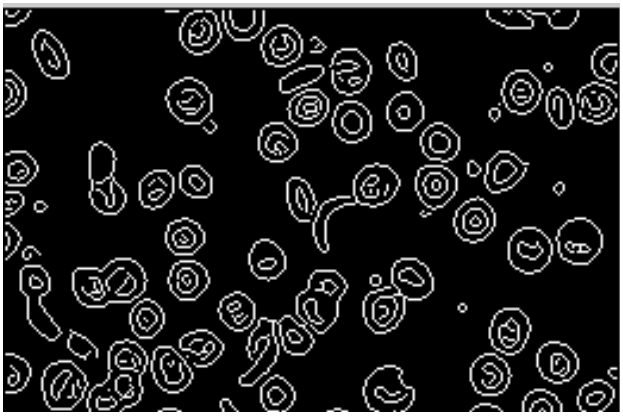
b) Prewitt operator



c) Robert's cross operator



d) LoG operator



e) Canny operator

Figure 6 Images showing edge detection using a) Sobel operator b) Prewitt operator c) Robert's cross operator d) LoG operator e) Canny operator

3. Cell Merging

The morphological operations are applied on the image for the uniformity of cells. Watershed algorithm is used primarily for the required transformation.

Watershed Algorithm:

For the morphological transformation, the magnitude of gradient for the image is considered as a topographic surface [5]. The magnitude of gradient for the image is considered as a landscape [6] because the values for intensity subject to elevation. Catchment basins would be those regions of the image where a raindrop would drain to the same minimum and watersheds are the lines which separates adjacent catchment basins.

Steps involved:

- Weak edges are removed because of noise.
- The gradient map of the entire image is calculated.
- The maximum value of the gradient map is evaluated.
- A drowning threshold is selected as DT=MAX* l/n.
- Consider individual cell with its 8-neighbor. If the intensity value of selected cell and its neighbor is smaller than DT, current cell is merged with its neighbor.
- Smaller areas are merged.

The result of watershed algorithm is shown:

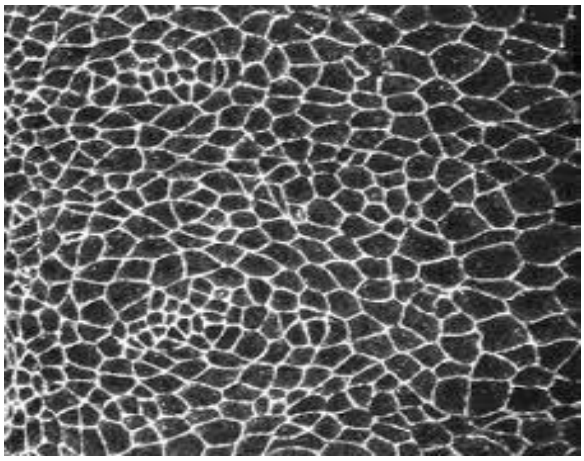


Figure 7 Image showing watershed transformation

4. Extraction of cells

Circular Hough Transform Method:

A widely known feature extraction technique used in image processing and pattern recognition. For the identification of circular cells [7] in an image, Circular Hough transform (CHT) is used. A group of edge points are transformed into a group of accumulated points from image space to parameter space. The presence of circular shape is indicated by the elements of array that carries maximum number of votes.

The result of Circular Hough transform method is shown:

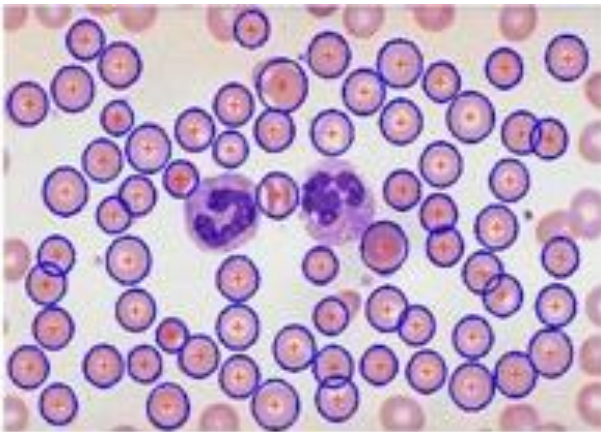


Figure 8 Image showing Circular Hough transform

From the previous step we have obtained the circumference of the red blood cells. From the circumference, it is easy to evaluate the radius and therefore area of the red blood cells can be easily obtained

.

III. Conclusion and Future Scope

The main aim is to detect red blood cells from the blood cell sample image .It can be done by calculating the area of the

cells in the sample. Area can be obtained through effective implementation of various segmentation techniques such as:- thresholding, edge detection, watershed algorithm and circular hough transform method. The proposed methodology can work well for the estimation of uniformity of beads in membrane filter.

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