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AUTOMATIC RED BLOOD CELL DETECTION AND COUNTING SYSTEM USING HOUGH TRANSFORM

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Abstract:

Blood cell analysis, including blood cell counting, is the key point for pathological study and also medical diagnosis. The old strategy of RBC counting under microscope gives an unreliable outcome. Another strategy for RBC counting utilizes the programmed hematology analyzer, this machine is extremely costlier. In this work a software based approach to count RBC from the blood smear image using Hough transform is presented. The Hough transform is an efficient technique used for feature extraction in digital image processing. This approach for blood cell count is also compatible with telemedicine system.

Objective: *Research was held to find solution for automatic red bloo cell count to use for detection of different diseases like anemia.*

Place and Duration of Study: *Present research paper was completed in the period of seven months from Jan, 2018 to July, 2018 at the venue of Tehsil Headquarter Hospital (THQ) Fateh Jhang and Fatima Jinnah Women University Rawalpindi.*

Material and Methods: *Blood smear images taken by a camera attached with microscope are used to detect and count RBC's in this process. In this work the images are collected from THQ hospital Fateh Jhang. Blood samples of almost 500 subjects is taken and blood semar slides are made for them. After that their imaegs are taken by a camera attached with microscope.*

In this work a software based approach to count RBC from the blood smear image is presented. There are five stages in the process. These are input image acquisition, reprocessing, segmentation, feature extraction, RBC counting using Hough transform. Implementation of whole process is done in Matlab.

Results:

The accuracy of the proposed technique in this research is calculated by using following formula:

$$Accuracy = \left(\frac{Actual\ count - RBC\ count\ by\ CHT}{Actual\ count}\right) * 100$$

The accuracy of up to 94.98 % is achieved by the proposed method.

Conclusion: *Our research concludes that to perceive, analyze and count the circular cells proposed technique can give cost effective and alternative approach. It can independently count the overlapping RBC. In light of the result the person can be determined to be normal or abnormal.*

Keywords: *Red Blood Cell Counting, Hough Transform, Digital Image Processing.*

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I INTRODUCTION:

Platelets, red blood cell and white blood cell are three types of cell in the human blood. In human body the maximum in number of blood cells are red blood cells. Normally doctors utilize one of the primary data to analyze different sicknesses is the red blood cell count. Actually RBC's count is a test that doctors use to find out how many red blood cells (RBCs) one has. It is also called an erythrocyte count. This test is vital on the grounds that RBCs contain hemoglobin, which conveys oxygen to your body's tissues. The quantity of RBCs you have can influence how much oxygen your tissues get. Your tissues require oxygen to work. In shape the red blood cell is like biconcave disk. To analyze sicknesses like Anemia, thalassemia and malaria red blood cell counting is important.

This red blood cell count can be automated by image processing techniques on blood smear images that save more time and give more accurate results. To enhance image quality image processing techniques are used to modify the pictures of blood smear. Hence, it can be examined in many applications. The major steps involved in image analysis are preprocessing, segmentation, feature extraction and red blood cell counting. The most critical step is image segmentation in light of the fact that the feature extraction and red blood cell counting relies on upon the correct segmentation of red blood cells. In this paper, a computerized system of RBC counting in microscopic images of blood smear using circular Hough transform is proposed. In Digital Image Processing the circle Hough Transform is actually a feature extraction technique used for detection of circular objects in an image. In this work it is used to detect RBC's.

I. LITERATURE SURVEY

Many previous attempts were made to count blood cells using image processing techniques. In this work a software based approach to count RBC from the blood smear image is presented. There are five stages in the process. These are input image acquisition, reprocessing, segmentation, feature extraction, RBC counting. The blood smear image is converted into saturation image in the preprocessing stage. Histogram thresholding is used to carry out segmentation. Then by morphological operations feature extraction is done to differentiate RBC's from other cells. To count red blood cells by using Hough Transform technique is the last step. Another algorithm is proposed that counts RBC's from thin blood smear images. Here cell segmentation is done by morphological operations and thresholding.[i] Another proposed method to count RBC in peripheral blood smear image is by circular Hough transform. In this process segmentation of a single cell image of RBC is done after preprocessing then after cropping it to get the range of cell's radius. Then to count RBC on the basis of range of cell's radius circular Hough transform method is used.[ii] Some other work provides a method to count RBCs by analyzing hyper spectral microscopic blood cell. The classification algorithms, SAMs and SVMs are used for blood cell image segmentation. RBCs in the image are identified by standard RBC model built to match red blood cells in the segmentation results on the basis of SAM algorithm.[iii] Another paper introduces a method for RBCs counting utilizing Circlet Transform. It operates on grayscale images without need of binary segmentation. First, obtain RBC's mask. Then, apply circlet transform on grayscale image. Then, estimate RBCs minimum and maximum count. At last, RBCs are counted by soft-thresholding method.[iv] An automatic red blood cell counting is also helpful in counting fetal and maternal blood cells. This method can be used to count RBC's on clinical KB slides.[v] Another approach presents method for red blood cell segmentation for red blood cells counting. The involved methods are color conversion, masking, some morphological operations and watershed algorithm.[vi] In another work the fuzzy set threshold selection approach is applied on peripheral blood images, to subdivide image components, for segmentation and cell counting.[vii] Another work presents a method to extracts red blood cells on the basis of quality of a PCNN preprocessed binary image. This method provides a solution for many issues of blood smear caused by the cell dyeing ways.

II. METHODOLOGY:

In this work a software based approach to count RBC from the blood smear image is presented. There are five stages in the process. These are input image acquisition, reprocessing, segmentation, feature extraction, RBC counting. Implementation of whole process is done in Matlab. In the preprocessing stage the blood smear image is enhanced by converting it to geryscale and binary image. Segmentation is carried out by histogram thresholding. Then feature extraction is done through morphological operations like dilution inorder to differentiate red blood cell from other cells and background. The last step is to detect and count red blood cells by using Hough Transform technique.

- **Flowchart of proposed system**

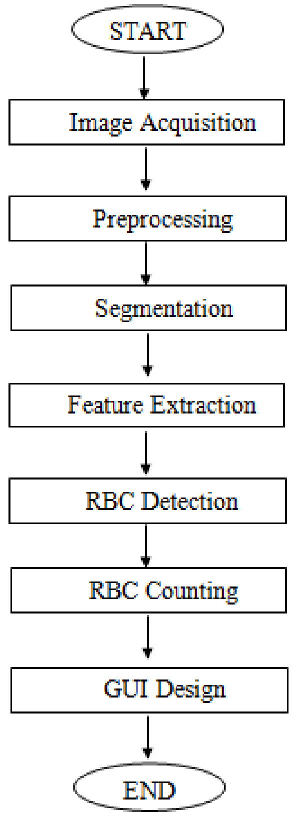


Figure I. Flowchart of proposed system

A. Data Collection

Blood smear images taken by a camera attached with microscope are used to detect and count RBC's in this process. In this work the images are collected from THQ hospital Fateh Jhang. Blood samples of almost 500 subjects is taken and blood semar slides are made for them. After that their imaegs are taken by a camera attached with microscope.

B. Preprocessing

Image preprocessing is enhancing image technique to make it suitable for next computations. Different preprocessing techniques are used in different systems depending on their functionalities. In this work simple image processing techniques are used like conversion to grey scale and binary image so that red blood cells can be easily distinguished.

C. Segmentation

After preprocessing, segmentation is done. Thresholding and Morphological operations are used in this step. Morphological operations like opening, closing and dilation are used to denoise image and close ends. This image is now suitable for detecting and counting red blood cells by further techniques.

D. Feature Extraction

Morphological operations and Hough transform is used in this step for extraction of red blood cells from blood smear images differentiating them from other blood cells like white blood cell and platelets. In image analysis Hough transform is feature extraction technique used to find circlular objects in an image. Equation (I) is the equation of a circle in parametric form. Where r is the radius and a and b are the center of the circle in the x and y direction respectively.

$(x-a)^2 + (y-b)^2 = (r)^2$ Equation (I)

The circle is described by equation (II) and (III).

$x = a + r\cos\theta$ Equation (II)

$y = b + r\sin\theta$ Equation (III)

Implementation of this process involves following steps. First of all all edges of an image are detected. Then, a circle is drawn of desired radius at each edge point in the parameter space as shown in Fig. II. The center of the circle in the image is detected where highest number of circles intersect.

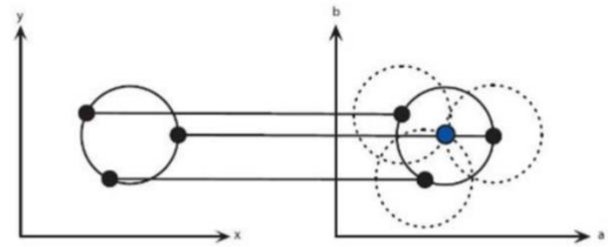


Figure II. Points in image space and parameter space with constant radius

E. RBC Detection and Counting

Red blood cells are detected by Hough transform using above circles in image. They are then counted with the help of center point of red blood cells.

F. GUI Design

At the end GUI is designed in Matlab. Figure III. Shows the GUI of red blood cell detection and counting system.

A. Detection of RBC
B. Counting of RBC

Figure III. A & B GUI design of proposed system

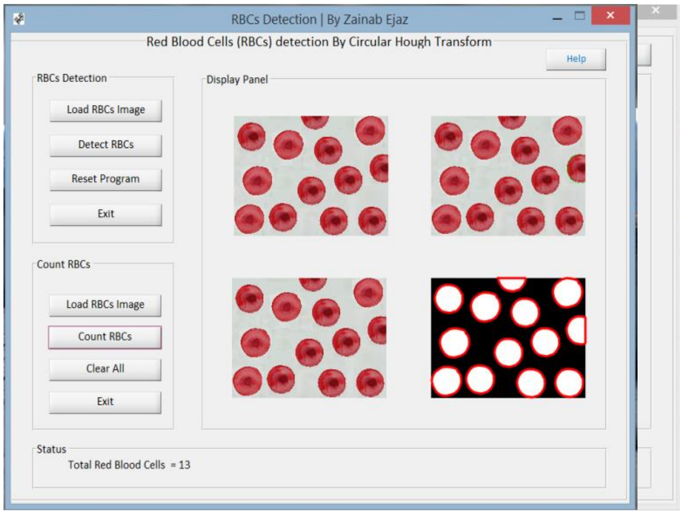
III. RESULT ANALYSIS:

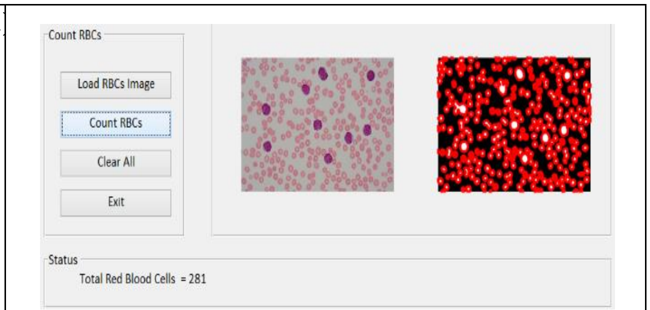
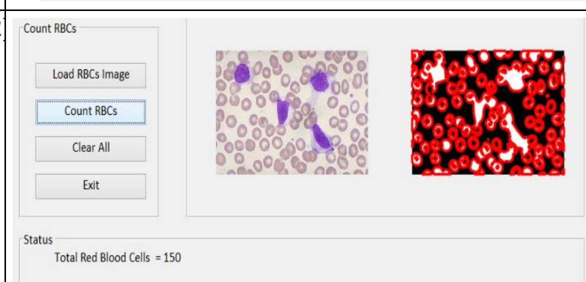
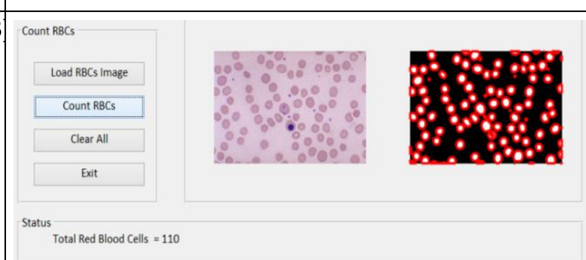
The accuracy of the system can be measured by comparing result of RBC counted using the CHT technique and the result of manual counting. Following equation is used to calculate the accuracy of system.

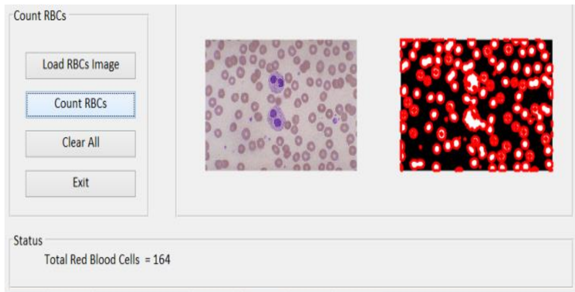
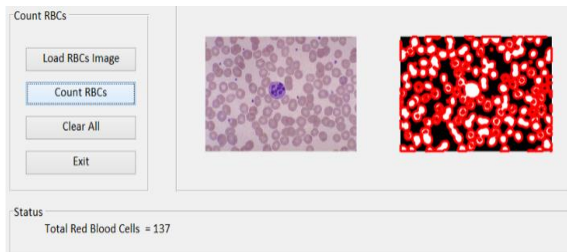
$$\text{Accuracy} = \left(\frac{\text{Actual count} - \text{RBC count by CHT}}{\text{Actual count}}\right) * 100$$

TABLE I. RESULT OF RBC COUNTING USING CHT

Sr. No.	Number of Red Blood Cell		Percentage accuracy
	Actual number	Counted using CHT	
1)	13	13	100
2)	156	158	99.82
3)	29	30	97.45
4)	301	313	97.12
5)	310	323	96.91
6)	266	281	95.47
7)	137	150	91.62
8)	92	110	91.54
9)	149	164	90.04
10)	113	137	89.87


RBCs Detection | By Zainab Ejaz
Red Blood Cells (RBCs) detection By Circular Hough Transform
Help
RBCs Detection
Load RBCs Image
Detect RBCs
Reset Program
Exit
Display Panel
Count RBCs
Load RBCs Image
Count RBCs
Clear All
Exit
Status
Total Red Blood Cells = 13

1	Count RBCs Load RBCs Image Count RBCs Clear All Exit Status Total Red Blood Cells = 281
2	Count RBCs Load RBCs Image Count RBCs Clear All Exit Status Total Red Blood Cells = 150
3	Count RBCs Load RBCs Image Count RBCs Clear All Exit Status Total Red Blood Cells = 110

4	 Count RBCs Load RBCs Image Count RBCs Clear All Exit Status Total Red Blood Cells = 164
5	 Count RBCs Load RBCs Image Count RBCs Clear All Exit Status Total Red Blood Cells = 137

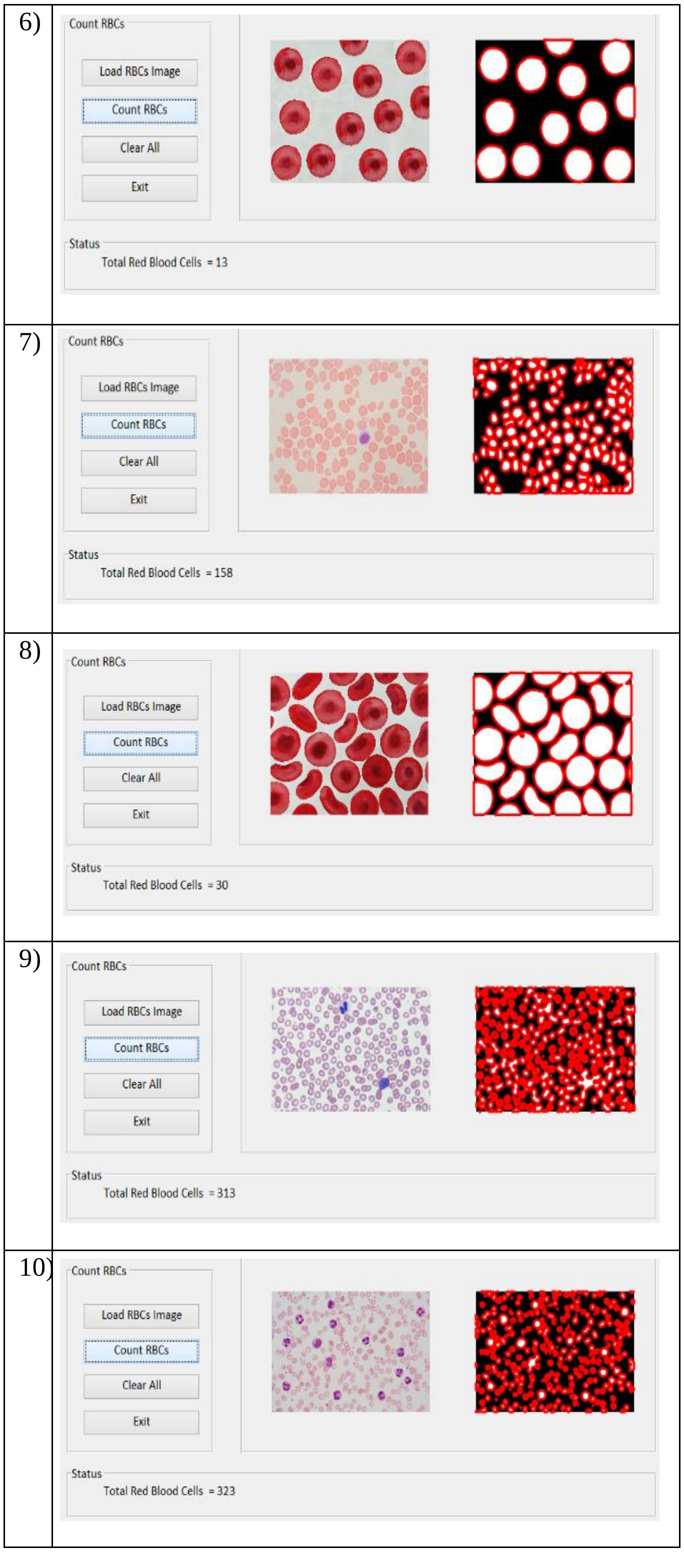


FIGURE IV. The result after performing CHT of 10 samples of RBC

IV. CONCLUSION:

The objective of this work is to deliver a proficient computerized framework to distinguish and count the red blood cell in microscopic images of blood smear using circular Hough transform consequently. It is less tedious strategy as compared to manual counting. To perceive, analyze and count the circular cells this technique can give cost effective and alternative approach. It can independently count the overlapping RBC. In light of the result the person can be determined to be normal or abnormal. The accuracy of up to 94.98 % is achieved by the proposed method. In future work, will be centered on entire blood cell count like white blood cell count and platelets count utilizing appropriate segmentation and counting algorithm in view of the shape and size of the cells.

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