Automated Detection and Counting of Red Blood Cells for Enhanced Diagnostic Accuracy in Pathology

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Abstract

In healthcare, blood testing is regarded as one of the most crucial medical examinations. In pathology laboratories, many types of blood cells are enumerated to diagnose patient disorders. Counting red blood cells (RBCs) in blood cell pictures is crucial for detecting and monitoring the treatment of several disorders, including anaemia and leukaemia. The manual counting and analysis of blood cells with a microscope is laborious, time-consuming, and requires significant technical expertise. Therefore, there is a want for an automated blood cell detection and counting system that can assist physicians in diagnosing disorders swiftly and efficiently. Current research categorizes red blood cells into four types of abnormalities: elliptocytes, echinocytes, teardrop cells, and macrocytes. This work presents a system for the automatic counting of red blood cells (RBCs). In the proposed approach, photos are categorized based on color, texture, and morphology. The cell counting procedure consists of three stages: image processing including texture feature extraction via morphology, thresholding segmentation, and cell counting via Hough transformation. The suggested approach attains an overall accuracy of 91.667% and has high computational efficiency.

KEYWORDS: Image edge detection, Transforms, Red blood cells, Microscopy, Manuals, Detectors, Biomedical imaging

1. INTRODUCTION

The Complete Blood Count (CBC) is the blood test used to evaluate the health of person and to detect the disorders like anemia, infection and leukemia. In medical diagnosis complete blood count is very important. There are mainly four categories of cells: Red Blood Cells (RBCs), White Blood Cells (WBCs), Platelets and Plasma. These groups can be differentiated using texture, color, size, and morphology of nucleus and cytoplasm. Cells count is important to determine the immunity and capability of the body system. The abnormal count of cells indicates the presence of disease and person needs medical help. Current research is on an implementation of image processing based on automated counting of RBCs and WBCs from blood image. WBCs are also called leukocytes. These are also called leukocytes. These cells are an important part of immune system. These protect body by removing virus and bacteria in a body. Medical term use to describe low count is Leucopenia. Leucopenia indicates the presence of infection. Medical term used to describe high count is leukocytosis. Leukocytosis indicates an existence of infection, leukemia or tissue damage. RBCs are also known as erythrocytes. The function of RBC is to carry oxygen and collects carbon dioxide from a lung to the cells of body. They contain protein called hemoglobin. The presence of inner and outer layers of protein gives red color to blood. Hemoglobin does the work of carrying oxygen. An abnormal count of RBCs leads to anemia which results in mental tiredness, illness, weakness, dizziness. If it is not treated immediately it results into more serious symptoms like malnutrition and leukemia. RBC indicates gives information about size and shape of cells and are also useful in differentiating types of anemia. In addition, diagnosis results always tend to be subjective and imprecise and also are difficult to be reproduced afterwards. As a substitute, automatic identification technology of RBCs known for low-cost, homogenous accuracy has gained more and more focus in domain of hepatic related disease diagnosis. In general, the system consists of four parts: RBC segmentation, feature extraction, classification, and counting. Since segmentation results directly influence the accuracy of classification and counting, it has become a very hot topic in clinical diagnosis.

2. LITERATURE SURVEY

Ankita Mandal.report presents an automated method for counting red blood cells present in a blood sample. The proposed method addresses the problems of holes present in blood cells and overlapping characteristics of the red blood cells. The procedure is quite simple and straightforward, which utilizes mathematical morphological operations of erosion and dilation for performing the different steps. It first thresholds a grayscale image to obtain the binary image using the Otsu thresholding method, and then performs the hole filling process on the red blood cells if they have holes. Then the process moves on to the job of counting the red blood cells. For this, each red blood cell is extracted, and its shape analysis is performed to decide whether it is circular, non-circular, overlapping or just partially present in the sample. If a cell is only partially present in the image, then it is discarded and in case of overlapping the number of cells in the overlapped area is determined. Several experimental results have been presented to support the validity of the method. One of the important findings is that the proposed method gives accurate count of red blood cells of the blood sample and classifies each cell into one of the four categories.

Cseke [4] presented a fast segmentation scheme with automatic thresholding where thresholds are selected with a simple recursive method derived from maximizing the interclass variance between dark, gray, and bright regions based on the method proposed by Otsu. The method works well for nucleus and background segmentation.

3. EXISTING SYSTEM

In this approach based on morphological processes is employed to detect white blood cells automatically data acquisition, we used sample images from an online medical library as an input image. These images can be acquired by the user through a simple user interface, from their computers. As these images contain noise and are not fit for direct processing they need to be enhanced for further analysis RGB image conversion to gray scale and computation of the lightness component The various algorithms that we have described for mathematical morphology in Section 9.6 can be put together to form powerful techniques for the processing of binary images and gray level images. As binary images frequently result from segmentation processes on gray level images, the morphological processing of the binary result permits the improvement of the segmentation result.

Morphological operations work by using predefined structuring elements (also called kernels or masks) to process an image, modifying its features based on the interaction between the structuring element and the image. Here's an in-depth explanation of some common morphological operations and how they can be applied to blood cell detection:

Dilation Operation: Dilation is used to expand the boundaries of white regions (foreground) in a binary image while reducing the black regions (background). in final segmentation result mainly comes from two aspects: background and red blood cells. The following two steps background extraction and red blood cell separation are all somewhat based on this fact. In histogram of the contrast-stretched gray image presents a triple-modal, respectively,

$$B(x, y) = \{1, \text{ if } I(x, y) >= T$$

$$0, \text{ if } I(x, y) < T\}$$

In this case, if the intensity I(x, y) at a pixel is greater than or equal to the threshold value T, it is set to 1 (white), indicating foreground. If it is less than the threshold, it is set to 0 (black), indicating background. Due to differences in illumination among images, which affect the detail of the existing cell, grayscale images are transformed to binary images based on four threshold values

Issues:

- Counts can vary between laboratories and populations. What is considered normal in one region or laboratory may not be the same elsewhere.
- Normal ranges for blood cell Lack of Specificity:

4. PROPOSED METHOD

The major contribution of proposed work is a software system that can automate the manual method of detecting and counting RBCs on the basis of morphological functions using feature extraction, thresholding segmentation and counting of cells using Hough transformation. The most significant and tricky step is segmentation of blood cells because exact cell count is based on the accurate segmentation of blood cells. In addition to that, the uncertainties intrinsic to the microscope image to classify the object as a cell or foreign body, such as dust, can obstruct the image analysis procedure. The proposed algorithm achieves better result

The acquisition block is in charge of acquiring one or more images of blood samples of anaemia patient or person that facing RBC disease.

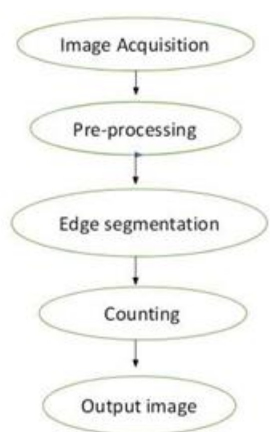

Fig 4.1: Diagram of our proposed method

4.1 Edge Detection

Edge preservation is an image processing technique to recover degraded and blurred images resulted while reducing the negative effect of noise in images. It can be a preliminary step toward better binarization and object segmentation. Apply Canny Edge Detection: Use the edge function in MATLAB to apply the canny edge detection algorithm. Apply Canny Edge Detection: Use the Convolve image f(r, c) with a Gaussian function to get smooth image f^(r, c).

$$f\hat{}(r, c) = f(r,c) * G(r,c,6)$$

- Apply first difference gradient operator to compute edge strength then edge magnitude
- and direction are obtained as before.
- Apply non-maximal or critical suppression to the gradient magnitude.
- Apply threshold to the non-maximal suppression image.

Unlike Roberts and Sobel, the canny operation is not very susceptible to noise. If the Canny detector worked well it would be superior edge function in MATLAB to apply the canny edge detection algorithm Gradient Calculation: Compute the gradient of the smoothed image to find the strength and direction of edges. This is typically done using techniques like Sobel or Prewitt operators. Non-Maximum Suppression: Suppress non-maximum pixels, which help to thin the edges by keeping only the local maxima in the gradient magnitude. Locating edges then consists of finding the zero crossings between the double edges. The digital implementation of the Laplacian function is usually made through the mask below,

0	-1	0
-1	4	-1
0	-1	0

G_x

-1	-1	-1
-1	8	-1
-1	-1	-1

G_y

Table 4.1: canny operators

The Laplacian is generally used to found whether a pixel is on the dark or light side of an edge. Apply high and low thresholds to determine strong and weak edges:

- If G(x, y) > High_Threshold, it's a strong edge pixel.
- If Low_Threshold < G(x, y) < High_Threshold, it's a weak edge pixel.

- If G(x, y) < Low_Threshold, it's not considered an edge pixel.

These equations are used iteratively across the entire image to detect edges. Please note that the canny edge detection algorithm implementation can vary slightly depending on the programming language and libraries used.

4.2 REMOVE BORDER

Morphological Operation Morphology is a broad set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors.

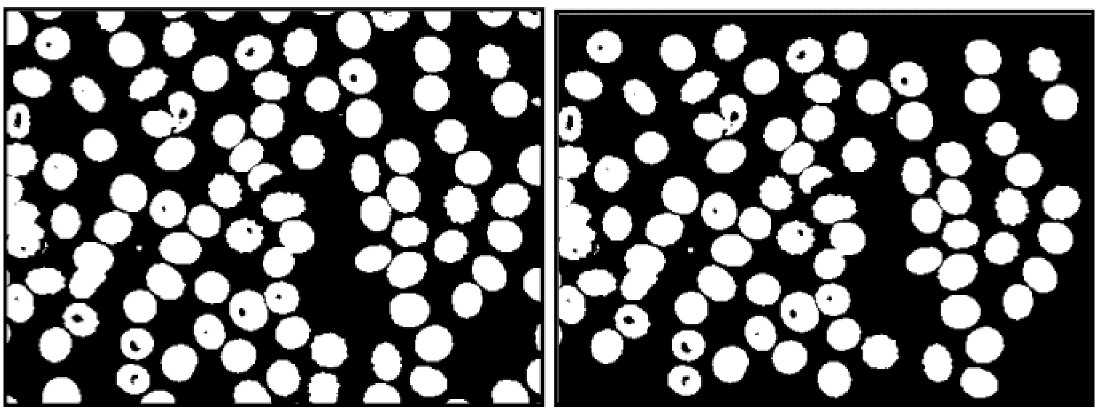

Figure: (a) Before remove border object, (b) After remove border object

4.3 Blood Cell Counting

The area property of region props tool is used to calculate area by returning the number of pixels for every 8-connected object for each detected WBCs and RBCs in the binary image. The is member function creates a binary image with objects whose area exceeds 100 pixels. The size of the array returns the actual detected RBCs count in the binary image. Total blood cell count is calculated by the following formula,

TBC Count = WBC Count + RBC

Count Based on the total blood cell count, RBC and WBC percentage are calculated. In each and every case, the round-off value is only taken and stored in the corresponding terms.

5. RESULTS

The proposed system is implemented in the image processing toolbox MATLAB software. blood cells Database is used The input blood-smeared image as shown in Figure 5.1 , Based on the threshold value set by canny operator in Figure 5.3 and detected cells are highlighted The RBC count and over lapped RBC count in Figure 5.4 and 5.6

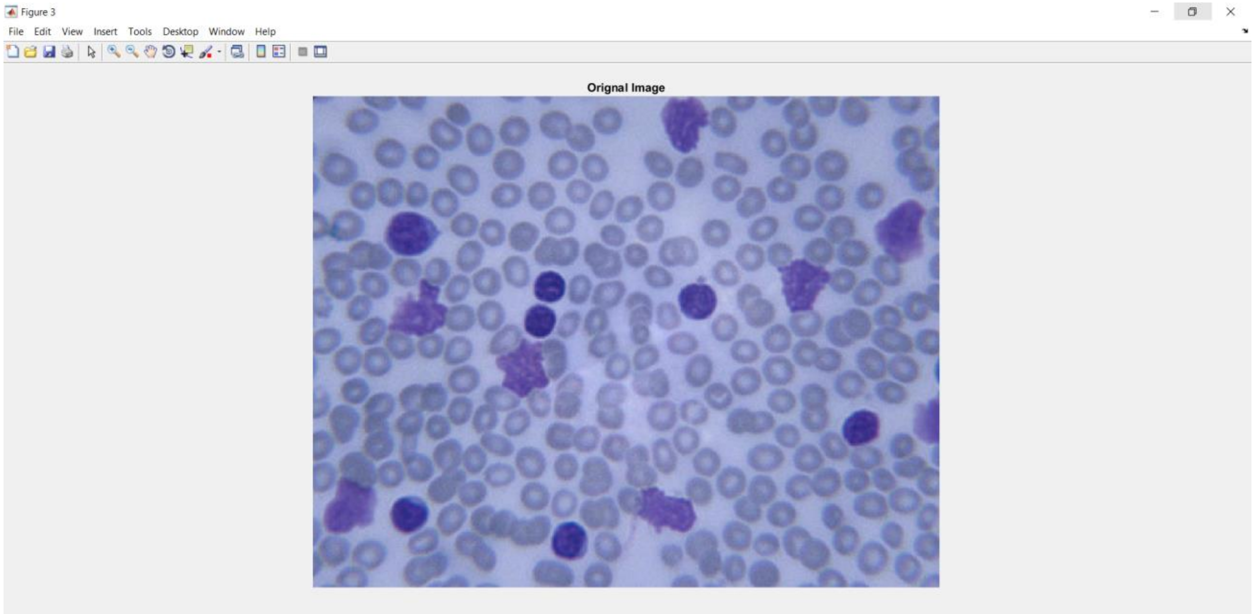

Fig 5.1: This image can be obtained through a microscope with an attached camera or other imaging devices

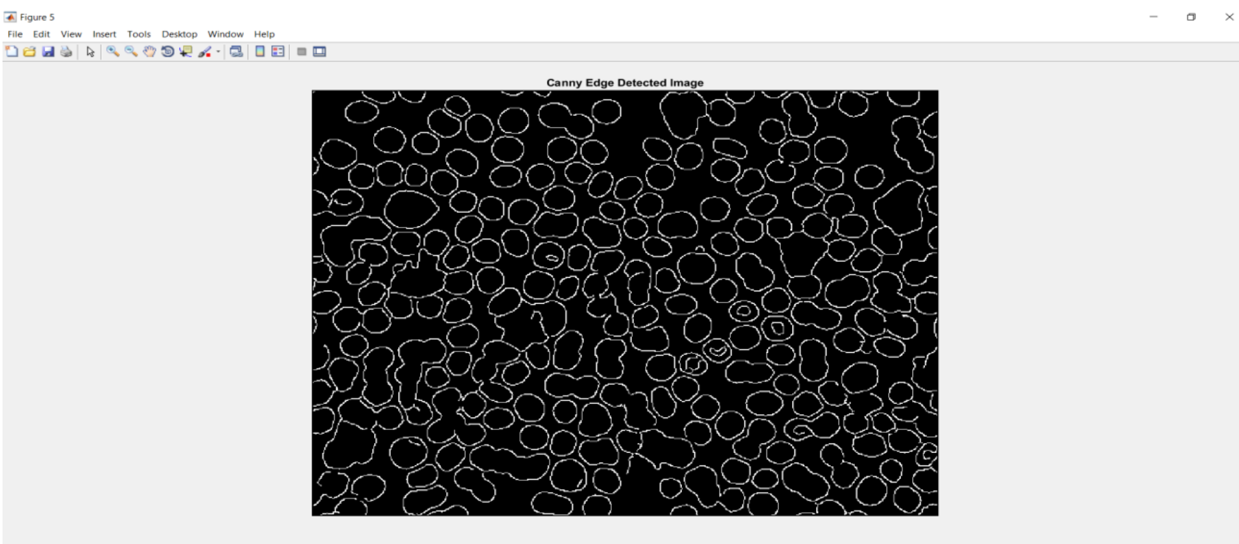

Fig 5.2: To Use Canny Edge Operator To Identify Circular Patterns In Red Blood Cells (Rbcs)

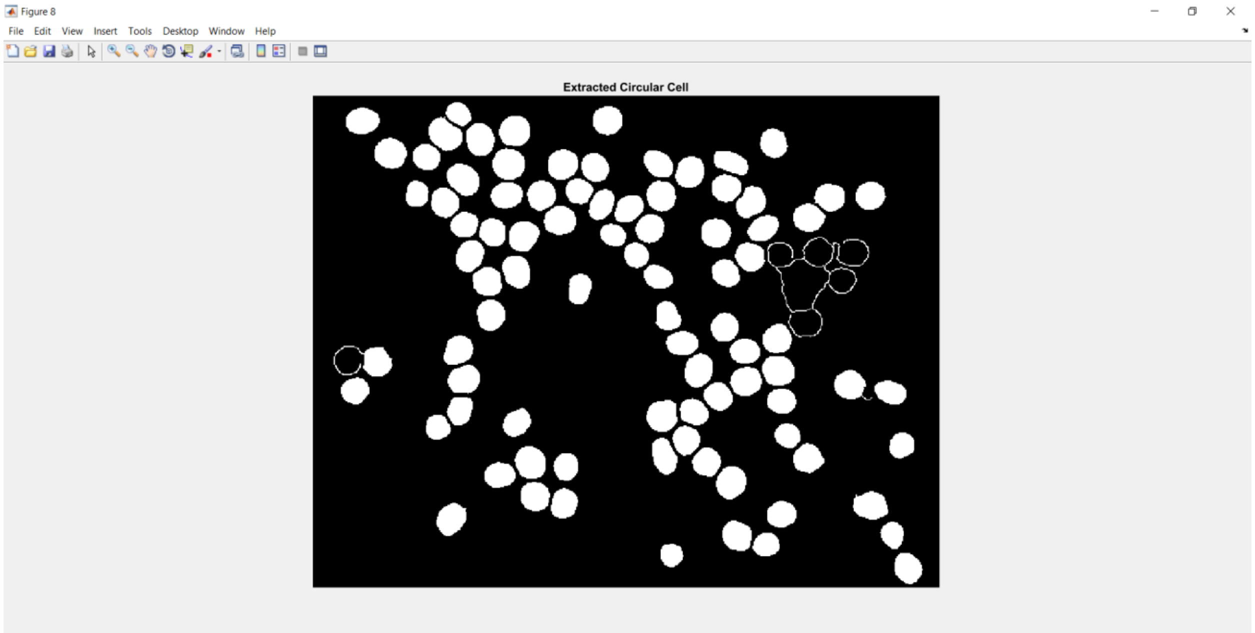

Fig 5.3: To Display The Exact Circular Cells After To Remove Unwanted Blood Cells

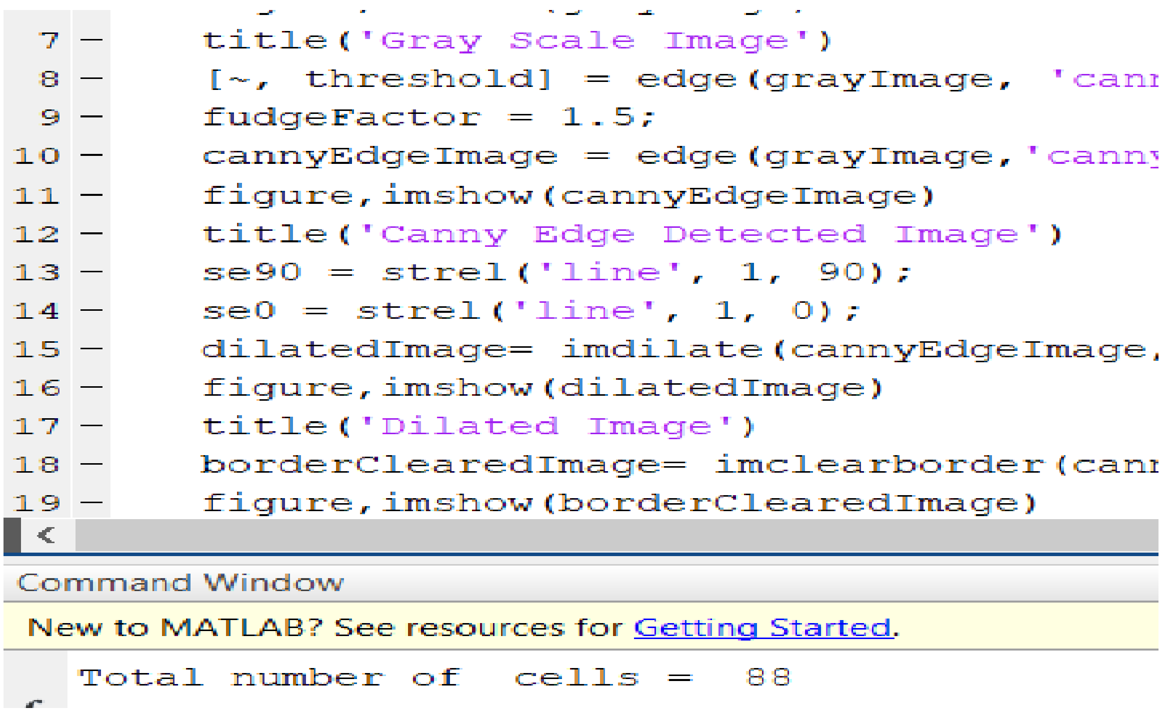

Fig 5.4: To Display RBC Circular Cells Count

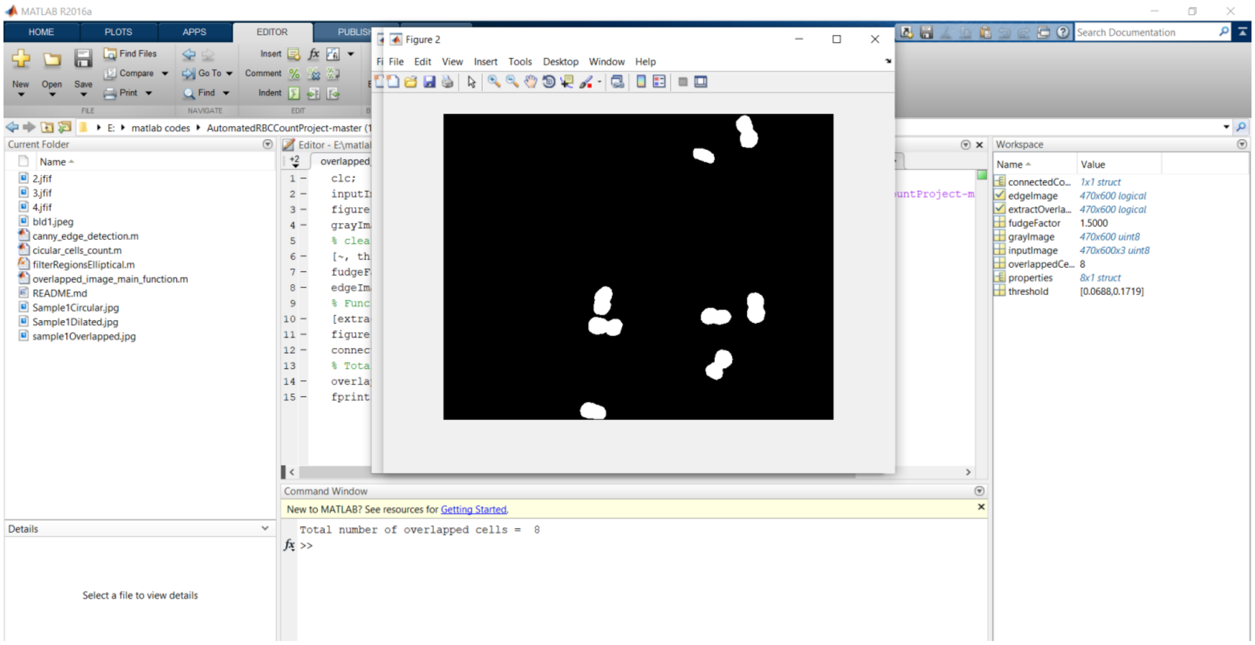

Fig 5.5: To Display The Over Lapped Cells

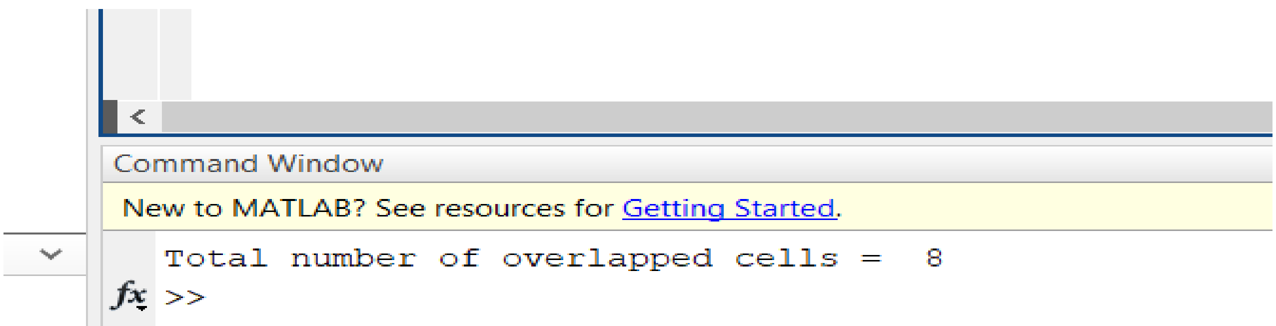

Fig 5.6: To Display RBC Over Lapped Cells Count

6.CONCLUSION

This paper puts forward an automated process for counting RBCs in acquired images using a number of image processing techniques. The traditional approach of cell count using microscopic slides is based on naked eye observations by technical specialists which is tiresome, prolonged, deliberate and inconsistent. In proposed technique, input data contains images of cells at arbitrary position. Various image processing and morphological operations are applied on the input image for counting RBCs automatically without human intervention. Experimental outcomes show that the proposed technique achieved 91.667% accuracy. This suggests that the proposed technology can be effectively used by pathologists in laboratories to automate the process of cell counting which can be helpful to physician to diagnose disease in swift and proficient way. Future extension of this work may include improving the accuracy of the proposed technique is improved.

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