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Robust and Efficient Method for White Blood Cell Counting in Microscopic Image

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ABSTRACT: Human blood consists of three types of major cells: Red blood cell (RBC), White blood cell (WBC) and platelets. Each of them has their own functions in our body. RBC helps in supplying oxygen, WBC fights against infection and platelet helps in clotting of blood. The cells of the immune system that are involved in protecting the body against both infectious disease and foreign invaders are white blood cells (WBCs),also called leukocytes. The bone marrow which is derived from multipotent cells is known as hematopoietic stem cells. Leukocytes are found throughout the body, including the blood and lymphatic system. To perform the segmentation, this project uses the techniques such as Green Plane Extraction, Arithmetic operations, Linear Contrast Stretching, Histogram Equalization and Global Thresholding and GLCM is used for classification. This project describes the results of fast and accurate blood cell segmentation of white blood cells**.**

KEYWORDS: white blood cells, leucocytes, segmentation, classification .

I. INTRODUCTION

The research work is concentrated mainly on the WBC counting [1]. The main scope in this project is detecting WBC cell from the blood sample helps the doctor to found various diseases associated in human body [2]. Also WBC counting is an increasing challenge that aims to treats patients and prevent their illness.

A. WHITE BLOOD CELLS

Leukocytes(WBCs) are the cells present in the immune system and they protect our body from both the infectious disease and foreign invaders[4]. All white blood cells have nuclei present in it, which seperate them from the other blood cells, a nucleated red blood cells (RBCs) and platelets[6]. The WBC count is an important subset of the complete blood count. The white cell count is normally between 4 × 109/L and 11 × 109/L. They make up approximately 1% of the total blood volume in a healthy adult, making them substantially less numerous than the RBCs at 40% to 45%.However, this 1% of the blood makes a large difference to health, because immunity depends on it[3]. The number of leukocytes increase over the upper limits is called as leukocytosis. It is normal when they are the part of healthy immune responses[7]. They are said to be abnormal, when it is neoplastic or autoimmune in origin leukocytes can be classified in many ways.

In Fig.1,the broadest categories is shown. It can be further divided into the five main types:

- neutrophils
- eosinophils
- basophils
- lymphocytes
- monocyte

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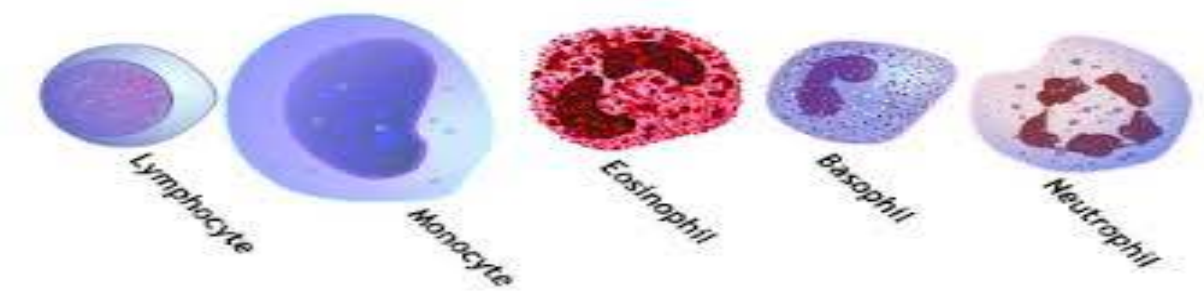

Fig.1 WBC classification

II. RELATED WORK

Recent advancement in genomics technologies has opened a new realm for early detection of diseases that shows potential to overcome the drawbacks of manual detection technologies. In this work, we have presented efficient contour aware segmentation approach based based on fully conventional network whereas for classification we have used extreme machine learning based on CNN features extracted from each segmented cell. We have evaluated system performance based on segmentation and classification on publicly available dataset. Experiment was conducted on 64000 blood cells and dataset is divided into 80% for training and 20% for testing. Segmentation results are compared with the manual segmentation and found that proposed approach provided with 98.12% and 98.16% for RBC and WBC respectively whereas classification accuracy is shown on publicly available dataset 94.71% and 98.68% for RBC & its abnormalities detection and WBC respectively.

White blood cell (WBC) segmentation, which is important for cytometry, is a challenging issue because of the morphological diversity of WBCs and the complex and uncertain background of blood smear images. This paper proposes a novel method for the nucleus and cytoplasm segmentation of WBCs for cytometry. A color adjustment step was also introduced before segmentation. Color space decomposition and k-means clustering were combined for segmentation. A database including 300 microscopic blood smear images were used to evaluate the performance of our method. The proposed segmentation method achieves 95.7% and 91.3% overall accuracy for nucleus segmentation and cytoplasm segmentation, respectively. Experimental results demonstrate that the proposed method can segment WBCs effectively with high accuracy.

DISADVANTAGES

- Quantitative analysis is not performed well in this system.
- Segmentation process is implemented by color based segmentation.

III. EXISTING SYSTEM

The existing method is based on segmentation, classification and counting cells based on their size of white blood cells. Nucleus is first segmented, followed by extraction of texture, statistical, and wavelet features.There are five divisions in WBC: they are basophil, eosinophil, neutrophil, lymphocyte,and monocyte. The numerous benchmark databases validate the effectiveness and efficiency of the proposed system .By applying the colour thresholding algorithm is used to change RGB to HSI color image.The counting of leukocytes, classifying WBCs, anatomical structures, diagnosis, treatment planning, localizing tumours, and other pathologies are used in study of medical imaging in image segmentation through various applications.

Disadvantages

- This method carried on the sub-images.
- They produce less accuracy when compared to proposed system.

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IV. PROPOSED METHOLOGY

This section gives the process and working of each system in proposed work. Block diagram gives overview of the project. Each techniques and algorithm is explained with this system.

Proposed system

There are five types of WBC such as Neutrophils, Lymphocyte, Monocyte, Basophils and Eosinophil images are captured from peripheral blood smear images with varying intensities and background. Image with different sizes and stained images conditions are also considered.

Image segmentation refers to the partitions of an image into a set of disjointed and similar regions, which are meaningful to a particular application. Global thresholding is a better option to segment microscopic blood smear images. However, cytoplasm, nucleus, and background have their own unique grey levels. Thus, global thresholding can perform worse when the lighting level varies from one image to another image. Colour based segmentation of WBCs includes five different techniques to segment them from other cells of the image. The user can select one of these methods and check the precision and accuracy of different techniques to decide the correct algorithm for a particular application and disease. In order to select the suitable segmentation method for the proposed framework, we considered K-means cluster based segmentation, OTSU'S and simple thresholding method. Through experiments, we found colour K-means to be the best candidate for the underlying tasks as it is simple and comparatively more accurate for colour based segmentation.

Advantages

- Good accuracy than existing methods
- Use of minimum filter thrice improves the segmentation result

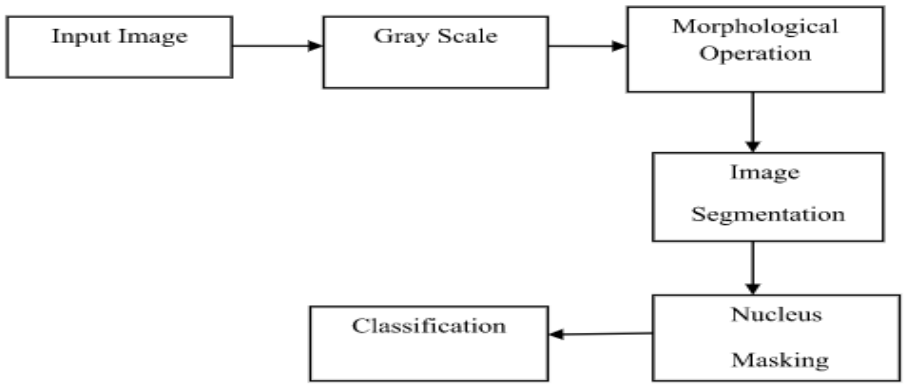

Fig.2 Architecture of proposed system

ALGORITHM EXPLANATION

1. Image segmentation

Segmentation involves separating an image into regions corresponding to objects; it involves selecting only the area of interest that is WBC in an image. This is done by removing all the unwanted area that is RBC, platelets and stains in an image and preserving only the required area. By turning all pixels below some threshold to zero and all pixels about that threshold to one the Thresholding creates binary images from gray-level ones by turning all pixels below some threshold to zero and all pixels about that threshold to one. The details of the proposed algorithm: In the

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beginning the original image is resized. In gray scaled image nuclei is represented as the darkest area in the image. All the subsequent steps will work on the gray scaled image. Two copies of the gray scale images are made on which image enhancement is than performed. On first image copy intensity values are adjust with a linear contrast stretching representing this image as (C) and on the second copy histogram equalization is performed result obtained by this is referred as (E).

Now arithmetic operations are performed on the enhanced image. Contrast stretched image is than added with histogram equalized image giving resultant image (D) which brightens most of the details in the image except the nucleus.

D=C+E (1)

The histogram equalized image (E) is than subtracted from the resultant image D forming next resultant image D1 which highlights nucleus of WBC.

D1=D−E (2)

The last arithmetic steps involves addition of two images D and D1 which retains the nucleus of WBC with minimum effect of distortion on it and remove other blood component which is not of interest.

D2=D+D1 (3)

Then minimum filter is applied three times to the image D1 this increase the intensity values making the nucleus part darker for easy detection.

Then Thresholding technique such as Otsu's method is applied to convert into binary image. Next the binary image is complemented. Then apply morphological opening to remove false objects. By applying area test remaining false objects are removed. Final step is nucleus masking for verification to locate nucleus in WBC and to check if segmented nucleus was correctly obtained from the location.

V. SIMULATION RESULTS

In this section, proposed methods are implemented by means of a software module (MATLAB). The working is demonstrated with the help of software module and the output is analyzed.

The microscopic image of a white blood cell is taken as an sample input image taken from data sets and is reffered in fig.3

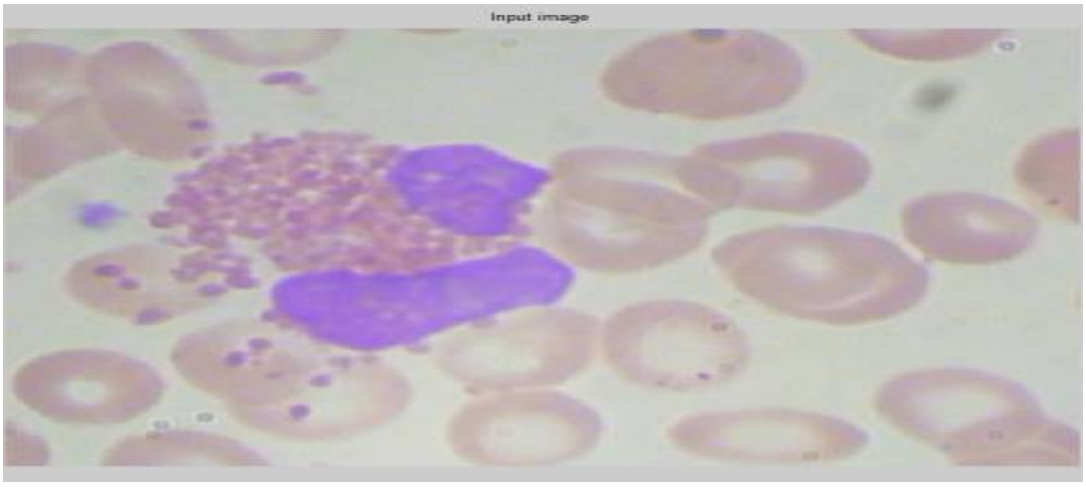

Fig.3 Sample input image

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Then the sample input image is converted into an gray scale image for the viewer convenience.

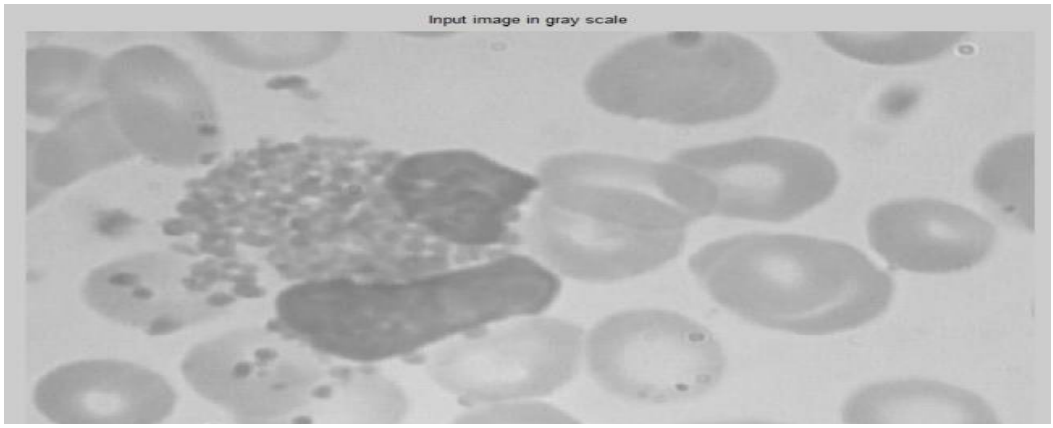

Fig.4 Input image in gray scale

To get the clear view of the nucleus cell(WBC) linear contrast stretching process is undergone and is shown in fig.5

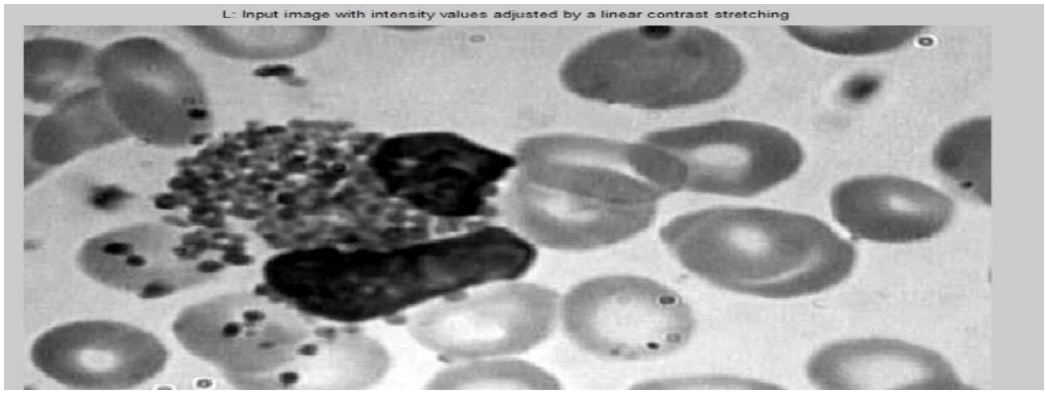

Fig.5 L: Input image with intensity values adjusted by a linear contrast stretching

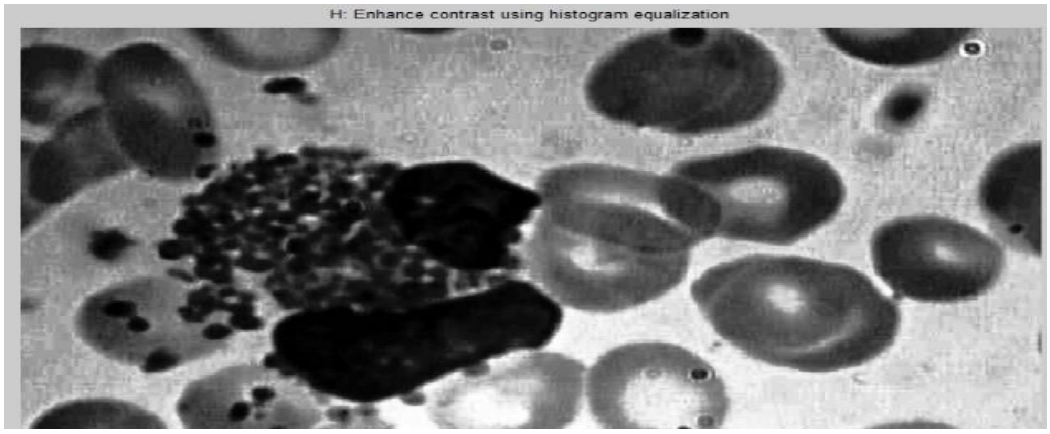

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Fig.6 H: Enhance contrast using histogram equalization

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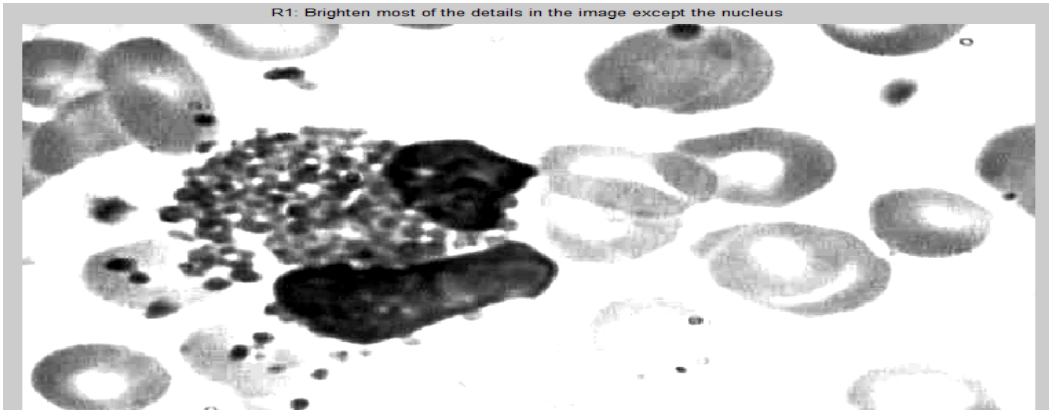

Fig.7 R1: Brighten most of the details in the image expect the nucleus

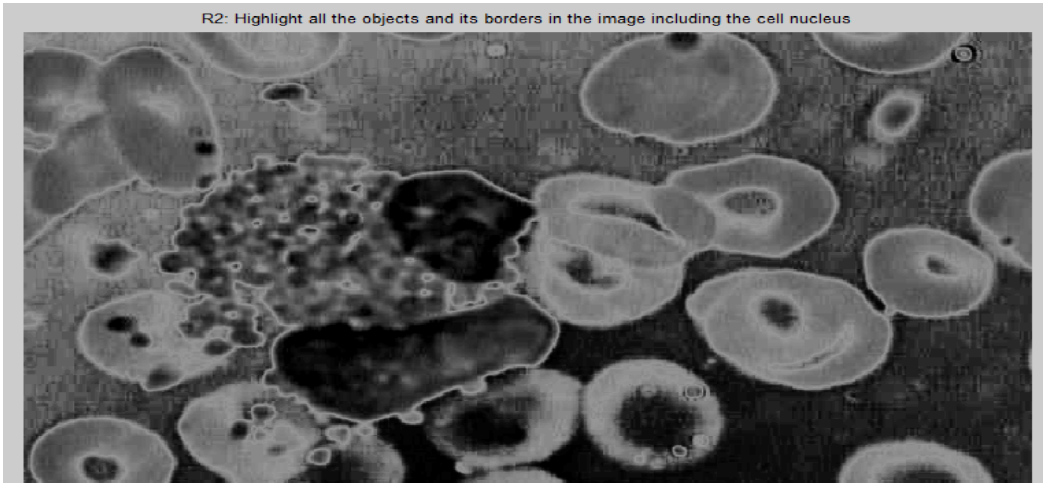

Fig.8 R2: Highlight all the objects and its borders in the image including the cell nucleus

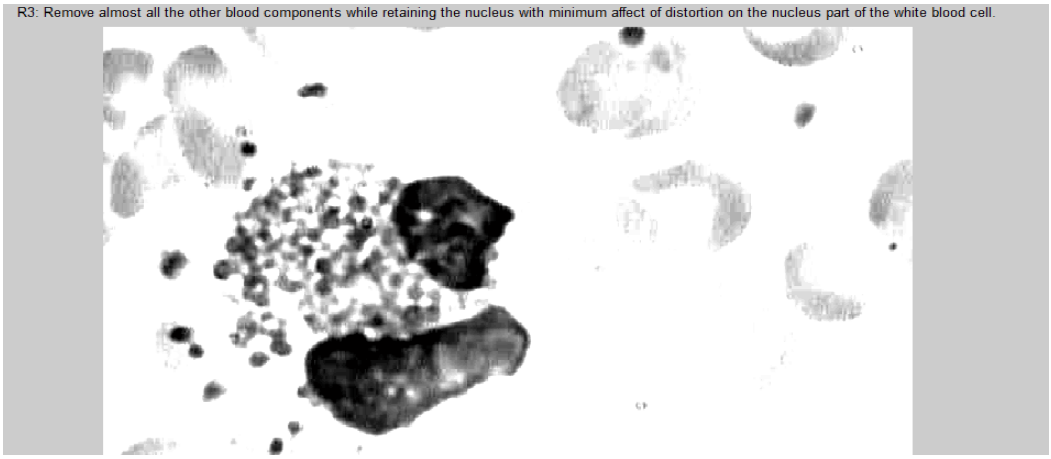

Fig.9 R3: Remove almost all the blood components while retaining the nucleus with minimum affect of distortion on the nucleus part of WBC.

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By performing global thresholding nucleus portion can be viewed clearly

Fig.10 Global threshold using otsu's method

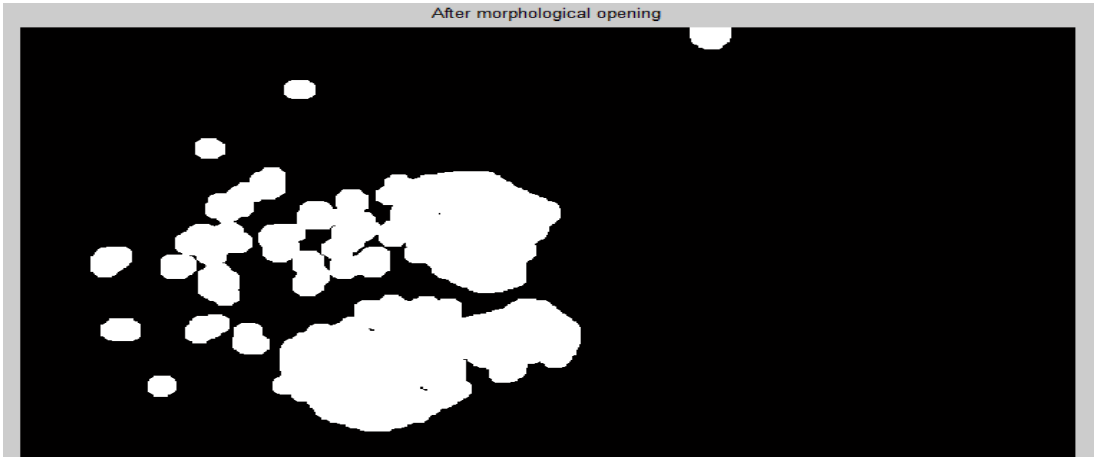

Fig.11 After morphological opening

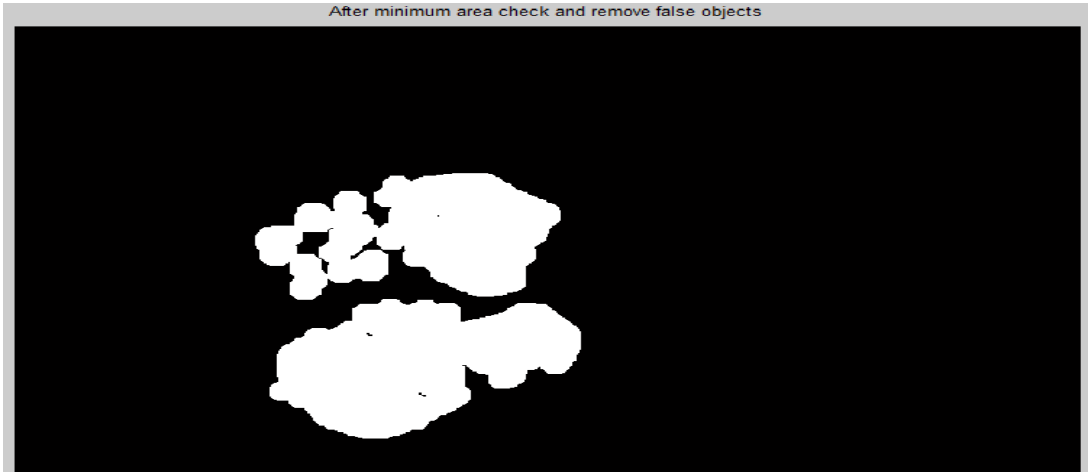

Fig.12 After minimum area check and remove false objects

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Fig.13 Segmented image is differentiated from original image

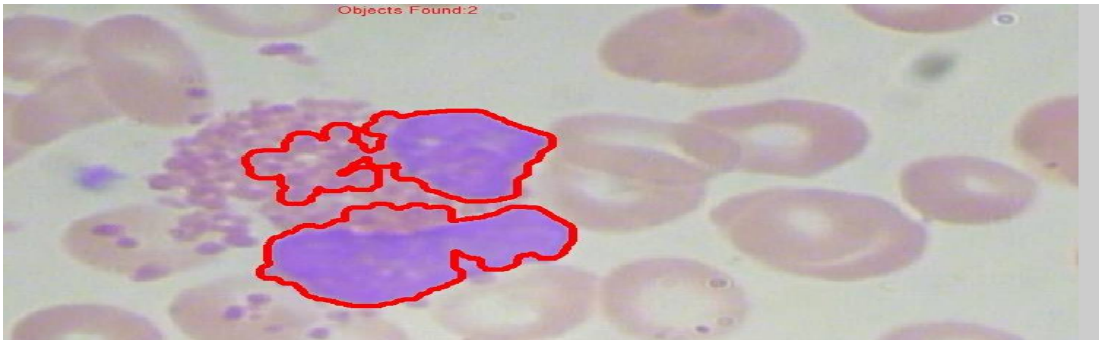

Fig.14 WBC counted image

VI. CONCLUSION

This project attempts to study and provides a brief knowledge about the WBC cells and their counting present in an blood smear image. It shows the computationally efficient method for segmentation of WBC cell when compared previous process. Where preprocessing and morphological operations are undergone to segment the WBC cell accurately. Where the simulation results helps us to known how the WBC cell is segmented and counted.

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