

Determination of Blood Components Count in Real Time Microscopic Images Using Image Processing

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Abstract—RBCs, WBCs, and platelets are all components of blood, which is one of the body's most vital organs. The state of health is characterized by a complete blood count. Consequently, segmenting and identifying blood cells is crucial. Many hospitals and healthcare facilities still count blood cells manually using the outdated conventional approach. This method takes a lot of time and can lead to inaccurate results. On the other hand, health centers cannot afford expensive equipment like the hematology analyzer. This

study describes a raspberry-pi based image analytic system that is meant for the segmentation and counting of blood cells from microscopic blood-smear images using linked component labeling and the Hue, Saturation, and Value (HSV) thresholding method, respectively. On 10 microscopic pictures, RBCs, WBCs, and platelets have been identified and counted. A statistic-based analysis was done to contrast the values recorded by the suggested system with each patient's actual total blood count test result. It demonstrates that the proposed approach has an accuracy of 90% or higher in relation to the real results of CBC testing. Additionally, an Android app was created to assist users, particularly those in the non-urban regions, in determining the amount of blood cells and to send the results from the Graphical User Interface to a certified physician or expert through Short Message Service for remote diagnostic purposes [3].

Keywords— HSV thresholding, connected component labeling, Blood counter, Red Blood Cell, White Blood Cell, platelet, Image Analysis.

I. Introduction

The accurate counting of blood is crucial in the field of biomedicine. Complete blood count (CBC) blood tests are implied to assess an individual's general health and identify a variety of infections or diseases. Previously, a blood sample was manually analyzed in order to count the blood cells and diagnose any diseases under a microscope. The majority of data will be made available within a certain number of hours or a day of testing, which takes time and increases the risk of human error during the testing process. Nowadays, using an automated analyzer allows the process to be completed with the least amount of human help. Receiving healthcare, however, might be challenging in rural places because clinical laboratories are unable to provide such pricey and advanced technology. Platelets. Currently, blood cell analysis and counting are done by hand, which can lead to numerous human errors. Previous research-based studies suggested a software-based, inexpensive, and effective alternative in identifying and analyzing blood cells; the suggested technology makes use of digital image processing. However, these were implemented to separate the white blood cell nucleus from the other cells in the image and to extract the key details from the pictures, such as lines, corners, and curves.

Several hardware components, including a hematology analyzer, were also introduced, but their limitations and exorbitant price made them unsuitable for usage in rural areas. The researchers came up with the study of developing an image processing software-based cost-effective Android application that will recognize and count the blood cells and that enables the doctors from rural areas to easily send the result to other specialists for further diagnosis because providing equipment such as Automated Hematology Counter for blood-smear analysis is quite unaffordable in rural areas where there are frequently fewer doctors or physicians may not be available at all.

A. Basic Concepts of Image Processing

Any algorithm for processing digital images typically has three stages: input, processor, and output. A camera records the image during the input step. It was delivered to a specific system, and the system's output was an image that had been processed [4].

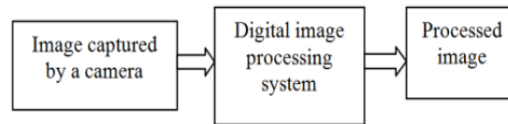


Fig 1. General block diagram of image processing [4]

B. Working

The main controller in the suggested solution is a raspberry pi board. Firstly, all the needed packages in MATLAB are downloaded in order to support Raspberry Pi. A setup is done such that the board is in a proper connection with the Wireless/LAN network being used and a setup procedure is done based on the same. A Raspbian image is burned to a SD Card and a connection between the MATLAB operating system and the board is established.

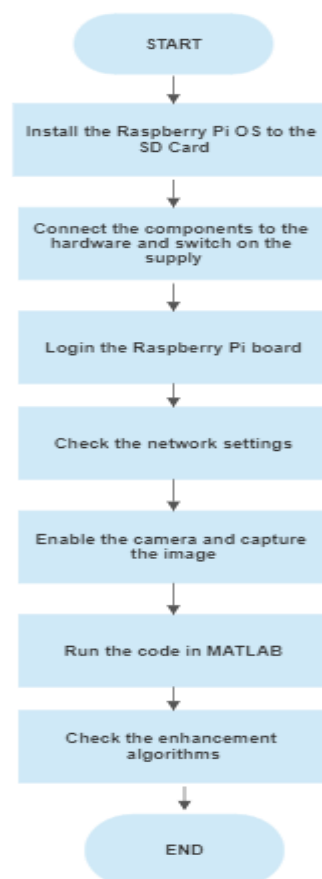


Fig 2. Flowchart of the Proposed Model

II. Proposed Methodology

A. Image Acquisition

A stained blood smear is kept under a microscope and with the help of a Raspberry Pi board and a USB based web camera we need to acquire a live feed of the blood smear kept under the microscope. As soon as we feel the image is stable to be analyzed we can capture the image and allow further analysis to be taking place.

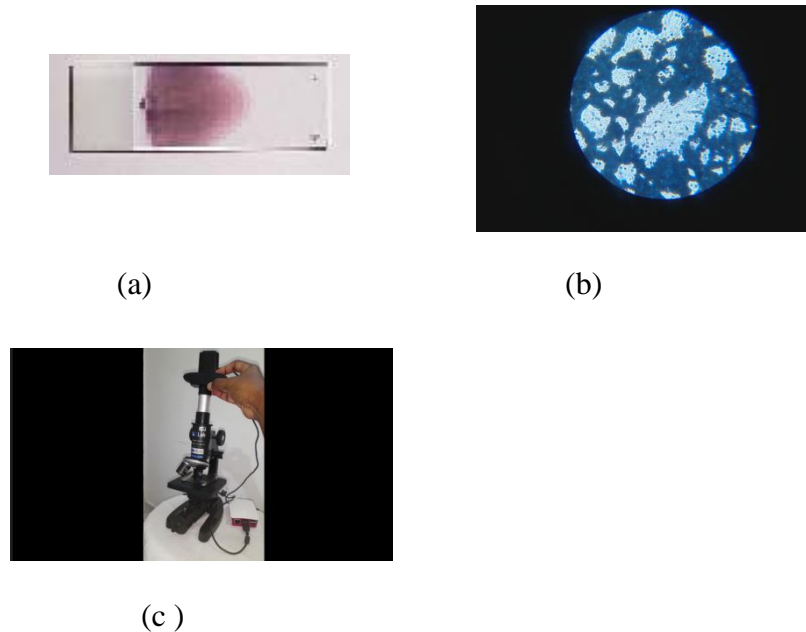


Fig 3.(a)Stained Blood Sample (b) Blood Smear Image

(c)Microscopic Setup

B. Image Enhancement and Pre-Processing

Enhancement techniques sharpen an image's features and enhance its quality, contrast, and brightness. Basic picture enhancement techniques include histogram charting, histogram equalization, image negation, image subtraction, and filtering. In order to improve an image, hue saturation is used. The histogram threshold process is employed to separate the leukocyte or WBC nucleus from the other cells in the picture[2].

Pre-processing is followed by image enhancement. Operations for picture enhancement raise the image's quality. They can be applied to enhance an image's brightness and contrast, lessen its noise content, and sharpen its features. Picture negation, histogram plotting, image subtraction, and other filtering algorithms are some examples of image enhancement techniques. The example of an image enhancing process using median filtering is shown in Fig. (d)[3].

C.RGB Conversion

Usually, the image captured will be in a raw format therefore we need to distinguish them into Red Plane, Green Plane and Blue Plane respectively so that it can further get into the

process of analysis. Blue plane is highly transparent due to the original image being blue in color.

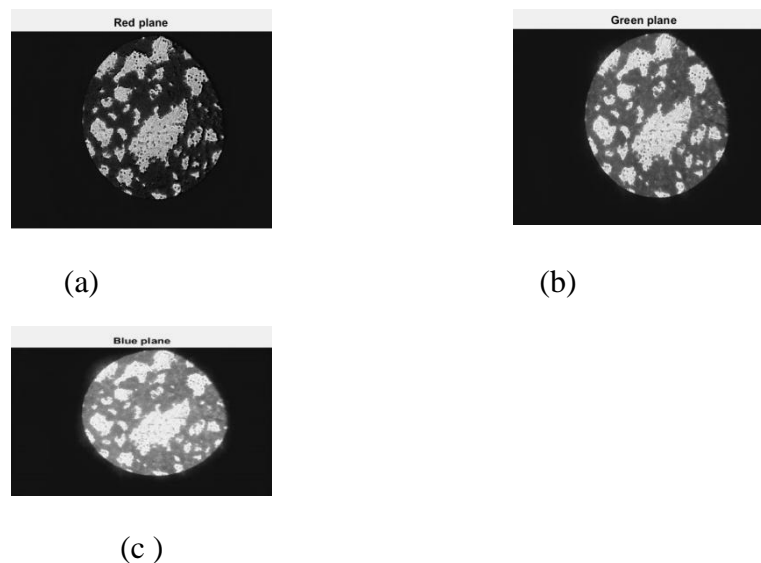
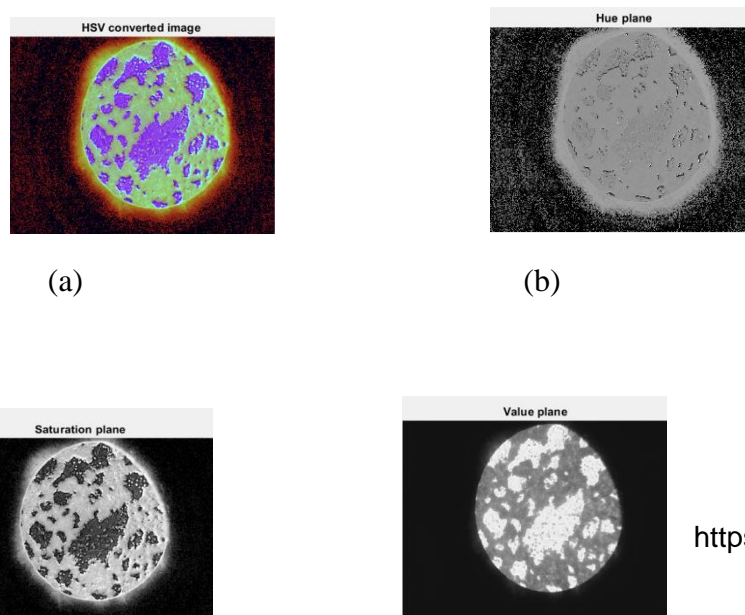


Fig 4. (a)Red Plane (b)Green Plane (c)Blue Plane

D. Image Segmentation

Hue, saturation, and value (HSV) is a color model used in image processing to represent colors in an intuitive way. Hue is the color information, represented as an angle in the color wheel, where each color has a unique hue angle. For example, red has a hue angle of 0 degrees, green has a hue angle of 120 degrees, and blue has a hue angle of 240 degrees. Saturation represents the intensity or purity of the color. A highly saturated color has a pure hue, while a desaturated color has a more muted or washed-out appearance. Value represents the brightness or lightness of the color. A higher value corresponds to a brighter color, while a lower value corresponds to a darker color. The HSV color model is useful in processing the image because it separates the color information from the brightness information, allowing for more intuitive and flexible image processing operations. Such that we would be able to get the count of Red Blood Cells, White Blood Cells and Platelets respectively.



(c) (d)

Fig 5.(a)HSV Converted Image (b)Hue Plane (c)Saturation Plane (d)Value Plane

E. Feature Extraction

Morphological operations come after feature extraction. Features extract process, also known as description, deals with the extracting of several features that produce quantity-based information of interest of traits that are essential for distinguishing a certain class of objects from another. Descriptors like lakes (holes) and bays are effective features that aid in distinguishing one portion of alphabets from another in terms of character identification [3].

The features considered are based on (i)Shape (ii)Color (iii)Texture. The areas of the cell and nucleus, the ratio of the nucleus to the total cell area, the cell perimeter, the compactness, and the nucleus boundary are shape characteristics. Contrast, homogeneity, and entropy are texture characteristics derived from the gray-level co-occurrence matrix. The color features in the CIE-Lab domain are the color histogram, mean, and standard deviation of the color components [3]. There are numerous ways that can be used to extract features. Features are extracted using classifiers such the Artificial NEURAL network (ANN) and support vector machine (SVM), the Local Binary Pattern (LBP) and co-occurrence matrix, and the Sequential Forward Selection (SFS) algorithm [3].

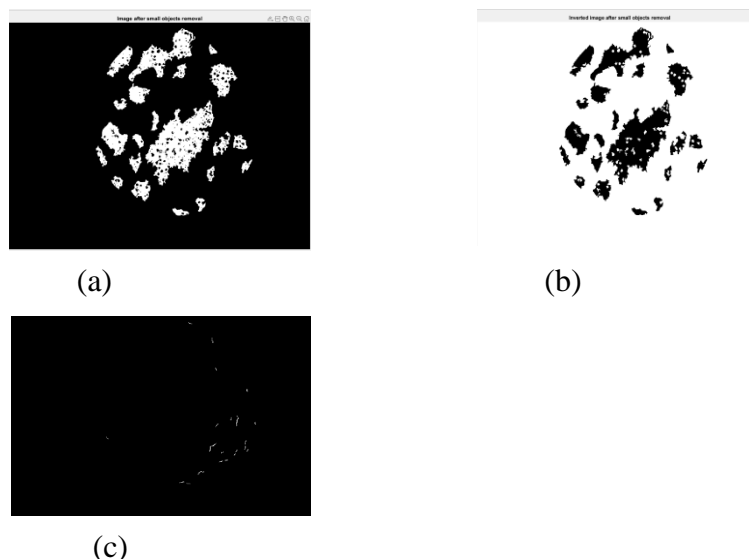


Fig 6.(a)Image after small objects removal (b)Inverted Image of(a) (c)Extracted Features

F. Detection and Counting

The Machine Learning method that we will be investigating for the rest of the system may be an undeniably promising upgrade over such methods for a number of reasons: it is based on simple imagery, therefore the equipment required is significantly less expensive. In contrast to the previous procedures, it produces results relatively instantly.. As we categorize and count more blood cells and expand our dataset sizes, it, like all Machine Learning, promises to improve over time. Furthermore, because it is software-based, we can regularly update it over the air and provide clients with an ever-improving experience.

Following the extraction of photos from an existing dataset, an associated diagnostician labels them manually. They eventually died and were replaced by photographs obtained with our own microscope. As with all good Machine Learning, we spent a disproportionate amount of time cleaning out and prepping the dataset.[2][3][4].

MATLAB is being used as it is highly reliable and provides a stable performance and is also highly user friendly and exceptionally oriented.

G. Cells Count

Counting rule is applied to the live range of Red Blood Cells and White Blood Cells.

Formula for counting RBC: $N = C/A \times 10000$

Formula for counting WBC: $N = C \times 50$

Where N - RBC/WBC count in cubic millimeters.

C - Count of RBC/ WBC in an image

A - Input image area

Normal WBC count in blood 4000-11000.

Normal RBC counts in blood 4.5-5.5 million[2][4].

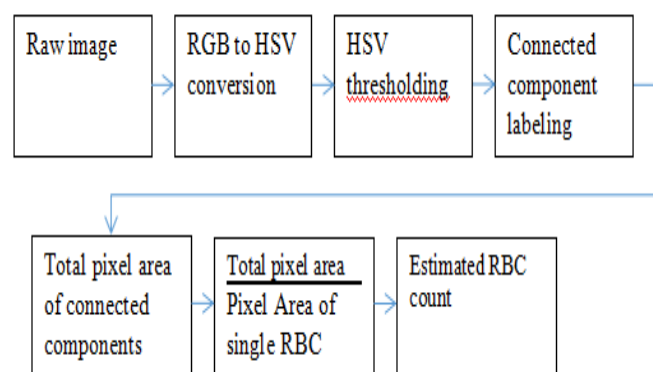


Fig 7. Block diagram of the algorithm for RBC

III.GUI Representation of Cell Count

The main aim is to make this procedure of counting blood cells highly user friendly and providing an interface of the same.

The interface aims to include details of the individual whose blood sample is acquired such as Patient's Name, Age, Sex

and also his Email in order to further communicate the results with the Patient so that he can get a clear vision of his blood count and also so that he can take it up to a physician for more further in depth analysis.

The interface is built using MATLAB. This is because it is highly user friendly and is easily accessible. The results are sent to the given Email via MATLAB. The result is generally in the form of a .JPG format.

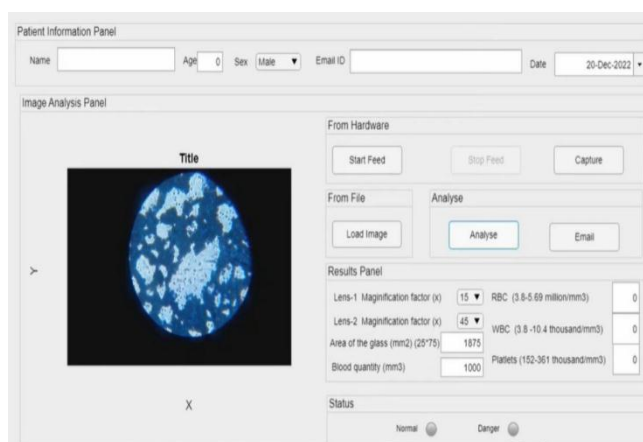
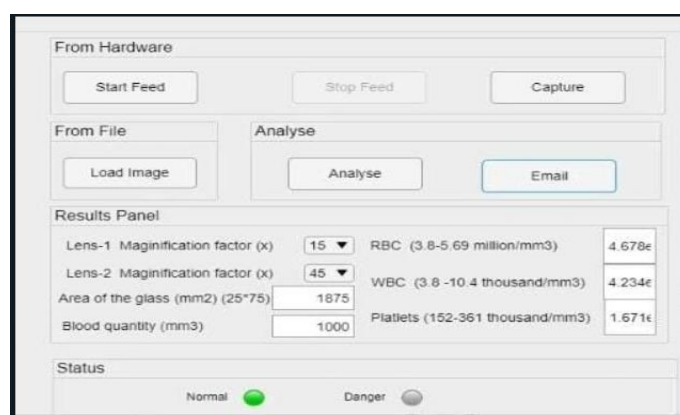


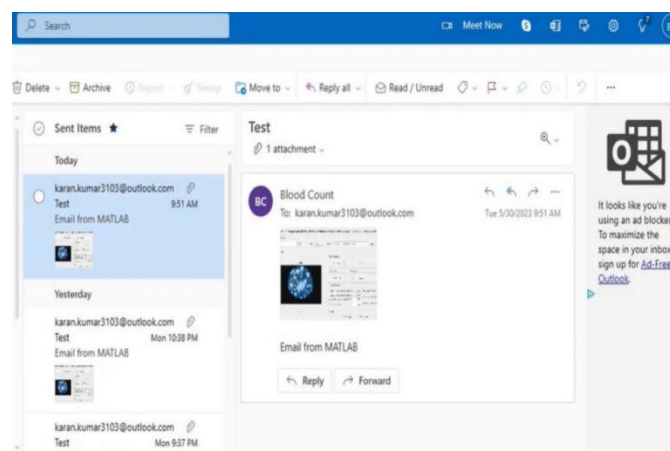
Fig 8. Graphical User Interface via MATLAB with image loaded

IV. Results

Firstly, the MATLAB program is made to run and as soon as the MATLAB application is launched, we need to enter the personal details of the Patient whose sample is being analyzed. The microscopic setup is done accordingly and the live feed is made to occur by tapping on the start feed option. As soon as we feel that the image is stable enough we click on capture and the same image is processed and analyzed in order to find out the values of the Red Blood Cells, White Blood Cells and the Platelets. There is also an alternate option in case the image is being taken from an exterior source so that the Counting process can be done on the same. The result is later shared to the Email of the Patient in order to give him a clear cut idea about his blood cell count. This result can also be used by a Medical Practitioner or a Physician in order to get details in more depth regarding the state of the Patient based on the results achieved.



(a)



(b)

From Hardware			
Start Feed		Stop Feed	Capture
From File		Analyse	
Load Image		Analyse	Email
Results Panel			
Lens-1 Magnification factor (x)	15	RBC (3.8-5.69 million/mm3)	9.356e
Lens-2 Magnification factor (x)	45	WBC (3.8 -10.4 thousand/mm3)	2.117e
Area of the glass (mm2) (25*75)	1875	Platelets (152-361 thousand/mm3)	5.569e
Blood quantity (mm3)	1000		
Status			
Normal		Danger	

(c)

Fig 9.(a)Normal Result Analysis (b) Danger Result Analysis (c)E Mail of results received from the application

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