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Automatic Detection of Malaria Parasite from Blood Images using MATLAB

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Abstract: Malaria is a mortal disease caused by parasites that are transmitted to people by mosquitoes. An estimated 700,000 people were killed by malaria in 2010 globally and approximately half the world's populations are at risk of the disease. Malaria is preventable and curable. The best way of diagnosing it is to look at samples of a patient's blood down a microscope. If one see malaria parasites then the patient has malaria. Quick diagnosis and treatment of malaria with anti-malarial drugs prevents deaths and reduces transmission. In this work automatic detection of malaria from blood images was done and 100% accuracy and sensitivity was found.

Keywords: Mortal disease, Mosquitoes, Microscope, Quick diagnosis, Anti malaria drugs, Robust, Transmission

I. INTRODUCTION

Malaria is a common and life-threatening disease in many tropical and subtropical areas. There are currently over 100 countries and territories where there is a risk of malaria transmission, and these are visited by more than 125 million international travelers every year. Malaria is a leading cause of morbidity and mortality worldwide. Prompt diagnosis and treatment are critical factors in reducing morbidity and mortality, as delayed treatment of malaria increases the risk of death. Microscopy has long been the standard of malaria diagnosis, but newer diagnostic tests now offer advantages in certain settings. Malaria diagnosis is complicated by the fact that acquired immunity to malaria can result in asymptomatic infections. In asymptomatic (febrile) patient, no existing malaria diagnostic test can distinguish malarial illness from parasitemia with concomitant fever of another cause. In this paper we discuss the available malaria diagnostic tests, appropriate applications for each, and the challenges of malaria diagnosis in both endemic and non-endemic settings. Migrants from countries/territories with malaria transmission living in malaria-free countries and returning to their home countries to visit friends and relatives.

II. DIAGNOSIS OF MALARIA

Prompt and accurate diagnosis is critical to the effective management of malaria. The global impact of malaria has spurred interest in developing effective diagnostic strategies not only for resource-limited areas where malaria is a substantial burden on society, but also in developed countries, where malaria diagnostic expertise is often lacking [4,5]. Malaria diagnosis involves identifying malaria parasites or antigens/products in patient blood. Although this may seem simple, the diagnostic efficacy is subject to many factors.

The different forms of the 5 malaria species; the different stages of erythrocytic schizogony, the endemicity of different species, the interrelation between levels of transmission, population movement, parasitemia, immunity, and signs and symptoms; drug resistance, the problems of recurrent malaria, persisting viable or non-viable parasitemia, and sequestration of the parasites in the deeper tissues, and the use of chemoprophylaxis or even presumptive treatment on the basis of clinical diagnosis, can all influence the identification and interpretation of malaria parasitemia in a diagnostic test. In the figure's 1, 2, 3, and 4,there are four types of human malaria – Plasmodium falciparum, P. vivax, P. malaria, and P. ovale. P. falciparum and P. vivax are the most common. P. falciparum is by far the most deadly type of malaria infection.

Image Source: lab medicinblog.com

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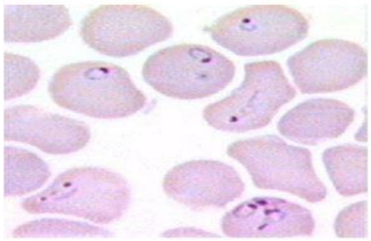

Fig.(1) Plasmodium falciparum

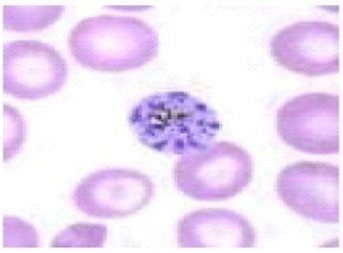

Fig.(2) P. vivax

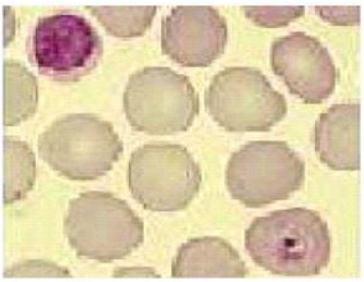

Fig.(3) P. malaria

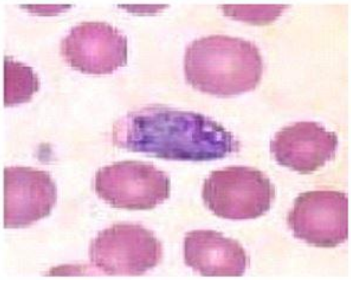

Fig.(4) P. ovale

III . METHODOLOGY

Methodology of the proposed work is shown in fig(5) in a form of a block diagram.

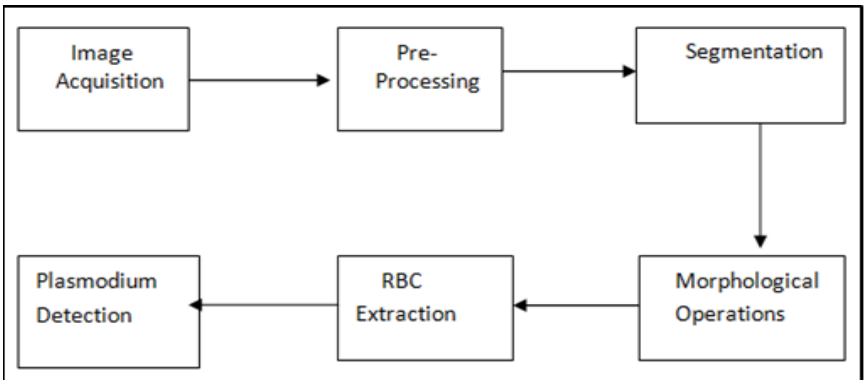

Fig.(5)Block Diagram

1 **Image Acquisition** The input images of Giemsa stained blood smears are selected from the database Library. Images are of different shape and sizes. Images show high variations in intensity, contrast color tone, etc.

2 **Image Preprocessing** The pre-processing block is designed, to remove unwanted effects from the image and to adjust the image as necessary for further processing. The microscopic input image is converted from RGB to gray scale to reduce the processing time. RGB to gray conversion is done by averaging all the three components i.e. R, G and B which results in gray scale.

3 **Segmentation** Smoothing is often used to reduce noise within an image or to produce a less pixilated image. Most **smoothing** methods are based on low pass filters. Smoothing is also usually based on a single value representing the image, such as the average value of the image or the middle (median) value. The simplest approach is neighbor-hood averaging, where each pixel is replaced the average of the by value pixels contained in some neighborhood about it. Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images. The purpose of image segmentation is to partition an image into meaningful regions with respect to a particular application.The segmentation is based on measurements taken from the image and might be Gray-level, colour, texture, depth or motion.

4 **Morphological Operation** Dilation is one of the two basic operators in the area of mathematical morphology, the other being erosion. It is typically applied to binary images, but there are versions that work on grayscale images. The

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basic effect of the operator on a binary image is to gradually enlarge the boundaries of regions of foreground pixels. Thus areas of foreground pixels grow in size while holes within those regions become smaller.

5. **RBC Extraction** Hough Transform (Circular or Elliptical) is applied on the image to find circles depicting RBCs. Since the radius needs to be pre-defined, we can provide a range of radii so that no circle or ellipse is left unidentified. After detection of each RBC, taking into consideration the center a circle is drawn around it using the previously captured radius. The final count is stored in a variable by detecting the number of circle centers in the image. The area of one blood cell is calculated in terms of pixels. Total number of blood cells can be attained by calculating the area of all the cells in image and dividing it by area of one cell. The formula will return an approximated integer of the result which gives total number cells.

6. **Plasmodium Detection** After morphological operations and corresponding color base segmentation it becomes easy to detect parasites from the image. The RBC counting step gives the dimension of each cell and circles them as well. The change in intensity of cell dimensions of all the cells is located by scanning its contour plot. Accordingly we get the total number of infected blood cells in the image and represent them using bright colored squares. By dividing the malaria parasite count by the total RBC count, percentage of malaria can be determined.

IV. RESULT

The input image chosen is shown below. After preprocessing and contrast enhancement we get an image which is free from noise and clearly distinguishable components.

Image Source : laboratorytest.net

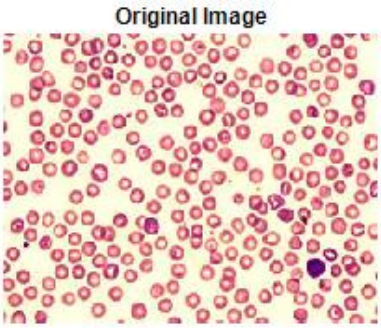

FIG 5.Original Image

Then, morphological operations are performed. Edges are detected by sliding a kernel over the image pixel by pixel. The edges are amplified with this filter according to the distribution of the values in the matrix or kernel. We use Canny in which partial derivative is performed on every pixel because it is more accurate. Next, region filling slides a disc over the image to fill in the unwanted gaps so that it is easier to spot the circular regions. In the color channel evaluation step we extract the green channel. We can also extract blue channel, but not red because the malignant cells are reddish in color. The image is then segmented by thresholding and extraction of green channel. The final step shows the centers of the RBCs and surrounds the malignant cells with a bounding box.

Image Source : laboratorytest.net

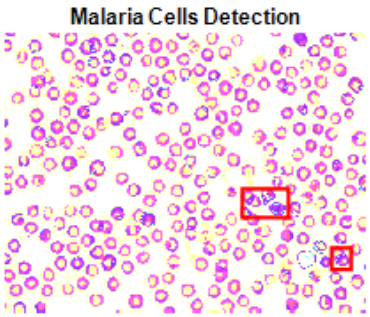

FIG.6.Automated Detection of Malaria Parasite

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Sensitivity and Accuracy of detected malaria parasite were calculated .For that confusion matrix was created.

Where N stands for normal state and Ab stands for abnormal state.

True Positive(TP), True Negative(TN), False Positive (FP), False Negative(FN) obtained for different states are:

Table 5.2.1. Confusing Matrix

States	NO. of Testing	Normal (30)	Abnormal (20)
Normal	30	N → N	N → Ab
Abnormal	20	Ab → N	Ab → Ab

Normal State:
TP = N ⟶ N
TN = Ab ⟶ Ab
FP = Ab ⟶ N
FN = N ⟶ Ab

Abnormal State:
TP = Ab ⟶ Ab
TN = N ⟶ N
FP = N ⟶ Ab
FN = Ab ⟶ N

Total no of normal state=30
Total no of abnormal state=20

Table 5.2.2.Parameters

States	TP	FP	TN	FN	S%	Sp (%)	PPv (%)	NPV (%)	Acc (%)
Normal	30	0	20	0	100	100	100	100	100
Abnormal	20	0	30	0	100	100	100	100	100

Accuracy(Ac)=TP+TN/(TP+TN+FP+FN)*100
Sensitivity(S) =TP/(TP+FN)*100
Specificity(Sp) =TN/(TN+FP)*100
Positive Prediction Value(PPV) =TP/(TP+FP)*100
Negative Prediction Value(NPV) =TN/(TN+FN)*100

In this proposed method sensitivity , specificity , accuracy , positive prediction value and negative prediction values are 100% because it is not real time images. All images are taken from laboratorytest.net.
In comparison with some existing methods accuracy of this proposed method is higher (100%).Like in "Automatic Detection of Malaria Parasite based on Microscopic Image Analysis" accuracy is 97.1% .

VI. CONCLUSION

The detection of Malaria parasites is generally done by pathologists manually using microscopes. So, the chances of false detection due to human error are high, which in turn can result into fatal condition. To curb the human error in detecting the presence of malaria parasites in the blood sample two different methods, image segmentation and feature extraction using minimum distance classifier are used. In image segmentation one gets the accurate and required results in the short period of time whereas in case of feature extraction more time is required i.e. more CPU utilization is there. The system works in a robust manner so that it is unaffected by the exceptional conditions and achieves high percentages of sensitivity, specificity, positive prediction and negative prediction values. The extraction of red blood cells achieves a reliable performance and the actual classification of infected cells.

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