DETECTION OF MALARIA PARASITES IN BLOOD SMEAR IMAGE USING COLOR-INTENSITY FEATURE EXTRACTION

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Abstract: Malaria is one of the life-threatening diseases that affect millions of innocent lives each year, mainly in tropical areas where the most serious illness is caused by the species of Plasmodium falciparum. The conventional microscopy used in the diagnosis of malaria disease has proved to be inefficient since the process is time-consuming and the result is difficult to be reproduced. The alternative diagnosis techniques which yield the superior standard results are expensive and hence inaccessible to poor countries and rural areas. Therefore, this study aims to develop a prototype system that detects malaria parasites automatically from microscopic images by using the color-intensity feature extraction. Two objectives had been made for this study which is to develop an automatic malaria parasite detection system and to detect the malaria parasites in the microscopic blood images using color-intensity feature extraction. The input image is processed with image processing algorithms which include image sharpening, image segmentation (Canny Edge Detection and Watershed segmentation), and feature extraction of the malaria parasites (color-intensity feature extraction). Overall, the accuracy test of the proposed system achieved 98.7% when tested in 300 blood smear images.

Keywords: *Image Segmentation, Malaria parasite detection, Red blood cell image, Feature Extraction.*

1. INTRODUCTION

Malaria is a life-threatening parasitic disease caused by the protozoan parasites of the genus Plasmodium and is transmitted through the bite of the female Anopheles mosquito. Millions of lives had been claimed by this disease which was reported by the national public health institute [1]. According to [2], there are three major diagnostic methods accessible for malaria parasites diagnosis which are rapid diagnostic tests (RDT), microscopy, and polymerase chain reaction (PCR). The method of microscopy and RDT are still the top-notch methods for diagnosing malaria due to their high accuracy diagnosis performances. RDT is also called malaria rapid diagnosis devices (MRDDs), which give evidence of the presence of malaria in human blood when there is no good quality of microscopy services provided especially in the rural areas hence this diagnosis is their top choice. However, the limitation of the device may lead to false-negative results.

With the microscopy method the clinical experts able to quantify and differentiate the malaria parasites according to their species [3], but the cost is too high and the time taken for the result is long, it might take days or weeks to complete the diagnosis, due to the shortage of medical experts. Apart from that, the diagnosis accuracy is determined by the quality of the blood smear preparation and laboratory equipment, the skills of the microscopist, and the quantity of parasite. Therefore, the study

of a computer vision-based system that can perform detection of malaria parasites automatically through a series of image processing techniques to the digital images obtained from the digital microscope in which the system is standalone and portable for any computer devices is essential. This study aims to develop an automatic malaria parasite detection system based on color-intensity feature extraction technique to detect the malaria parasites inthe microscopic image.

2. METHODOLOGY

The proposed method begins with image sharpening to remove the blurring effect in the input image. This is followed by converting the input image to grey-scaled before further simplified with Otsu thresholding [4]. After noise removal, Canny edge detection [5] is applied to extract the edges, and Watershed segmentation is then needed [6] to highlights the significant boundary of the red blood cells. At this stage, the image only contained the red blood cells and the malaria parasites that exist in them. The malaria parasites exist as a ring shape and in blue color (refer Figure 1).

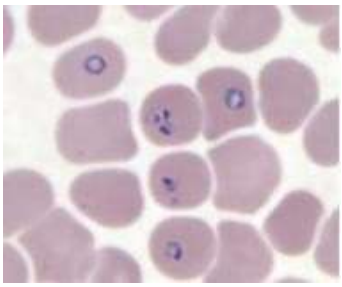

Figure 1. Red blood cell with malaria parasites.

The extraction of malaria parasites is expressed mathematically [7] in equation 1 below:

$$g(m,n) = \begin{cases} x(m,n,i)\ if, 127 \le x(m,n,1) \le 202 \\ \qquad\qquad 35 \le x(m,n,1) \le 131 \\ \qquad\qquad 143 \le x(m,n,1) \le 211 \\ 255 \qquad\quad Otherwise \end{cases} \tag{1}$$

Where,
g(m,n) is m rows by n columns 24-bit color image obtained after malaria parasites extraction, x(m,n,1) is the 8 bit red color plane in x(m,n), x(m,n,2) is the 8 bit green color plane in x(m,n), x(m,n,3) is the 8 bit blue color plane in x(m,n).

Overview of the system framework for the proposed method can be classified into three parts which are input, process, and output. (Refer to Figure 2)

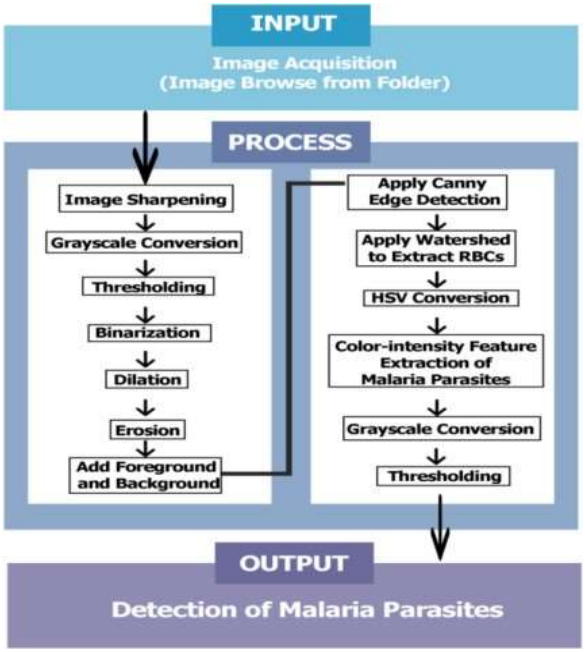

Figure 2. System framework

3. RESULTS & DISCUSSION

The test is conducted by using 300 thin blood smear images in the format of JPEG and PNG. In which 20 of the images taken from [8] are clear from infection and 280 of images [9] are infected.

3.1 Accuracy Test

To analyze the accuracy of the proposed method, seven metrics were used. Those seven metrics are True Positives (TP), True Negatives (TN), False Positives (FP), False Negatives (FN), Sensitivity, Specificity, and Accuracy. The results obtained were tabulated in Table 1 below.

Table 1: Malaria parasite detection sensitivity, specificity and accuracy.

	Infected Images	Non-infected Images
Positive	280	16
Negative	0	4
Sensitivity	100%	
Specificity	80%	
Accuracy	98.7%	

From Table 1, the detection sensitivity was 93% while the specificity 80%. The system showed that it can fully identify 280 infected images. On the other hand, the system could identify 16 non- infected images out of a total of 20 non-infected images. Out of 300 blood smear images used, only 4 were falsely identified. Moreover, the detection accuracy is 98.7%. Since the blood smear images were originated from various resources, the images varied in pixel dimensions and resolution. Hence, have an impact on accuracy. Besides that, there are inconsistency staining concentrations and appearances

of the microscopic images. In addition to that, the images contain noises that also affected the accuracy.

4. CONCLUSION

The malaria parasites in the blood smear have been successfully detected using color-intensity feature extraction in the sample images. The system is portable and does not require any wireless connectivity. To further improve the system accuracy, upcoming research on malaria diagnosis and classification methods based on deep learning should be considered.

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