An Image Processing Approach for Screening of Malaria

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Abstract. Diagnosis of diseases like malaria in the rural area is challenging because of lack of experts. The modern digital facilities helps in solving this problem. The image based approach enabled by computer technology that helps in diagnosis of digital slide is termed as digital pathology. In case of malaria, the infection is detected by observing Red Blood Corpuscles (RBC) manually using microscope. The digital slide preparation of a malaria blood sample and diagnosing the details of disease is challenging. The development of malaria detection system using image processing technique is a significant part of a modern digital telepathology. The proposed work presents the image processing approach for classification of malarial from blood image using YIQ color space. A set of images belonging to malarial and non-malarial classes were processed and a classification accuracy of 97.5% is obtained.

Keywords: Malaria, Blood Image, Red Blood Corpuscles, YIQ Color Space

1 Introduction

In identifying pathologic conditions or diseases, the medical system is now transforming into digital. Digital pathology area is very much challenging and interesting, is expected to modernize the existing pathological diagnostic approaches with an alternate information technology based application. This computerized approach for analysis of various details from blood smear or tissue involves handling of large database. Several researches are going on in digital pathology applications [1, 2]. In screening of disease (like malaria or leukemia), the blood sample is analyzed using microscopic approach manually. This manual approach of diagnosis is time consuming and may lead to inconsistency. Thus this demands trained and experienced technicians or pathologists. This approach once digitized will reduce the time taken for screening the disease. This will improve the consistence in diagnosis [3].

The tropical disease Malaria has affected millions of people worldwide and it is seen appearing every year [4]. The parasite called plasmodium is responsible for the disease. This parasite passes from one human to another by the bite of infected Anopheles mosquitoes. The injected parasites (called sporozoites) travel through the bloodstream to the liver, where they mature and release another form called merozoites. The merozoites enter the bloodstream and infects red blood cells. The parasites get multiplied in the Red Blood Corpuscles (RBC) [5].

Several works have been accomplished for the computerized detection of malarial parasite using HSV color space [3], extraction of parasite component using gray scale image [6], detection of malaria using texture analysis [7], calculation of RBC and parasite [8], detection of malaria by extracting cell features [9]. However these approaches have not reached to a 100 % accuracy.

This paper focuses on processing of blood image for extracting RBCs, later the image converted to YIQ color space. The Q layer of the YIQ color space is extracted in order to get the parasitic information. Further it is classified as malarial or not based on rule based approach. This diagnostic tool thus helps in rural places for faster diagnosis.

2 Methodology

The MATLAB code is developed for processing the digital blood image for the detection of malaria. The stages of proposed algorithm includes the acquisition of blood image, extraction of RBCs, converting the RGB image into YIQ color space, detection of parasite by extracting the Q layer of the YIQ color space and classifying the image into malarial or non-malarial. Figure 1 represents the block diagram of developed system for detection of malaria from the blood image.

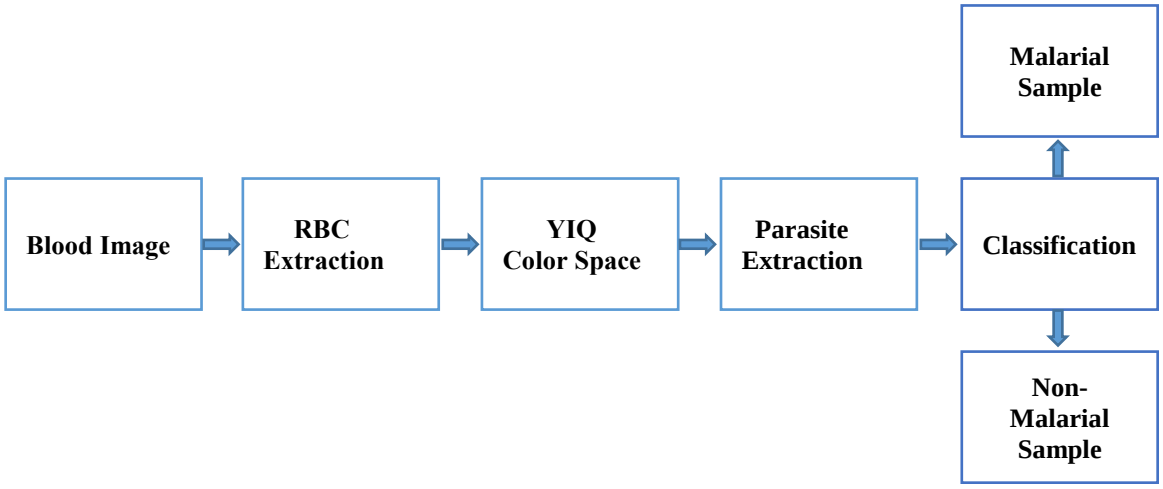

Fig. 1. Block diagram of developed system for detection of malaria from blood image.

2.1 Blood Image

The blood smear slides were prepared and observed under the microscope from Olympus (BX51). The blood images with a resolution of 1280x960 were obtained using Olympus DP25 digital camera which is connected with the computer. The images are acquired at different magnification and they are shown in the figures 2 (a-c). The images are indicating possibility of detecting malaria at various magnification using image processing approach. The processing of images with 1000X magnification is proposed in this work. The blood images with non-malaria and malaria are shown in the figure 3(a) and figure 3(b) respectively. The images were obtained from the Hematology Lab, Kasturba Medical College (KMC), Manipal.

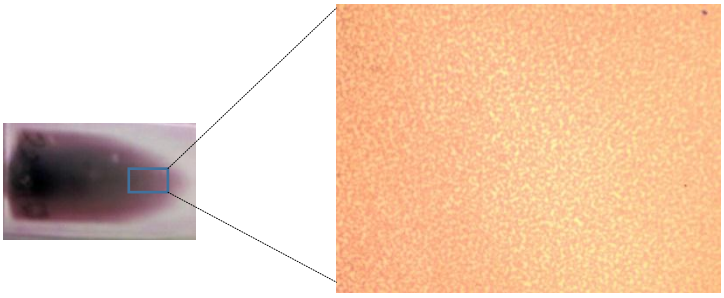

Fig. 2(a). Blood smear slide and image obtained at 40X magnification.

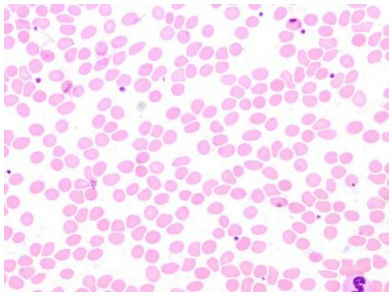

Fig. 2(b). Image at 400X magnification.

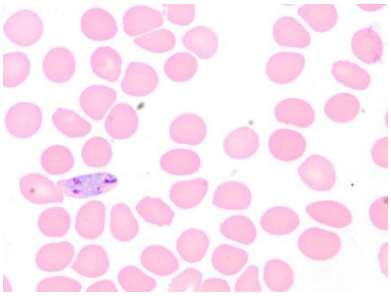

Fig. 2(c). Image at 1000X magnification.

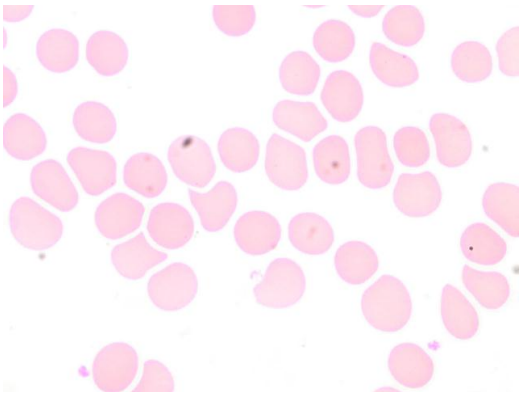

Fig. 3(a). Non-Malarial Blood Image.

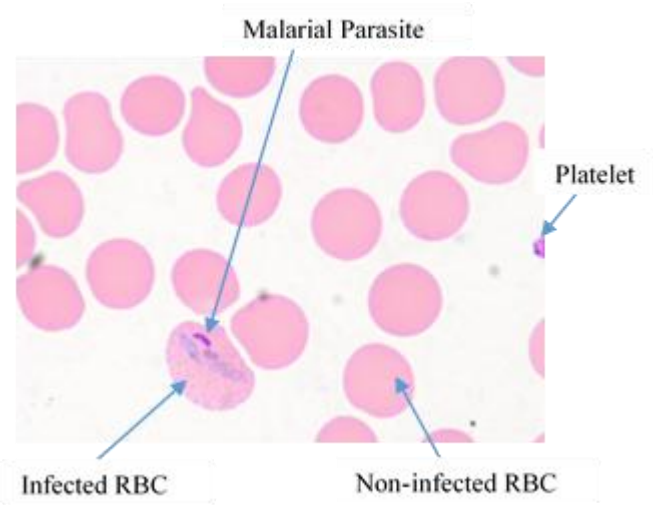

Fig. 3(b). Malarial Blood Image.

2.2 Red Blood Corpuscles (RBC) Extraction

For the extraction of the RBCs, the image is performed with several operations. The input RGB image is converted to gray scale and to binary image. The holes in the binary image are filled with the morphological operation (imfill). The blood image contains platelet and other artifacts, which are considered as unwanted objects in the image. Morphological operation is performed to eliminate the smaller objects which include platelets. The resulted binary image is shown in the Figure 4 (a). The binary image is super imposed with the original image so that the RGB image of extracted Red Blood Corpuscles in obtained.

2.3 YIQ Color Space Representation

In the YIQ color space, Y component represent the intensity, I and Q component represents the color information. The YIQ components are obtained by a linear transformation of the RGB components [10-12]. The resulted color image of RBCs is converted to YIQ color space for the segmentation of the parasite as shown in the Figure 4 (b).

2.4 Parasite Extraction

The three individual components of YIQ color image are analyzed. The Malarial parasite is more distinguishable from background objects in Q component of YIQ color Space. The Q component of image is extracted as shown in the Figure 4 (c). A threshold value is set based on the experimentation. Using a preset threshold on Q layer, the parasite region is segmented as shown in the Figure 4 (d).

2.5 Classification

The number of 'on' pixels in a binary image is calculated to obtain the area of parasitic region. A decision rule is fixed based on the area feature. Area threshold value is set to decision rule for classifying a given blood image into malarial or non-malarial sample.

3 Results and Discussion

The developed algorithm removes unwanted objects including platelets from the image efficiently. Better signature of parasite is found in Q layer of the YIQ color Space. The threshold is set on Q layer for the segmentation of parasite. The threshold is

obtained based on the experimentation on different images. The algorithm calculates the area of the parasitic region. Based on the area the given input image can be categorized into malarial or non-malarial efficiently.

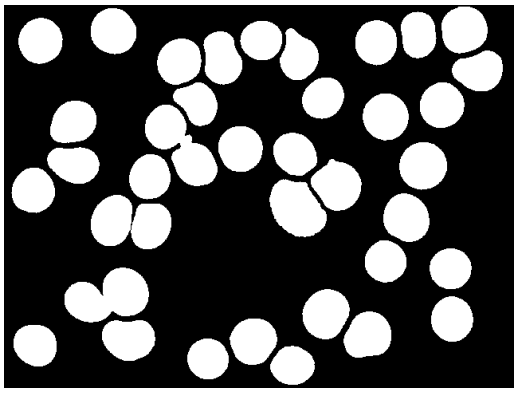

Fig. 4(a). Binary Image.

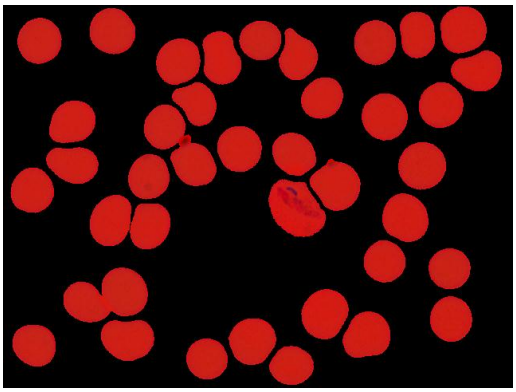

Fig. 4(b). YIQ color space representation.

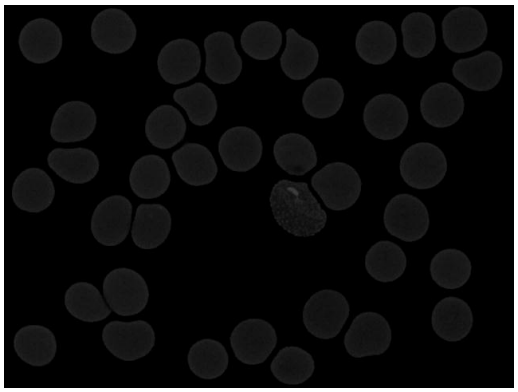

Fig. 4(c). 'Q' layer of YIQ color space.

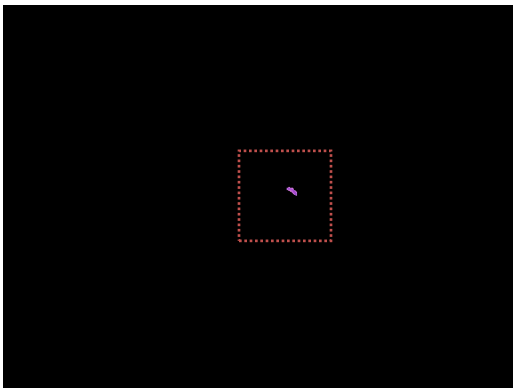

Fig. 4(d). Segmented malarial parasite.

The developed algorithm is tested with 20 Malarial and 20 Non Malarial images. Out of 20 malarial images the algorithm classified all 20 images correctly. And out of 20 non-malarial images 19 images are correctly classified and 1 image is misclassified. Table 1 shows the classification result in percentage that is sensitivity, Specificity and accuracy. We obtained a sensitivity of 100%, Specificity of 95% and accuracy of 97.5%.

Table 1. The experimental result in percentage for sensitivity, Specificity and Accuracy.

Total Test Images	Sensitivity	Specificity	Accuracy
40	100%	95%	97.5%

4 Conclusion

An efficient algorithm is developed for detecting the disease malaria from blood images. This computer based system is faster and helps in consistent diagnosis. The segmentation of parasite is performed using Q layer of YIQ color space in order to detect malaria. The result in categorizing the blood image into malaria or non-malarial is obtained with an accuracy of 97.5%. The developed classification tool is promising and can be useful in the rural areas for screening the malarial patients where there will be lack of trained technicians.

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