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Malaria Parasite Concentration Determination Using Digital Image Processing

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ABSTRACT*:* Malaria is an infectious disease caused by Anopheles Mosquito. Compared to 2015 World Health Organization report, in 2016 total 216 million cases are reported for malaria parasite which are 5 million more Victims of malaria are not decreasing when seen in statistics. Total reported deaths in 2016 are 445000 which is the same number to 2015 WHO report. The African and Sub-Saharan Region continues to account for about more than 90% of malaria cases and deaths worldwide. In the subcontinent regions mostly below the tropical, the countries are more infected with the malaria parasite. Mostly registered cases are women and children. The malaria parasite is detectable and curable still so many cases are reported. The standard methodology used to detect malaria parasite in blood is a '*gold standard*' conventional method. In which expert detects malaria parasite manually by checking each and every slide. There are 5 types of Malaria parasites which are responsible for worldwide malaria cases. The paper shows the accurate determination of malaria parasite as conventional standard may percolate human error. Also, the time required to perform the test is more. The expert can review handful number of infected slides. So the technique is proposed that follows image preprocessing image segmentation filtering classification and finally the detection of the malaria parasite.

KEYWORDS*:* Parasitemia, Manual microscopy, Giemsa stained Blood Smear Image, Malaria, Exchange Transfusion

I. INTRODUCTION

Malaria is a very severe disease which can lead to death if not diagnosed properly or diagnosed late. Globally, malaria is a major public health problem. According to World Health Organization report [1], every year 445000 people died because of malaria. Yet Malaria can be diagnosed very easily and is treatable. The most affected parts of the world are African continent and sub-Saharan regions. Even in India, there are large numbers of cases of malaria are ported and the most often women and children are affected. These areas mentioned are affected the most because the conditions are favorable for the malaria parasite to grow very easily Malaria parasite undergoes a very complex life cycle. When female Anopheles mosquito which is infected with malaria parasite bites the victim to obtain the blood meal, it releases the anticoagulant in victim's body along with elongated sporozoites. The complete life cycle of malaria parasite from mosquito to victim and back to vector mosquito is shown in fig. 1.

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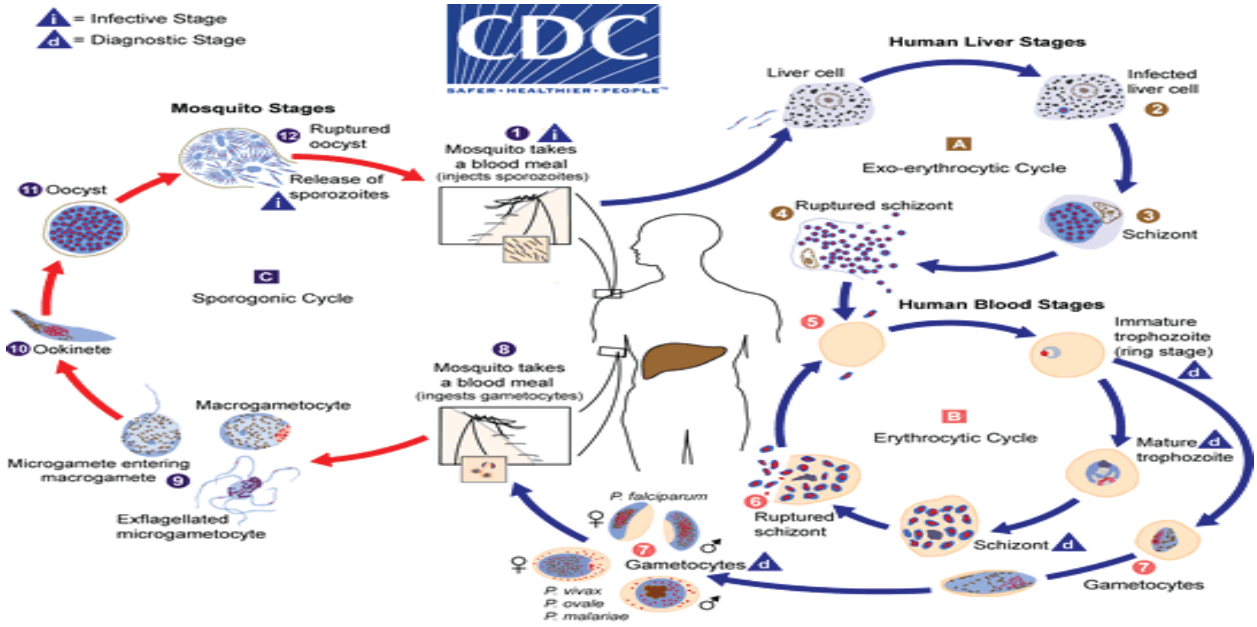
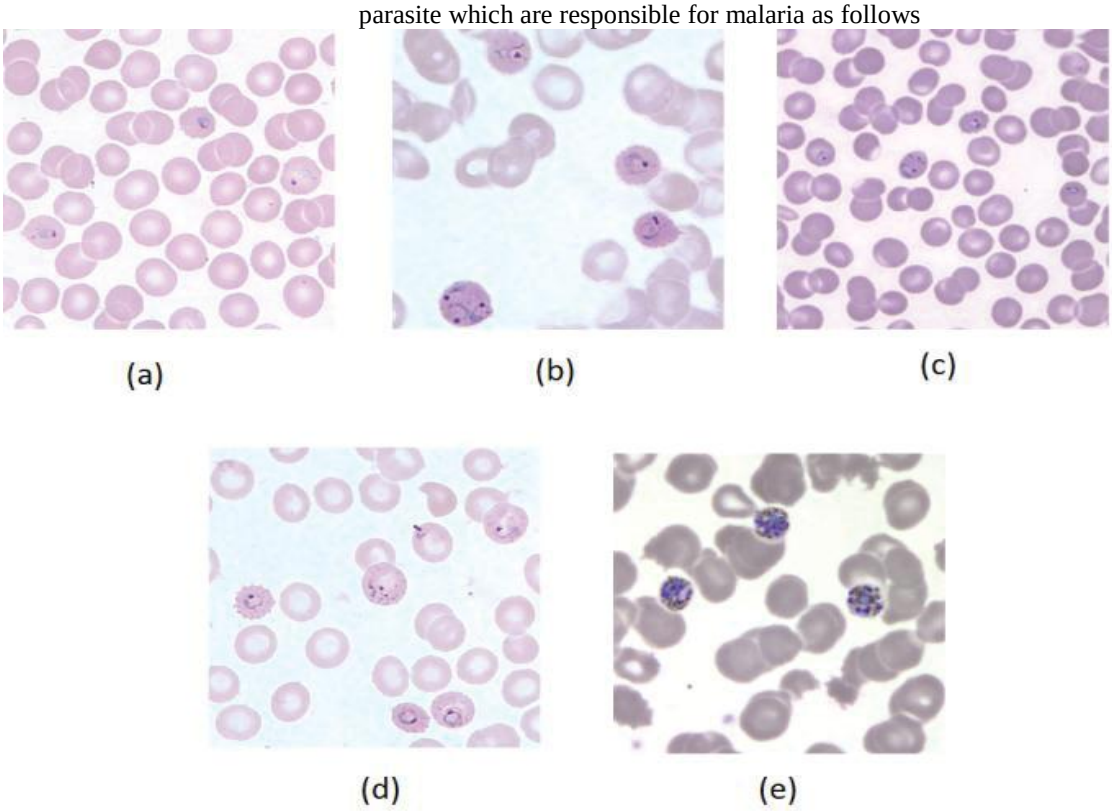


Malaria parasite uses Red Blood Cell (RBC) as a host and infects it. There are five types of Plasmodium malaria parasite which are responsible for malaria as follows



Malaria parasite species, (a) P. Vivax (b) P.ovale (c) P. Knowlesi(d) P. Falciparum (e) P. Malaria

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In the conventional gold standard method, the expert observes each and every slide carefully for any malaria parasite. This is considered to be the gold standard for malaria parasite determination. But there is lack of experts in the affected regions. Also, the conventional method is prone to human error. Manual diagnosis is also a time-consuming plays an important role to save the life of the patient. So the paper proposes a method for identification of malaria parasite in the blood smear image. The choice of appropriate treatment depends on the species of infecting parasite and the parasite density. Patients with severe malaria required intensive care and parental treatment until the parasite density decreases to less than 1% and they can tolerate oral therapy. If parasitemia exceeds 10% or if there is evidence of complications exchange transfusion may be necessary. Hence finding malaria parasite density in blood is as important as finding its concentration for the proper course of treatment. Using intensity and texture feature system easily identify malaria parasite in the blood image. The paper focuses on detection of infected cells which helps in the calculation of parasitemia, the measure of infection. In addition, a semi-automated diagnostic process which detects the sexual stage i.e. gametocytes of the malaria parasite species for post-treatment. In this paper Section 2gives the idea about literature review. System design is presented in section 3. Section 4 shows the results and Section5 gives the discussion about the conclusion.

II. LITERATURE REVIEW

Back propagation algorithm may be used to train the proposed system [2]. The system uses the artificial neural network to work on the features extracted from the processed images acquired. The accuracy achieved using this technique is very high at 99.68%. Lack of trained technicians is always a problem in rural areas. Semi-Automated classification tool plays a promising role in such areas for screening malaria patients. Q layer of the YIQ color space is processed to perform the segmentation of malaria parasite image. The accuracy is achieved up to 97.5% [3] which has classified the image into the malarial segment and non-malarial segment. Maximum sensitivity achieved in his paper is 100% after working on total40 images. Comparative study of two different classification techniques using Euclidean classifier and Support Vector Machine is proposed [4]. Malaria parasite detection using SVM classifier gives the better accuracy of 93.33% compared with the Euclidean classifier which gives the accuracy of 80%. The methodology includes binarization using Poisson's distribution based Minimum Error thresholding, followed by refinement of the image using Morphological opening. Multi scale Log filter implements seed point localization. Electronic recording of holograms and their numerical reconstruction by stimulating diffraction system is proposed[5]. So here they described the digital holographic microscopy(DHIM) with focusing on automatic identification of malaria infected red blood cell (RBCs). Morphological method for malaria parasite detection in blood smear image is implemented in the paper [6]. Dimensions and color are the parameters considered to identify parasite. Automatic thresholding based on morphological approach has been used. Watershed algorithm is combined with morphological operators to perform segmentation. In this paper [7], approach template is used for detection of RBC. Parasites are detected using the variance based technique. From grey scale image and the second approach is based on color co-occurrence matrix.

III. SYSTEM ARCHITECTURE

The system consists of different blocks which include image processing, image acquisition, image segmentation, image classification and finally detecting the malaria parasite and finally counting the number of infected cells. Fig. 3. Proposed Block diagram of malaria parasite detection system. The images used are acquired from the standard database from official website of the Centre for Disease Control. Images are in the RGB format provided for the study of the malaria parasite.

A. Image Preprocessing

The image preprocessing consists of the initial steps of resizing the image. But CDC provides the images in the standard form of 300×300 pixel dimension. No need to resize them. The provided images are in RGB format. We can process the images with less time if we convert an RGB image into a grayscale image. The infection in the cell that is malaria parasite is in violet color and the red blood cells are in pink color in the Giemsa stained blood smear image. As the intensity level of these two images is quite different so we can easily discriminate between infected and non-infected blood cells. Hence we convert an RGB image into a grayscale image using Matlab function rgb2gray.

B. Image Segmentation

Using image segmentation the foreground and the background can be separated in which RBCs are foreground and remaining part is background. Main focus is on cell region where the infection is either present or not present. With the target image selected, the segmentation is performed using segmenter App and setting the automatic threshold. The image is evolved using region-based iteration which has produced better results. Small holes in the cell region are

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removed using refinement for minimum size with920 to infinite pixel size for the target image. This is nothing but BW area filtering producing following output which is a good result for further processing.

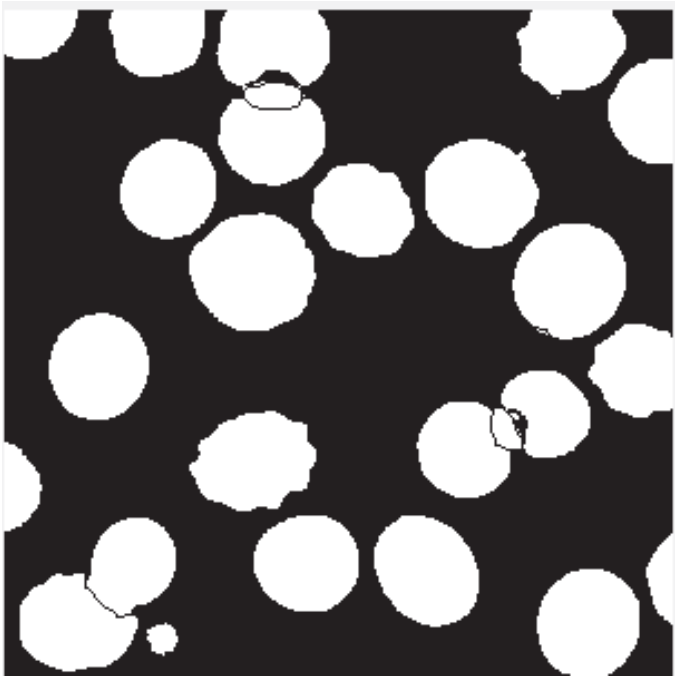

Image after Segmentation

1. Watershed Segmentation

There are some images which contain overlapping of cells also called as contagious objects. We need to find out the number of cells in the image. For that, we need to separate out the overlapping cells. Watershed segmentation is the best way to do so. It separate outs the overlapping regions and help in counting the number of cells correctly. Following diagram shows the watershed segmentation but faces the problem of over-segmentation.

Over segmentation Of Image Fig.6. Minima Suppressed Image

The over segmentation shows the lines which differentiate the contiguous cells. But lots of interior of the cells are segmented because of noise. So these minima need to be suppressed.

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C. Classification

We need to separate out each cell and process them individually to find for any infection in it. So using morphological approach to our segmentation, we can use shape information. Circle information can be used to check for any infection as the infection in the cell has different intensity value. By applying proper threshold value within the circle radius we can find whether the given cell is infected or not. The cells detected with infection are highlighted and total numbers of cells are counted to find the percentage cells infected in the total number of cells.

IV. RESULTS AND PERFORMANCEANALYSIS

The Giemsa stained malaria-infected image is given to the system. The infected cells are highlighted. Total number of cells are identified and counted in the image using circle finder function based on intensity feature. Out of total cells, malaria infected cells are counted and are expressed in percentage. Sensitivity and specificity are the parameters which determine the performance of the diagnostic test. To evaluate the overall accuracy of the system sensitivity and specificity are used.

True Positives (TP): Infected RBC is detected (Infected cell shows positive test).
True Negative (TN): Non-infected RBC is neglected (Non infected cell shows negative test).
False Positive (FP): Non-infected RBC is shown detected(Non-infected cell shows positive test).
False Negative (FN): Infected RBC is neglected (Infected cell shows negative test).

V. CONCLUSIONS

Manual microscopy is a time-consuming process and prone to human error. Proposed system takes the Giemsa stained blood smear image as an input. Result highlighted the cells infected with the malaria parasite. Percentage infection is shown at the top of the image which can be verified by looking at the original image. The system shows 46.7% infection in the image which is 97.76% accurate.

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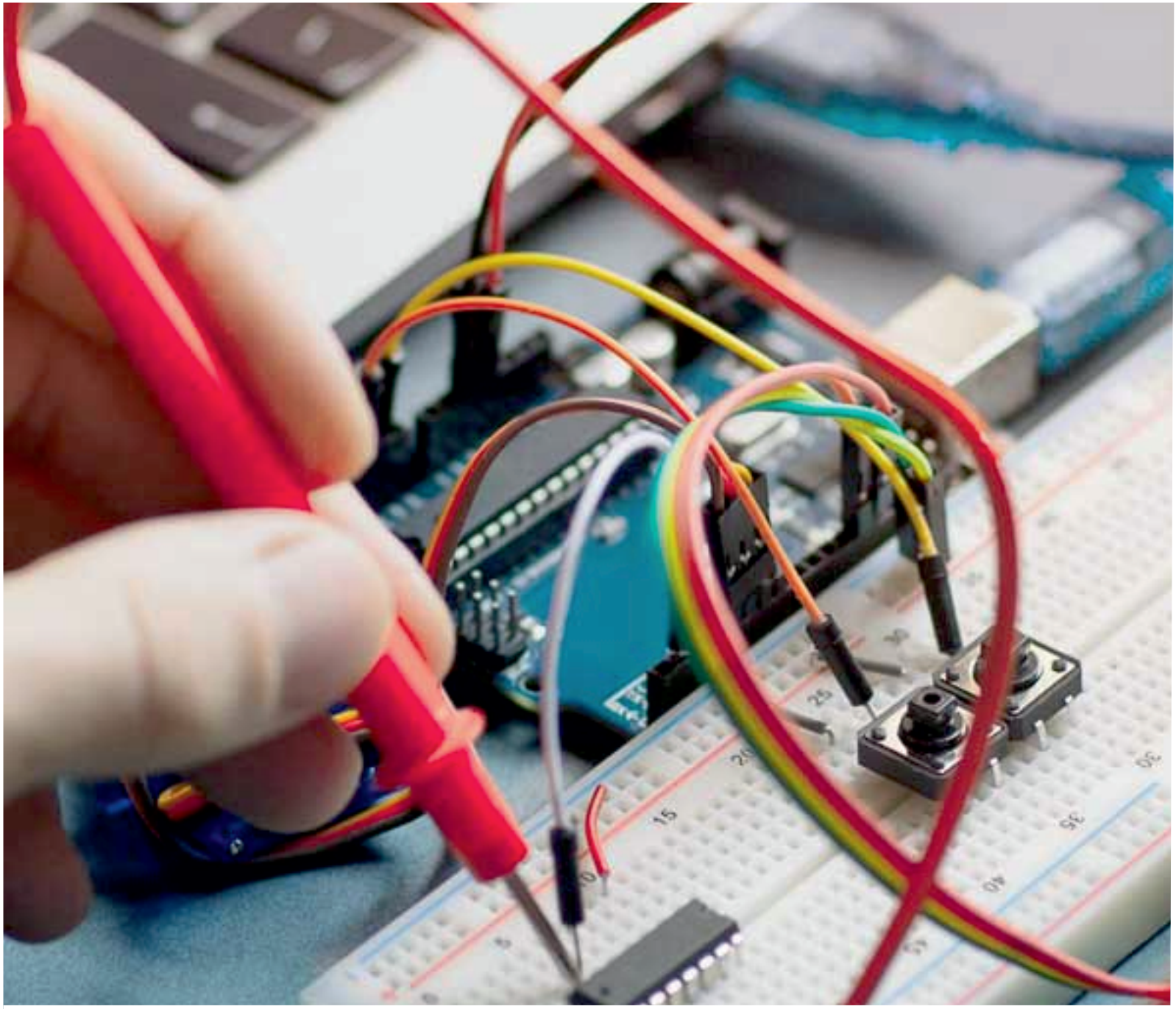

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