International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.07, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Detection of malaria in human blood using image processing and machine learning

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ABSTRACT

Malaria is a life-threatening disease which is caused by the plasmodium parasites and is transmitted in human blood through the bite of a female ANOPHELES mosquito. It is a dreadful disease and may even lead to death if not rapidly diagnosed. This project aims an automated system which will detect malaria parasite in human blood. There are basically four types of malaria namely, P.falciparum, P.vivax, P.ovale and P.malariae. Image processing technique is used in this proposed system thus automating the detection process. This method involves steps like image acquisition, pre-processing, segmentation, feature extraction and classification. The type and the stage of the malaria parasite will be determined using multi-stage support vector machine(SVM).

Keywords: ***image acquisition, pre-processing, segmentation, feature extraction, classification, SVM***

I INTRODUCTION

Malaria is a very dangerous disease which can lead to millions of deaths if not detected at an earlier stage. People with malaria often experience fever, chills and flu like illness. According to [2] in 2016 an estimated 216 million cases occurred worldwide and 4,45,000 people died, mostly children in African region. About 1700 cases of malaria are diagnosed in the United States each year. According to [3] malaria infected people in the year 2013 is 300-500 million.

The life cycle stages of malaria parasite are primarily described into three stages. The host female anopheles mosquito injects the sporozoites into the blood from their saliva. These sporozoites then enter into the liver and assault the liver cells. The invented liver cells then contain the full grown sporozoites which later burst and the merozoites are spread all over the blood infecting the red blood cells. These merozoites give rise to the trophozoites, schizonts and gametocytes which are considered as the life cycle stages of the malaria parasite.There are basically four types of malaria namely Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, Plasmodium malariae. Among the 4 types of malaria P. falciparum is most common and most dangerous type of malaria.Also, there are three different stages to each of these five types of malaria i.e. trophozoites, schizonts and gametocytes; shown in Fig 1.

Trophozoite stage- at this stage the parasite is in a ring shape with small one or two cytoplasm dots.

Schizonts stage- these are matured trophozoites which can be recognised by the circular shape with many

cytoplasm dots in it.

Gametocytes stage- this stage is known as the sexual growth stage and the male female parasites are formed in this stage. The male size is smaller than the female gametocytes which are somewhat banana shaped.

There are different ways to detect malaria in blood smears using image processing proposed by different researchers, some of them are; S.S. Savkare used otsu thresholding, watershed transform and SVM classifier to detect the type of malaria[4]. F.B Trek and A.G Dempster used colour normalization and Bayesian decision rule which achieved satisfactory results[5]. Subhamoy Mandal presented an optimized normalized cut method for segmentation and the efficiency was tested using Rand's index [6]. Miss kshipraCharpe used color model conversion, feature extraction and SVM classifier which gave good results[7]. AkshayRandive detected P.vivax by using thresholding and sobel filtering for feature extraction, and concluded that the infected cell is large in size with a dot and a ring inside the cell [8]. Pallavi Suradkar proposed an algorithm which detected malaria by counting malaria parasites in blood smear images[9].

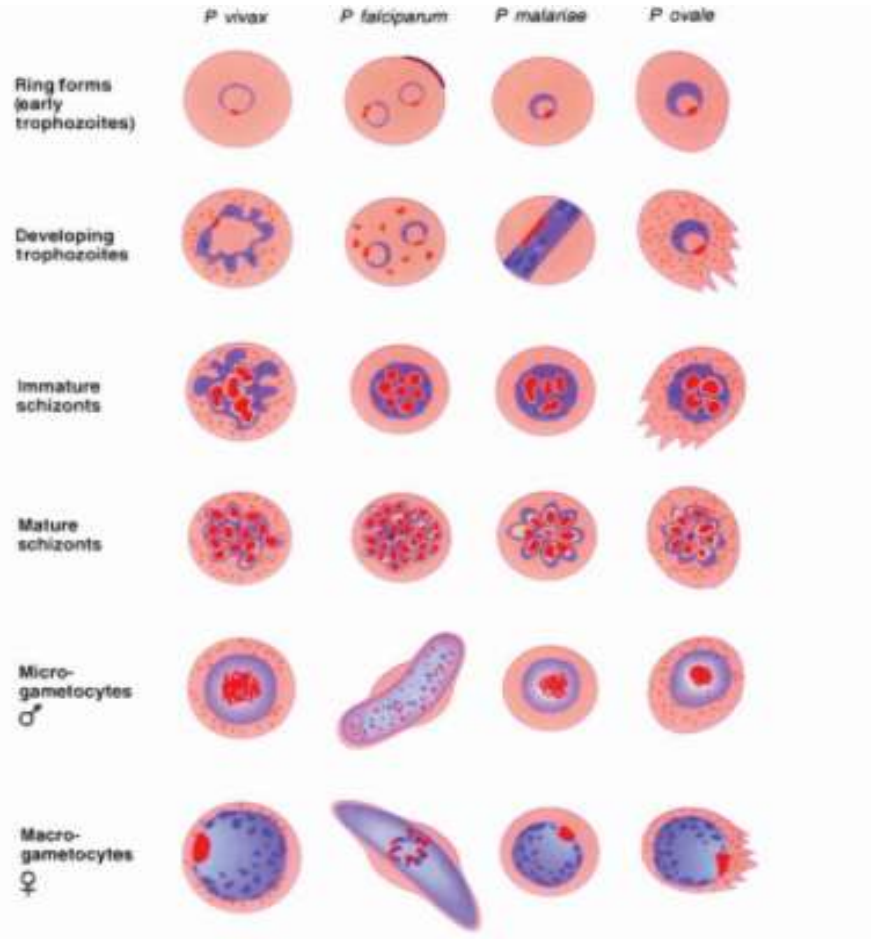

Figure 1: stages of different types of malaria.[10]

II METHODOLOGY

Following are the detailed steps followed for detection of malaria and its various stages.

1) Image acquisition
2) Image pre-processing
3) Image segmentation
4) Feature extraction
5) Classification

IMAGE ACQUISITION

Images of human blood smears infected by malaria parasites (P.falciparum, P.vivax, P.ovale, P.malariae,) are obtained from online data base[1] [3].

IMAGE PRE-PROCESSING

Main aim of image pre-processing is to improve the image data that is, to suppress unwanted distortions or enhance some image features important for further processing.In this step the colored image is converted into the greyscale mage in order to analyze the intensity of the image which is further required to calculate the different features of an image

IMAGE SEGMENTATION

Segmentation is often considered to be the first step in image analysis technique. The purpose of segmentation is to subdivide an image into meaningful non-overlapping regions, which would be used for further analysis (i.e. feature extraction and classification of life cycle stages of malaria parasite).

FEATURE EXTRACTION

Features are the main distinguishing points of any object. To distinguish the infected RBC from the non-infected RBC, we have to consider some features which will help us to detect the malaria and its different stages. Following are the features on which this work is being focused on; size, shape, mean, kurtosis, standard deviation, intensity and skewness.

CLASSIFICATION

The SVM classifier is used to classify the type and the stage of the malaria. It consists of the training set and the test set. When a test image is selected the classifier compares the features of the training set with the test set and classifies the type and the stage of malaria. The advantage of SVM classifier over other classifiers is that there are no upper limits on the number of features used also, it is highly accurate and fast.

III EXPERIMENTAL RESULTS

The data set consists of 300 images of blood smears which are infected by different types and different stages of malaria. The segmentation outputs obtained are shown in Fig 1, in which the type of malaria detected is P.falciparum and Table 1 shows the features extracted from various stages of P.falciparum

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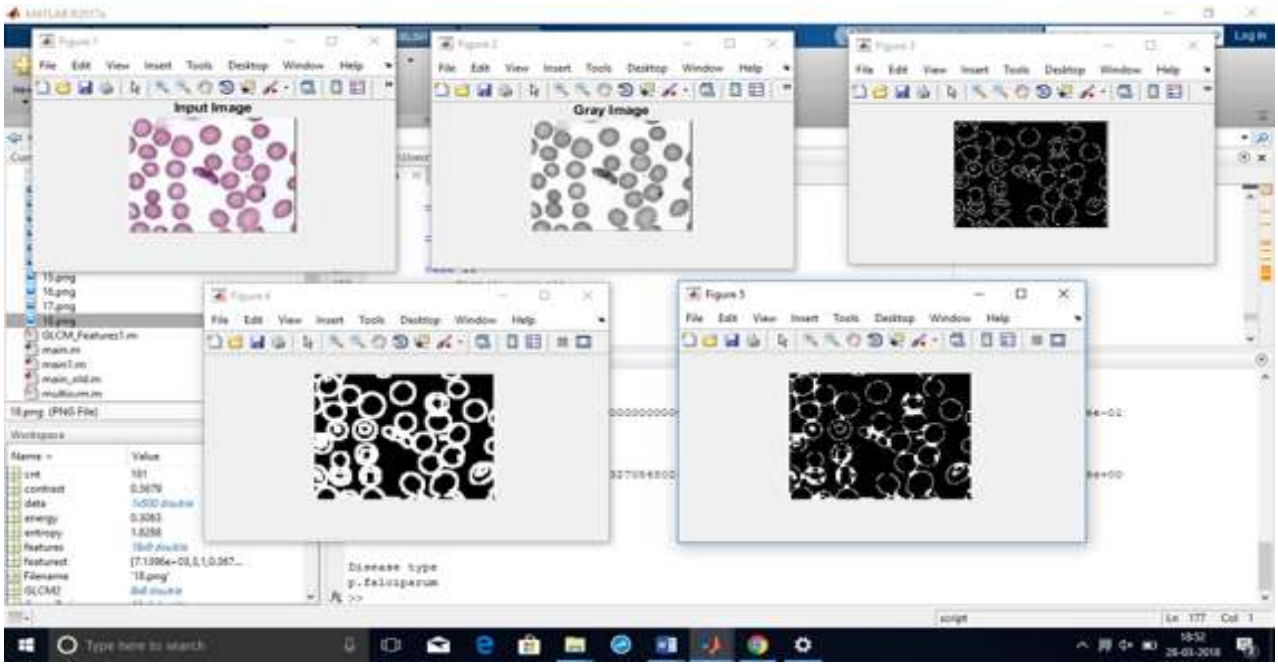

Figure 2: segmentation of blood smear images and classification of malaria using SVM classifier(output shows P.falciparum)

Table 1: features extracted from P.falciparum and its different stages(trophozoite, schizonts, gametocytes)

Feature extracted	Trophozoite Stage	Schizont Stage	Gametocyte Stage
Size(micrometer)	1.58	6.65	7.13
Shape	Round	Round	Oval
Kurtosis	9.00	4.68	5.43
Standard deviation	2.88	3.60	3.44
Intensity	1	1	1
Skewness	2.82	2.2	2.10

IV CONCLUSSION AND FUTURE WORK

This work mainly focuses on detection of malaria and its types, and as well as its stages. The results obtained are highly accurate since maximum number of features are extracted from the blood smear images and then the decision is made (type, stage). Support Vector Machine (SVM) classifier is used for detection and classification.

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