Detection of Malaria Based on the Blood Smear Images Using Image Processing Techniques

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***Abstract*— Even though the world has been advanced technologically, the disease called malaria life-sucking disease. The disease malaria is transmitted by the female anopheles mosquito. In 2015, 91 countries were affected by the malaria. To prevent the mortality rate, WHO recommends the diagnosis of malaria in laboratories. However, the manual assessment of malaria through the microscope is prone to false detection because of some artifacts. To avoid these kinds of errors, the computerized digital image processing techniques must be implemented. The project proposes an algorithm to detect the malaria parasite. The images are acquired from the giemsa-stained thin blood smear slides and the captured color images are converted in to gray-scale images, the noise reduction technique, contrast stretching for the image enhancement are employed. The infected erythrocytes are segmented, classified using support vector machine for accurate detection of the parasite and to effectively classify positive and negative cases of malaria.**

Keywords*— Gray-Scale Conersion; Noise Reduction; Contrast Stretching; Support Vector Machine;

I. INTRODUCTION

In today's world, there are several global health diseases which are serious and infectious. The disease called malaria is one of the prominent disease among them. The bite of female anopheles mosquito causes malaria. The protozoan blood parasite of the genus *plasmodium* makes red blood cells as host cells for its reproduction cycle. The five variety of species of genus *Plasmodium* are *P. falciparum, P. vivax, P. ovale, P. malariae* and *P. knowlesi.* The major species that is responsible for the malaria is *plasmodium vivax.* Globally, 29% of the populations is infected by malaria among all age groups and 35%among the children under the age of 5. The African region carries high share of malaria. It is the home for 90% of the malaria case and 92% of the malaria deaths. Hence, to achieve immortality, WHO recommends diagnostic procedure which is a manual microscopic diagnosis of the peripheral blood parasite. Manual diagnosis of malaria parasite involves visual determination and microscopic evaluation of geimsa stained thin blood smears. The procedure involves counting of infected red blood cells against the normal red blood cells manually. However, this type of analysis involves trained and experienced person, requires man power and also time-consuming process. The accuracy of the diagnosis mainly depends on the skill and experience of the technicians. The tools and instruments required for the diagnosis may be expensive and may not be available in the poor nations. Rapid diagnostic tests (RDTs) and polymerase chain reaction tests (PCR) are some of the tests involved in the microscopic malaria diagnosis. Although the malaria a is both preventable and curable, the vision based manual microscopic method of evaluation of malaria may not be accurate. Manual assessment sometimes leads to errors. Even the experienced clinical experts sometimes fail to give accurate results. To avoid these consequences and to reduce the mortality rate of the people, the image based techniques must be developed and implemented. This is achieved by digital image processing concept.

The proposed project aims to implement the computerized image processing technique for the detection of malaria parasite in the thin blood smear images which accurately detects the infected RBCs and effectively classifies positive and negative cases of malaria compared to traditional method of detection of malaria.

II. LITERATURE REVIEW

Number of studies on the possibility of detecting plasmodium parasites using images of thin blood smear has been carried out in the past. In this section number of these studies is critically reviewed. In this study the literatures are reviewed, the commonly used methods are Digital Image Processing techniques. Some of them are highlighted as follows.

Ravi raja et al.,[1] proposed a new technique to detect the parasites using a digital image or color photograph of stained malarial blood from a microscope in order to evaluate the existence of parasitaemia in the RBC. Manual analyses of slides are tiring and time consuming, hence this research work aim to automate the faster and accurate analysis of the microscopic images obtained from the blood sample slides. In this research, he proposed a method to separate automatically the parasites (trophozoites, schizonts and gametocytes) from the rest of an infected blood image. Using the information of colour, shape and size, then compare the image with infected images after transformation of image by scaling, shaping to reconstruct the image. The images returned are statistically analyzed and compared to generate a mathematical base. The images returned are statistically analyzed and compare to generate a mathematical base. Also the evaluation of the size and shape of the nuclei of the parasite is also considered.

Isha Suwalka, Ankit Sanadhya, Anirudh Mathur, Mahendra S Chouhan presented a method to detect the parasites using image processing by evaluating the curved structure of the parasite. This approach makes the detection more accurate as compared to prediction done using conventional manual process.

Ashok Manikchand Sutkar.,[6] developed a robust, unsupervised and sensitive malaria screening technique with low material cost and one that has an advantage over other techniques in that it minimizes human reliance and is therefore, more consistent in applying diagnostic criteria.
Tejashri chaudhari[7], Prof.D.G.Agrawal[7], developed a system that would offer speedy and accurate malaria diagnosis in human blood media based on the colour and morphological features of Plasmodium parasites and infected erythrocytes.
Silvia et al. proposed a technique for estimating parasitemia. Template matching is used for detection of RBCs. Parasites are detected using variance-based technique from grayscale images and second approach is based on color co-occurrence matrix. Support Vector
Machine (SVM) as the classifier which exploits the texture, geometry and statistical features of the image.
Ms. Snehal Suryawanshi[9], Prof. V. V. Dixit[9] presented enhanced technique for Malaria Parasite Detection, where cell segmentation process consists of various steps such as image binarization using Poisson's distribution based Minimum Error Thresholding, followed by Morphological Opening for the purpose of refinement. Seed point localization is done by multiscale LoG filter. Since frequency and orientation representations of Gabor filter are same as that of human visual system, it is used for feature extraction. Two algorithms are compared in this paper in order to get superior classification. Results show that SVM gives better accuracy of 93.33% than that of Euclidean Distance Classifier which is 80%.
Diaz et al.,[10] developed a technique for detection, quantification of parasitaemia and parasite life stages. Pixels color features were extracted and used to train classifiers for detection and determination of parasite life stages. Clustered erythrocytes were resolved by use of template matching before parasitaemia was estimated. The study reported a sensitivity of 94% for detection of infected erythrocytes and 79% for stages identification. The technique was not fully automatic as it called for human intervention during training of the classifier every time diagnosis had to be made.
Pallavi T. Suradkar.,[2] developed a fully automated image classification system to positively identify malaria parasites present in thin blood smears, and differentiate the species. The algorithm generated will be helpful in the area where the expert in microscopic analysis may not be available. The effort of the algorithm is to detect presence of parasite at any stage. One of the parasites grows in body for 7 to 8 days without any Symptoms. So if this algorithm is incorporated in routine tests, the presence of malarial parasite can be detected Automatic parasite detection has based on color histograms.
From the above mentioned survey and references, the project will be a developed using image processing algorithm which gives accurate and efficient outcome.

III. OBJECTIVES

The specific objectives of the project are as follows:

1) Design and develop an image processing algorithm to detect the malaria parasite in the blood smear images.
2) Design and develop a classification system to identify the malaria infected cells positively and accurately.

IV. PROJECT ARCHITECTURE

1. Image acquisition

   Blood smear slides were prepared from the blood sample which is to be tested and the slide is giemsa stained. This stain differentiates the cytoplasmic and nuclear morphology of red blood cells, white blood cells, platelets and blood parasites. The slide is fed to digital microscope which is interfaced with the personal computer which can access blood film slide as an image and the captured image is stored in the JPEG format.

2. Image pre-processing

   This step is followed to remove unwanted effects from the image and adjust the image as it is required for the further processing steps. The acquired images are color images (RGB components). To reduce the image processing time, the RGB images are converted into gray-scale images. The converted gray-scale images are subjected to median filtering which is a noise reduction technique to eliminate the noise in the images. The median filter replaces the value of each pixel in the image by the median value of the intensity level in the neighborhood. The parasite detail remains same in this operation.

3. Image contrast enhancement

   The malaria images captured may be low contrast due to the variation of light illumination. Hence, it needs to be enhanced as per the requirement for the image processing. Contrast stretching is a method of image enhancement technique which improves the quality and contrast level of the captured malaria images. Now, the intensity levels are equally distributed and the image is said to be enhanced.

4. Image segmentation and classification

   This is the step which is performed for segmenting the peripheral blood parasites from the healthy red blood cells. There are various methods for the segmentation of cells since the classification using Support Vector machine classifier performs the best for the proposed project this can be used for faster and accurate results.

   SVM is a supervised machine learning algorithm that can be used for both classification and regression challenges. It discriminates the each class by separating hyper plane or a set of hyper planes in an infinite dimensional space. It works efficiently both as a linear and non-linear classifier. The SVM algorithm operates on the basis of finding the hyper plane which gives largest minimum distance to the training samples. This distance is referred as margin in SVM theory. Therefore, optimal separating hyperplane maximizes the margin of the training samples. The training samples closest to hyperplane are called support vectors. Here, cellular dimension and intensity are the features to be considered for the classification.

V. PROJECT FLOW

The pictorial representation is as shown in the Fig 1. This explains the image processing steps in each and every stage of the proposed system.

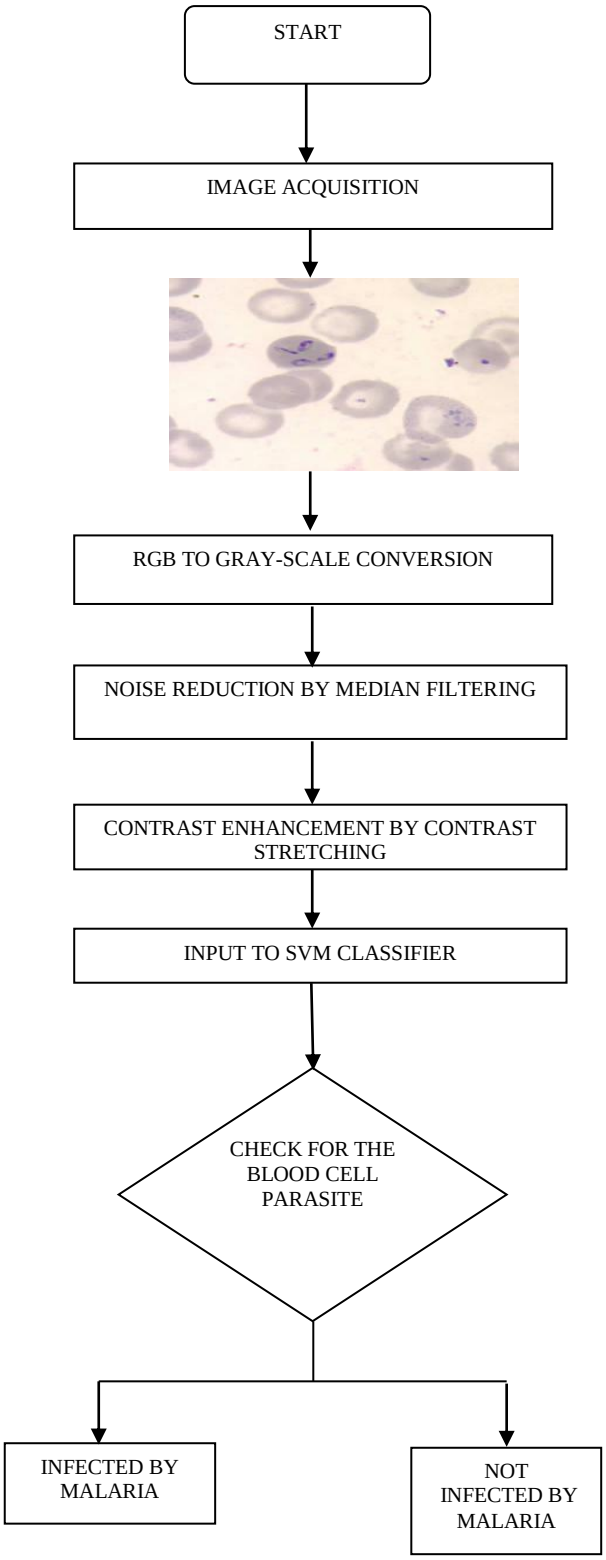

Fig 2: Flow chart that outlines the proposed project

VI. RESULTS

The detection of malaria parasites experiment is done by loading the input image to the personal computer. The developed algorithm is processed using the software MATLAB version 2015 B. the outcome obtained will be classification of infected red blood cells and the detection of infected and non-infected patients. The project is employed with the SVM classification system which gives approximately 90% of accuracy when compared with classical methods of evaluation of blood cell parasites of malaria.

VII. CONCLUSION

The malaria identification by the clinical experts using visual microscopic method requires skill and professional knowledge. Yet, this type of diagnosis prone to human errors due to the presence of some artifacts. This paper proposes the image processing algorithm for the image analysis which shows reliable performance in the positive and negative prediction from the blood sample images.

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