Automated Malaria Parasite Detection based on Image Processing

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Abstract— *Malaria is a female Anopheles mosquito-borne infection disease, and it is translated into human and other animals caused by the protozoan parasites of the genus plasmodium. This infection is invited by a bit from an infected Anopheles female mosquito by introducing life threatening parasite via pressure into the circulatory system and liver, where they mature and reproduce ultimately. The symptoms are fever and headache, which in some of the cases, patient's life cycle can progress to coma or death. Diagnosis of malaria parasitemia from blood smears is a subjective and time-consuming task for pathologists. The automatic diagnostic process will reduce the diagnostic time and also, it can be worked as a second opinion for pathologists and may be useful in malaria screening. This project presents an automatic method for malaria diagnosis from thin blood smears. Loading the image is the first phase, later the image is being preprocessed to remove unwanted noise and brightness. Feature extraction and successive segmentation techniques are then applied on the image to focus on important parts of the image. Finally, morphological operations are carried out to differentiate parasite cells from the RBC cells and their respective count is determined. After the implementation of the proposed approach for the lab sample images and for the available image database, it is found that the parasites count is near about matching with the manual count. From the above analysis it is found that the system gains accuracy of 85.54%, sensitivity of 95.5%, specificity of 80.8%, precision of 60.28, recall of 95.5 and F-score of 73.90. Hence the system can help as a diagnosis guide for physicians with almost no cost.*

Keywords— Grayscale image, Binary Image and Thresholding, Feature Extraction, Morphological Operation, RBCs and Parasite Count

I. INTRODUCTION

Malaria is a life-threatening parasitic disease, caused by the protozoan parasites of the genus Plasmodium and is transmitted through the bite of a female Anopheles mosquito. Inside the human body, the parasite undergoes a complex life cycle in which it grows and reproduces. During this process, the red blood cells (RBCs) are used as hosts and are destroyed afterwards. Hence, the ratio of parasite-infected cells to the total number of red blood cells – called important determinant in selecting the appropriate treatment and drug dose.

II. BACKGROUND

The definitive diagnosis of malaria infection is done by searching for parasites in blood slides (films) through a microscope. In peripheral blood sample visual detection and recognition of Plasmodium is possible and efficient via a chemical process called (Giemsa) staining. The staining process slightly colorizes the red blood cells (RBCs) but highlights Plasmodium parasites, white blood cells (WBC), and platelets or artefacts. The detection of Plasmodium spp requires detection of the stained objects. However, to prevent false diagnosis the stained objects have to be analyzed further to determine if they are parasites or not. Normal microscopy techniques are highly time consuming and requires lot of human intervention. There are other scientific methods such as flow cytometry being used but are limited due to their expensiveness and unavailability.

III. OBJECTIVES

To propose a new system for automated malaria status identification based on the standard routine used by medical practitioner performing microscopy diagnosis of malaria. To differentiate RBC and the infected cells which are present in blood smear slide and later compute the accuracy of detection. Finally, to compare the software based solution with manual analysis.

IV. LITERATURE SURVEY

Pallavi T Suradhkar[1] design is essentially an image classification problem, and thus takes the form of a standard pattern recognition and classification system. System architecture used for malaria parasite detection involves thresholding, grey scale image conversion, thinning labeling algorithm. It uses color range and image segmentation smoothly processing techniques to detect infectious cells in images acquired from giemsa stained pheripheral blood samples.

Makkapati and Rao [4] funded the segmentation for HSV color space. The process here is based on HSV color space that segments Red Blood Cells, white blood cells and parasites, and also calculating optimal saturation thresholds. In this processes using the image, and its images taken from Leishman-stained blood smears. This process was found to be 83% sensitivity. The process operates in HSV space. This processes is cannot determine local and global thresholding, but it's only determine optimum thresholding. This Scheme is segment Red Blood Cells and chromatin dots. This work uses color image processing techniques

V. SYSTEM DESIGN

The design is essentially an image processing based classification. The first step is acquiring digital image of microscopic blood smear. This is used as input to the system. The processing of this input image consists of five stages:

- Image Acquisition
- Preprocessing
- Segmentation
- Morphological Operation
- Cell Detection.

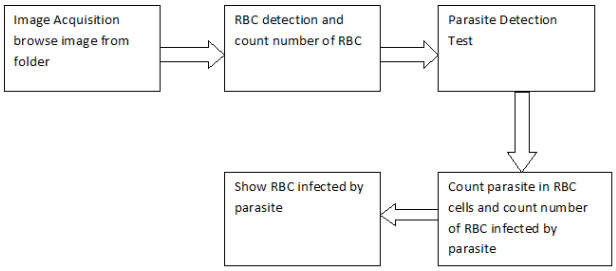

Fig 1: System Block Architecture

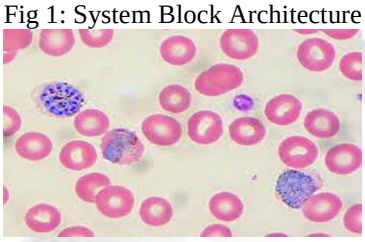

Fig 2: Digital image of malaria blood smear slide

A. *Modules*

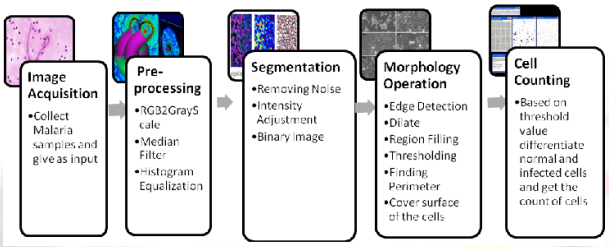

Fig. 3: Modules Block Diagram

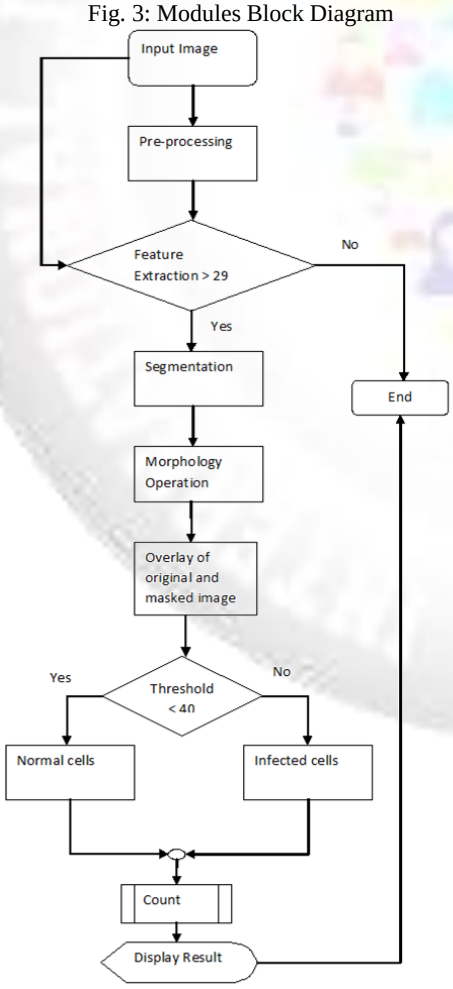

Fig. 4: Flow chart

B. *Image Acquisition*

Of the five Plasmodium species known to infect human, Plasmodium falciparum and vivaxwas used as source for parasite samples in this study.Each slides are been examined by experts, who have verified and given a species-specific and parasitemia diagnosis. Images were captured using a built-in digital camera microscope. Images were then analysed manually. Images were saved in the JPEG format in 1280 x 960 pixels size.These images are transmitted for pre-processing

C. *Preprocessing*

The segment of input image of (250 × 250) pixels is selected for further processing. The input image may have low brightness and contrast. Pre-processing methods uses small neighborhood of pixel in input image to get the new value of brightness in output image. Here median filtering of input image is done as pre-processing method. It is a non linear digital filtering technique, often used to remove noise. It is widely used in digital image processing because, it preserves edges while removing noise. The basic idea of this step is replacing the value of every pixel in the image by the median value of the intensity level in the neighborhood that will result in reduced "sharp" transitions. Median filter image will have low contrast, in order to enhance the details of parasite components and to obtain cleaner and brighter background it is histogram equally. Later, feature extraction is carried out.

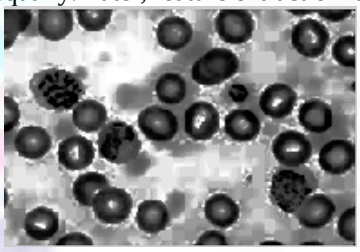

Fig 5: A final histogram equalized preprocessed image

The aim of the feature extraction process is to identify and extract relevant information from the image. Here we use color based feature extraction process to extract the cells in the image usually blue shades from the original image.

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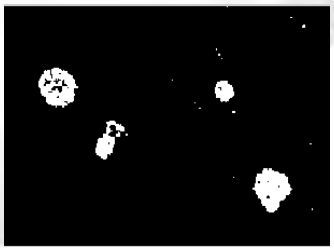

Fig 6: Feature Extracted image

D. *Segmentation*

Segmentation divides the image into its constituent regions or objects. Image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to

locate objects and boundaries in images. In our study we first remove noise, adjust intensity of the image, perform gray threshold and convert the image to binary form.

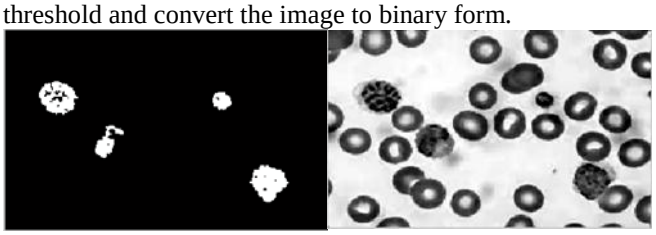

Fig 7: & 8: Noise Removal and Intensity Adjusted Image

E. Morphological Operation

Morphological operations are image processing operations which processes images based on shapes. It applies a structuring element of specific shape and size on input image. The output image is created by comparing the value of each pixel with its neighbours. These operations are sensitive to the shape of the structuring. Further operations such as holes filling, overlaying is carried out which helps in detection of infected cells. The various morphological operations that are performed shown below.

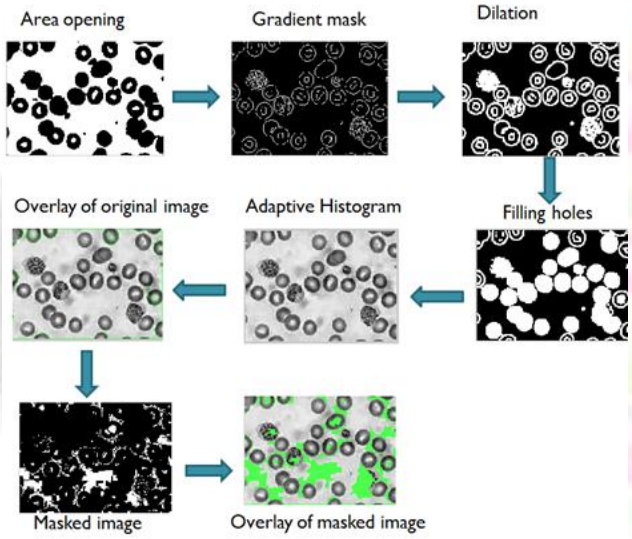

Fig 9: Morphological Operations

F. Cell Detection

After all the required image processing techniques are performed, the total number of cells are detected. Here wecount the cells having low density and connected using bwlabel() and find maximum number of components that are connected. High density cells are those which are not affected so find such cells having holes. Fill such image region and holes .Repeat the same procedure to get the count of infected cells. Finally superimpose the infected cells onto original image

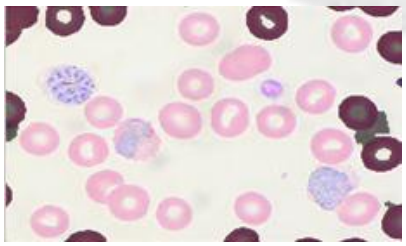

Fig 10: Figure Showing Infected Cells with Brown Color

VI. RESULTS AND ANALYSIS

The experiment was conducted by collecting blood samples of patients suffering from malaria. The microscope connected to the personal computer was used to view the blood films and these films were digitalized. Totally 10 samples are taken from different blood samples. The images were used as raw data for malaria parasite count. The result of some sample images are reported in table. The performances of the proposed system are evaluated by using six objective indices. These indices are accuracy, sensitivity, specificity, precision, recall and F-score. The samples are validated against manual method. From the above analysis it is found that the system gains accuracy of 85.54%, sensitivity of 95.5% , specificity of 80.8%, precision of 60.28, recall 95.5 and F-score of 73.90

Image No	Manual RBC Count	IP Approach RBC Count	IP approach count of malaria parasite	Manual count of malaria parasite	Difference in algorithmic count and manual count (%)
Image 1	20	23	4	4	0
Image 2	120	118	32	35	2.54
Image 3	62	59	12	15	5.08
Image 4	286	290	44	41	1.03
Image 5	803	820	137	139	0.24
Image 6	63	67	24	21	4.47
Image 7	70	72	2	3	1.38
Image 8	104	106	34	38	3.77
Image 9	148	153	138	137	0.65
Image 10	98	106	2	1	0.94

Table 1: Comparison of proposed system values with manual count

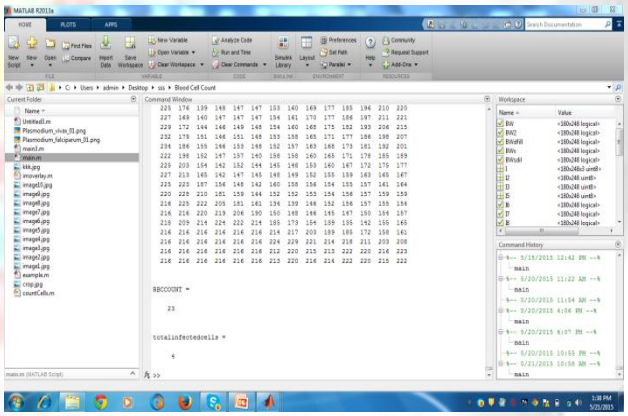

Fig 11: Command Prompt in MATLAB(GUI) showing RBC and infected cell count

VII. CONCLUSION

This paper proposes fast and accurate method for malaria parasites count. Results are validated against manual observations and error reported is very less. This approach can be used to train the laboratory fellows. It may assist pathologists to set the diagnosis fast. This work can be extended by increasing database by collecting images from various sources so as to make algorithm robust. A portable stand alone system can be developed by using this algorithm as a software base.

As further enhancement, Support Vector Machine (SVM) techniques can be used to analyze and classify the parasite species based on their shapes.

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