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CLASSIFICATION OF RBCs USING IMAGE PROCESSING TO DETECT MALARIAL PARASITES.

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Abstract - *One of the most serious infectious mosquito-borne disease spread worldwide is none other than malaria. The diagnosis of this threatening disease is done by microscopic examination of blood. But the diagnosis method requires efficient pathologists and lot of time. In this paper, we aim at introducing a fast and accurate method for RBC's classification which is based on image processing for parasites of malaria in particular. The generation of the database is done with the help of microscopic images of blood of 30 malarial patients. The total number of cells is counted on the basis of morphological operations. Based on the intensity profiles within the cells the infected cells are analyzed. The manual analysis is compared to validate the results. This approach will prove a boon to the rural areas where there is unavailability of experts and improper diagnosis can take a toll on the patients' health.*

Key Words: Image processing, RBC classification, malarial parasite detection.

1. INTRODUCTION

Malaria, being a mosquito borne disease, is caused by parasites of genus plasmodium. An infected female anopheles mosquito is mainly responsible for the infection. The bite introduces malarial parasites into the circulatory system. The parasite, just like other life forms, possesses a complex life cycle through which it ages and reproduces and to complete this life cycle the parasite uses RBCs as hosts which are then destroyed after the cycle completes. The statistics of World Health Organization (WHO) say that malaria leads to one million deaths per year and people infected by malaria sum up to nearly 250 million. The number of cases concerning malaria has been increasing worldwide mainly due to the decrease of malaria control in some areas causing quick transmission of the infection.

Diagnosis of malaria involves manual study of the patient's strained blood files and identification of malarial parasites present in it through a microscope. Chances of inaccuracy may arise if the patient's sample size is large. Untrained technicians may fail to distinguish the infected cells from the healthy ones while examining the blood smears since the various types of cells in the blood have to be differentiated which could be strenuous. Hence it is required to have experienced and well trained technicians for this job to avoid false negative and false positive detections. In some underdeveloped countries, the lack of resources could pose as a major barrier in accurate and timely diagnosis. Due to any of the above mentioned reasons there is a considerable probability of human error which makes the medical experts realize that machine identification would provide more reliable results.

2. LITERATURE SURVEY

S. Raviraja, in his research, presents a statistical model to detect the malarial parasites infecting the red cells from a blood image to evaluate the number of parasitaemia in the sample. Then the image is compared to an infected image as it is reconstructed and transformed by scaling, after which a mathematical base is generated. Area-normalized central moments are computed to detect the nuclei of the parasites. The proposed method works on separating the parasites from the rest of the image on the basis of color, shape and size of the infected cells.

Heechang Kim has presented an algorithm of image analysis for high content screening (HCS) of drugs against malaria that quantitatively detects and classifies the stages in the lifecycle of a Plasmodium. The algorithm is capable of discriminating between living and dead parasitaemia. There exist five Plasmodium species that are known to cause malaria in humans and P.falciparum is considered to be the most virulent amongst them all. The newly introduced algorithm estimates the number of isolated or

clustered red blood cells and identifies parasitized erythrocytes in viable parasites. The performance of the algorithm was validated by taking count of the infected and non-infected RBCs by manual analysis in variant image fields.

S. P. Narote has proposed an automatic technique in his paper for the detection of malarial parasites to detect Malaria parasitemia, that is, number of infected blood cells over total count of red blood cells by extracting red blood cells for input blood images and then detecting if the RBCs are clean or infected by the parasite. Malaria is caused by a parasite in the blood named Plasmodium spp. Proposed automatic approach performs Otsu thresholding on gray scale image, then performs cell segmentation by using green channel of the image, then separates the touching cells by applying watershed transform and then uses SVM binary classifier to classify the RBCs as healthy or parasite infected. Shape, color and statistical features are considered as the parameters for classification.

Jigyasha Soni has presented a technique in her paper that differentiates between the healthy RBC and malaria parasite and maximizes the productivity of algorithm by taking benefits of morphological operation, segmentation and thresholding. Malaria is diagnosed by searching for parasites in blood films through a microscope, which is a time consuming task. This approach develops a fully automated image classification system to categorize red blood cells into parasite infected and uninfected cells for estimation of parasitaemia with consecutive classification by positively identifying malaria parasites present in thin blood smears. The system performs image acquisition, image analysis, image segmentation, feature generation, classification of parasite and result verification in the order mentioned.

3. METHODOLOGY

The image processing based approach is developed in MATLAB. The steps included are as follows:

3.1 PRE-PROCESSING

An input image of (250 × 250) pixels selected by the user is selected for processing. The input image may contain noise and have low brightness and contrast. Hence this input image has to be pre-processed through median filter to reduce noise and saturation levels are adjusted for color enhancement to enhance the visual appearance. HSV transformations are performed to saturate the image by highlighting the red color in the image and its color is enriched through the method of erosion. Gray scale transformations are performed that change brightness irrespective of the position in the image using the conversion of RGB colors to grey scale by capturing and storing the red, green and blue channel values in three different variables. Based on area, the blood cells are separated from background and the overlapping cells detected at edge of image were taken into consideration. Edges are identified using the Canny edge detection algorithm. The different pre-processing methods that are used are normalization, filtering, image plane separation, etc. This paper presents the technique that normalizes the input image as a part of pre-processing method. This process changes the range of pixel intensity and gets the new value of brightness in the output image by using a small neighborhood of pixel which correspond to the same object and hence have same or similar brightness values in the input image. It expands the dynamic range of pixel values in an image into the range in which the image appears more normal.

3.2 MORPHOLOGICAL OPERATIONS

Morphological operations are image processing operations which process images (mostly gray scale images) based on shapes by applying a structuring element of specific shape and size on input image which acts as the mode of performing comparison. It could include dilation, erosion, opening and closing operations. Dilation enlarges the boundaries of regions of foreground pixels. Erosion erodes away the boundaries of regions of foreground pixels. Opening tends to remove some of the foreground (bright) pixels from the edges of regions of foreground pixels. Closing tends to enlarge the boundaries of foreground (bright) regions in the image and is used to remove the noise. Thus the closing of A by B is dilation of A by B followed by the erosion of the result by B[3]. The output image is created by operations that are sensitive to the shape of the structuring element which is achieved by comparing the value of each pixel with its neighbours. Morphological operations classify and differentiate the blood cells from each other. The counting is offered via simple formula at MATLAB platform.

3.3 COUNTING OF RBCs

Hough Transform (Circular or Elliptical) is applied on the image to find circles depicting RBCs. Since the radius needs to be pre-defined, we can provide a range of radii so that no circle or ellipse is left unidentified. After detection of each RBC, taking into consideration the center a circle is drawn around it using the previously captured radius. The final count is stored in a variable by detecting the number of circle centers in the image. The area of one blood cell is calculated in terms of pixels. Total number of blood cells can be attained by calculating the area of all the cells in image and dividing it by area of one cell. The formula will return an approximated integer of the result which gives total number cells.

3.4 SEGMENTATION

If the blood cell is infected, specific changes in intensity are observed for corresponding red, green and blue planes. Hence by locating the intensity changes in a cell dimension, infected cells can be found out. Image pixels are partitioned into different clusters based on color similarity and spacial relation [4]. RGB image is first transformed into HSV image which is then converted to 3 RGB planes in order to merge the pixels belonging to the same color together and display the total number of colors which is very helpful in quantization of the image.

The step wise processes for the algorithm are as follows:

1) Read an RGB image

2) Convert RGB image to HSV.

3) Three matrices are made by three different planes.

4) A single new matrix is formed so as to see values of RGB at each pixel.

5) In a single new matrix combine any two rows that are equal.

6) Calculate total number of colors in the original image.

7) Enter the number of colors user wants to see.

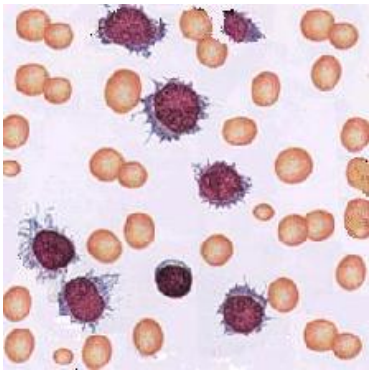
8) Image is converted back from HSV to RGB color space.

3.5 PARASITE COUNT

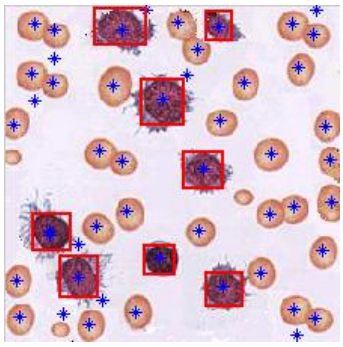
After morphological operations and corresponding color base segmentation it becomes easy to detect parasites from the image. The RBC counting step gives the dimension of each cell and circles them as well. The change in intensity of cell dimensions of all the cells is located by scanning its contour plot. Accordingly we get the total number of infected blood cells in the image and represent them using bright colored squares. By dividing the malaria parasite count by the total RBC count, percentage of malaria can be determined.

4. RESULTS

The input image chosen is shown below.



After preprocessing and contrast enhancement we get an image which is free from noise and clearly distinguishable components. Then, morphological operations are performed. Edges are detected by sliding a kernel over the image pixel by pixel. The edges are amplified with this filter according to the distribution of the values in the matrix or kernel. There exist 2 methods for edge extraction, namely, Sobel and Canny. We use Canny in which partial derivative is performed on every pixel because it is more accurate. Next, region filling slides a disc over the image to fill in the unwanted gaps so that it is easier to spot the circular regions. In the color channel evaluation step we extract the green channel. We can also extract blue channel, but not red because the malignant cells are reddish in color. The image is then segmented by thresholding and extraction of green channel. The final step shows the centers of the RBCs and surrounds the malignant cells with a bounding box.



Classification of RBC'S by image processing is a effective and reliable system for classifying normal and malignant RBC'S and has been tested on blood cell images and is observed that the results obtained by the proposed method offer a good conformity with the manual counting method. In our method, we do not count the white blood cells as compared to the real blood test where blood count is done by dilation. The count values by the proposed method slightly differ than the count values obtained manually. Increasing database by collecting images from various sources can make the used algorithm in the software more robust.

5. CONCLUSIONS

An efficient method for red blood cell counting has been used in this paper. For the enhancement of accuracy, the red blood cells are differentiated from the white blood cells, noise and background the image .The process of pre-processing helps in achieving image clarity. This further helps in segmentation and discarding of the white blood cells and platelets is done based on the number accountability and size of cells respectively. Most of the previous available methods which were being used for classification of red blood cells are time consuming and expensive. Pathologist's skill has an important role in the accuracy of results. Inspite of all of these facts, the several excluded results would sometimes have no coordination with each other. May be for a same sample, two pathologists can give different opinions on classification of the cells. In the used method, we perform morphological operations which have good efficiency as they consider the cells at the boundary of the image and overlapping of cells. Compared to previous works in this field, it required individuals to learn the system, but in this work we have introduced a new method which eliminates this necessity. The blood cell count is only constrained to red blood cells, but white blood cells and platelets are having same importance. We have used system integrated functions to increase the accuracy. The use of inbuilt functions make our system faster and optimized. The RBC count may differ sometimes, but the malignant cells are detected accurately. Since health of biodegradable objects and diseases are variable in nature and with elapse of time new terminologies are surfaced, the research in this field is a continuous and never ending process. Innovation of new methods with different properties and parameters of evaluation can help to cope up with new discoveries.

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