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A Survey on Detection of Malarial Parasites in Blood Using Image Processing

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ABSTRACT: Malaria is a serious infectious disease. According to the World Health Organization, it is responsible fornearly one million deaths each year. There are various techniques to diagnose malaria of which manual microscopy is considered to be the gold standard. However due to the number of steps required in manual assessment, this diagnostic method is time consuming (leading to late diagnosis) and prone to human error (leading to erroneous diagnosis), even in experienced hands. The focus of this study is to develop 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
.

KEYWORDS: RBC, Parasite, Microscopic images, Feature Extraction, SVM Classifier, NN Classifier

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.Approximately, 40% of the world's population, mostly those people living in the world's poorest countries, there is risk of malaria. A child dies of malaria every 30 seconds in the world. Every year, more than 500 million people become severely ill with malaria. Between 300 million and 500 million people in Africa, India, Southeast Asia, the Middle East, the South Pacific, and Central and South America have the disease of malaria. The worldwide annual economic burden of malaria, calculated to include spending on prevention and treatment as well as loss of productivity due to illness, was estimated at US$ 500 million in 2005.The biggest detraction of microscopy, namely its dependence on the skill, experience and motivation of a human technician, is to be removed. Used with an automated digital microscope, which would allow entire slides to be examined, it would allow the system to make diagnoses with a high degree of certainty. It would also constitute a diagnostic aid for the increasing number of cases of imported malaria in traditionally malaria-free areas, where practitioners lack experience of the disease.

II. LITERATURE SURVEY

Sr. No	Author and Title	Proposed System	We referred
1	Deepa.A.Kurer, Vineeta.P.Gejji, " Detection of Malarial Parasites in Blood Images " International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 3, Issue 3, May 2014	Proposed system implement a new approach to low-level image processing -SUSAN (Smallest Unvalued segment assimilating nucleus) Principle, which performs Edge and Corner detection. Images are acquired using a charge-coupled	New approach to low-level image processing -SUSAN (Smallest Unvalued segment assimilating nucleus).

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		device camera connected to a light microscope. Morphological and novel threshold selection techniques are used to identify erythrocytes (red blood cells) and possible parasites present on microscopic slides. Image features based on color, texture and the geometry of the cells and parasites are generated, as well as features that make use of a priori knowledge of the classification problem and mimic features used by human technicians.	
2	F. Boray Tek , Andrew G. Dempster, Izzet Kale, "Malaria Parasite Detection in Peripheral Blood Images " Applied DSP & VLSI Research Group, London, UK	This paper investigates the possibility of computerized diagnosis of malaria and describes a method to detect malaria parasites (Plasmodium spp) in images acquired from Giemsa-stained peripheral blood samples using conventional light microscopes. Prior to processing, the images are transformed to match a reference image color characteristics. The parasite detector utilizes a Bayesian pixel classifier to mark stained pixels. The class conditional probability density functions of the stained and the non-stained classes are estimated using the non-parametric histogram method.	Examples of stained objects 1. Plasmodium 2. WBCs 3. Includes a platelet 4. Artifacts Color Normalization Stained/Non-Stained Pixel Classification
3	Corentin Dallet , Saumya Kareem, Izzet Kale, "Real Time Blood Image Processing Application for Malaria Diagnosis Using Mobile Phones " 978-1-4799-3432-4/14/$31.00 ©2014 IEEE	This paper describes a fast and reliable mobile phone Android application platform for blood image analysis and malaria diagnosis from Giemsa stained thin blood film images. The application is based on novel Annular Ring Ratio Method which is already implemented, tested and validated in MATLAB. The method detects the blood components such as the Red Blood Cells (RBCs), White Blood Cells (WBCs), and identifies the parasites in the infected RBCs. The application also recognizes the different life stages of the parasites and calculates the parasitemia which is a measure of the extent of infection.	method detects the blood components such as the Red Blood Cells (RBCs), White Blood Cells (WBCs), and identifies the parasites in the infected RBCs.
4	Lifeng He, Yuyan Chao, and Kenji Suzuki, "A Run-Based Two-Scan Labeling Algorithm" IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 17, NO. 5, MAY 2008	We present an efficient run-based two-scan algorithm for labeling connected components in a binary image. Unlike conventional label-equivalence-based algorithms, which resolve label equivalences between provisional labels, our algorithm resolves label equivalences between provisional label sets. At any time, all provisional labels that are assigned to a connected component are combined in a set, and	Flow of Run-Based Two-Scan Labeling Algorithm.

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		the smallest label is used as the representative label.	
5	Bing Wang, ShaoSheng Fan, "An improved CANNY edge detection algorithm" 2009 Second International Workshop on Computer Science and Engineering.	CANNY arithmetic operator has been proved to have good detective effect in the common usage of edge detection. However, CANNY operator also has certain deficiencies. Based on the analysis of the traditional CANNY algorithm, an improved canny algorithm is proposed in this paper. In the algorithm, self-adaptive filter is used to replace the Gaussian filter, morphological thinning is adopted to thin the edge and morphological operator is used to achieve the refining treatment of edge point's detection and the single pixel level edge. The results of experiment show the improved CANNY algorithm is reasonable.	Flow of CANNY edge detection algorithm and The method of edge point detection and connect based on gradient direction.
6	S. S. Savkare, S. P. Narote, " Automatic Detection of Malaria Parasites for Estimating Parasitemia" International Journal of Computer Science and Security (IJCSS), Volume (5) : Issue (3) : 2011	In this paper an automatic technique is proposed for Malaria parasites detection from blood images by extracting red blood cells (RBCs) from blood Image and classifying as normal or parasite infected. Manual counting of parasitemia is tedious and time consuming and need experts. Proposed automatic approach is used Otsu thresholding on gray image and green channel of the blood image for cell segmentation, watershed transform is used for separation of touching cells, color and statistical features are extracted from segmented cells and SVM binary classifier is used for classification of normal and parasite infected cells.	System architecture used for Malaria parasite detection. SVM Classifier
7	F Boray Tek, Andrew G Dempster and Izzet Kale, "Computer vision for microscopy diagnosis of malaria " Malaria Journal 2009, 8:153	This paper reviews computer vision and image analysis studies aiming at automated diagnosis or screening of malaria infection in microscope images of thin blood film smears. Existing works interpret the diagnosis problem differently or propose partial solutions to the problem. A critique of these works is furnished. In addition, a general pattern recognition framework to perform diagnosis, which includes image acquisition, pre-processing, segmentation, and pattern classification components, is described. The open problems are addressed and a perspective of the future work for realization of automated microscopy diagnosis of malaria is provided.	Stained object classes: in a Giemsa-stained blood film an observed stained object can be a parasite from One of the four species of Plasmodium or a regular blood component such as white blood cell, platelet.

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8	S.Kareem, R.C.S Morling and I.Kale, "A Novel Method to Count the Red Blood Cells in Thin Blood Films" 978-1-4244-9474-3/11/$26.00 ©2011 IEEE.	This paper describes a novel idea to identify the total number of red blood cells (RBCs) as well as their location in a Giemsa stained thin blood film image. This work is being undertaken as a part of developing an automated malaria parasite detection system by scanning a photograph of thin blood film in order to evaluate the parasitemia of the blood. Not Only will this method eliminate the segmentation procedures that are normally used to segment the cells in the microscopic image, but also avoids any image pre-processing to deal with non uniform illumination prior to cell detection. The method utilizes basic knowledge on cell structure and brightness of the components due to Giemsa staining of the sample and detects and locates the RBCs in the image.	Red Blood Cells (RBCs), White Blood Cells (WBCs), Platelets, Giemsa stain, plasmodium species, morphological dilation and erosion, morphological opening and closing.
9	Son Lam Phung, Abdesselam Bouzerdoum, Douglas Chai, "Skin Segmentation Using Color Pixel Classification: Analysis and Comparison" IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, VOL. 27, NO. 1, JANUARY 2005	This paper presents a study of three important issues of the color pixel classification approach to skin segmentation: color representation, color quantization, and classification algorithm. Our analysis of several representative color spaces using the Bayesian classifier with the histogram technique shows that skin segmentation based on color pixel classification is largely unaffected by the choice of the color space. However, segmentation performance degrades when only chrominance channels are used in classification. Furthermore, we find that color quantization can be as low as 64 bins per channel, although higher histogram sizes give better segmentation performance. The Bayesian classifier with the histogram technique and the multilayer perceptron classifier are found to perform better compared to other tested classifiers, including three piecewise linear classifiers, three unimodal Gaussian classifiers, and a Gaussian mixture classifier.	SKIN COLOR CLASSIFICATION, Skin Segmentation Using Color Pixel Classification
10	A. Ms. Deepali Ghate, B. Mrs. Chaya Jadhav, C. Dr. N Usha Rani, " Automatic Detection Of Malaria Par-Asite From Blood Images " International Journal Of Advanced Computer Technology | Volume 4, Number 1	This paper removes the human error while detecting the presence of malaria parasites in the blood sample by using image processing and automation. This is achieved by using Image Segmentation techniques to detect malaria parasites in images acquired from Giemsa stained peripheral blood	System architecture used for Malaria parasite detection and two phases in this architectural model.

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		samples. This is comparative study of two methods for detecting malaria parasites; first method is based on segmentation and second uses feature extraction using minimum distance classifiers. We built the malaria detection system in a robust manner so that it is unaffected by the exceptional conditions and achieved high percentages of sensitivity, specificity, positive prediction and negative prediction values.	

III. PRAPOSED SYSTEM

In this paper, develop 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 malaria parasite can be detected Automatic parasite detection has based on color histograms. In a diagnosis scenario in this study we have proposed a solution for the parasite detection problem with two consecutive classifications. The design is essentially an image classification problem, and thus takes the form of a standard pattern recognition and classification system. It consists of five stages:

1. Image Acquisition (Done using high resolution Digital Camera)
2. RBC Extraction
3. Edge Detection
4. Binary Image
5. RBC Counting
6. Thresholding
7. Parasite Extraction

System architecture used for Malaria parasite detection involves following steps: Thresholding, gray scale image conversion, binary image, edge detection algorithm, thinning of binary image, labeling algorithm.

IV. METHODLOGY

Due to complexity of the blood sample images, malarial parasite segmentation and morphological analysis is a challenging problem. Machine vision based malarial diagnostic methods has been widely studied in order to provide early and accurate diagnose of malaria parasite. An ideal diagnostic method would be accurate, non-invasive, and inexpensive. The key tasks for malarial parasite classification involve segmenting the malaria parasite infected cells from the complicated background. We presented an approach for classification of malarial infected cells using Rao'sbased segmentation and BPNN for classification. We have divided the proposed methodology in to four basic steps.

1. Preprocessing
2. ROI Segmentation
3. Feature Extraction
4. Classification of Infected Cells

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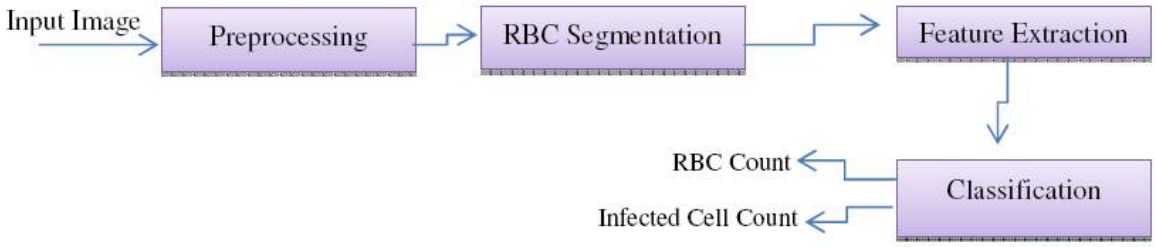

FIGURE 1: System Diagram.

A. PREPROCESSING

Blood smear images might be affected by illumination and color distribution of blood images due to the camera calibration and staining variability. Most of the microscopes provide uniform or relatively uniform illumination images. The aim of preprocessing step is to obtain images with low noise, high contrast than original images for the further processing. This particular problem poses difficulties for classification of blood cells since it is hard to deal with proper segmentations of objects with quite similar colors. This process contains two operations image enhancement and noise reduction.We have applied median filter for noise reduction. The median filter replaces pixel value with the median of its neighboring value. To get the finest coefficients details of noise free image, a Forward Discrete Curvelet Transform is applied to the V channel as shown. It is a multi-dimensional transformation which can sense both the contours as well as curvy edges of the overlapping objects in the image. The FDCT has high directional sensitivity along with the capability to capture the singularities. Edge and singularity details are processed to extract the feature. After obtaining the highest detailed coefficients Inverse Discrete Curvelet Transform is applied to high frequency band to obtain the detailed image. This detailed image is now having the stronger edges than the original and would perform better in lending edge details to the segmentation step. The next step is the adaptive equalization operation to spread out the intensity values along the total ranges of values in order to achieve better contrast. Adaptive histogram equalization differ from ordinary histogram equalization in respect that it computes several histogram of each corresponding to distinct section and use these histogram to redistribute the lightness value. After applying the adaptive histogram equalization, the background pixels have higher intensities than the cells.

B. ROI SEGMENTATION

In the analysis of automatic classification of malarial parasite procedures, the most important and difficult part is segmentation of malaria parasite infected blood cells from the background and other cells because the blood cells are often overlaid with each other and is the basis of quantitative analysis of its deformability and hence its filterability[2]. Cell shapes, light variation and noise are the other factors that make segmentation a difficult task. Accurate segmentation allows fruitful result in sub-sequent levels. Malarial parasite lies in erythrocytes thus we need to segment the erythrocyte form the blood images. We have used Rao's method for background segmentation. Rao's method extracts a rough foreground image using morphological rea top-hats [6]. Two different threshold values are determined form these backgrounds and foreground that are used to produce the refined binary foreground mask. At the end, a box counting algorithm is applied to the segmented image. Various algorithms are used for calculating the fractal dimensions, like the fractional (or fractal) Brownian motion and triangular-prism-surface area methods. The box counting algorithm counts the number of boxes having side length r needed to cover the surface of fractal objects and the number of boxes N, occupied by more than one pixel of the image. Two procedures are defined by two parameters in the box counting method. One is the selection of r and the other is the range of r. The blood cell image has finite set of points and the upper limit is the size of image while the lower is the pixel unit. Various researche propose using 2, 4, 8, 16, 2n pixels as box sizes to have a uniform spread of observation. The quadratic boxes cover the object, and the number of the boxes is recorded.

C. FEATURE EXTRACTION

Recent researches on feature extraction and selection of red blood cell have shown the importance of feature extraction phase for red blood cell analysis. Researchers have used different features based on their target blood cells/disease. The

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features which give predominant difference between normal cells and infected cells are identified as feature set. Textural [3] and color features [1] are very important in order to differentiate form other cells and has been widely used for blood cell recognition whereas color features plays important role in order to differentiate similar shapes and overlapped cells. We have used all geometrical and intensity features along with GLCM based texture features. Rules for identification of malarial species are presented.

V. CONCLUSION

The detection of Malaria parasites is done by pathologists manually using Microscopes. So, the chances of false detection due to human error are high, which in turn can result into fatal condition. This seminar curbs the human error while detecting the presence of malaria parasites in the blood sample by using image processing and automation. We achieved this goal using Image Segmentation smoothing processing techniques, gradient edge detection technique to detect malaria parasites in images acquired from Giemsa stained peripheral blood samples. The system in a robust manner so that it is unaffected by the exceptional conditions and achieved high percentages of sensitivity, specificity, positive prediction and negative prediction values. And the extraction of red blood cells achieves a reliable performance and the actual classification of infected cells.

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