International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Image Analysis Based System for Automatic Detection of Malarial Parasite in Blood Images

Varsha Waghmare[1], Syed Akhter[2]

[1]Department of Computer Engineering, Aditya Engineering College, Beed

[2]Professor, Department of Computer Engineering, Aditya Engineering College, Beed

Abstract: ***Malaria is an infectious disease caused by microorganism and it poses major threat to global health zone. Brisk and accurate diagnosis is required to control the disease. The proposed system mainly concentrate on development of sensitive malarial detection system for images of (JSB) stained thick blood slides acquired from conventional light microscopes. Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected mosquitoes. Light microscopy enables the visualization of malarial parasites in a thick or thin smear of the patient's blood. Automation of the evaluation process in the diagnosis of malaria is of high importance. The proposed system describes the computerized method of image analysis involving three main phases: pre-processing, where the images are corrected for luminance and transformed to a constant color space. A histogram based image segmentation processing where the maximum artefacts and over stained objects are avoided. Finally, Feature extraction along with a multi-layer, feedforward, backpropagation neural network was employed for classifying the objects as parasite/wbc. Support Vector Machine (SVM) models are a close cousin to classical multilayer perceptron neural networks. The objective of the project is to develop an image processing algorithm to automate the diagnosis of malaria on thin blood smears.***

Keywords: Jaswant-Singh-Bhattacherji (JSB) Stain, Malaria, Microscopic images, Feature Extraction, Artificial Neural network, SVM.

1. Introduction

Various works are going on analysing microscopic images to point out the presence of infection. According to the World Health Organization (WHO), it causes more than 1 million deaths arising from approximately 300–500 million infections every year. Manual microscopy for the examination of blood smears is widely accepted as a good standard for malaria diagnosis.

An automated diagnosis system can be designed by understanding the diagnostic expertise and representing it by specifically tailored image processing, analysis and pattern recognition algorithms. A complete system must be equipped with functions to perform: image acquisition, pre-processing, segmentation (object localization), and classification tasks. In order to perform diagnosis on peripheral blood samples, the system must be capable of differentiating between malarial parasites, artifacts, and healthy blood components

2. Literature Review

The literature review summarizes all the relevant literature researched during the course of this project. It presents certain approaches used by many researchers for classification. It also compares the performance of all classifier with other common classifier with same parameters. Finally the best parameters and classifier combination is discussed.

[3] Illustrate a technique for identifying the malaria for blood cell images. This paper involves the counting of Blood cell using an adaptive OTSU thresholding technique. Which use to segment the image and seprate the RBC and WBC for Counting? The paper also considers the area of cells to declare severity. The paper uses SVM as Classifier for declaring the result of whether the patient is affected by Malaria or Not. The proposed automated method of segmentation and classification of cell is simple. An approach is proposed to detect red blood cells with consecutive classification into parasite infected and normal cells for estimation of parasitemia. The extraction of red blood cells achieves a reliable performance and the actual classification of infected cells. Sensitivity of system is 93.12%, and Specificity is 93.17%. Shape based and statistical features are generated for classification. The features are selected for recognition of two classes only. This approach leads to the high specialization of each classifier and results in an overall increase in accuracy.

Raviraja and et al. [5] introduces a blood image processing for detecting and classifying malarial parasites in images of Giemsa stained blood slides, in order to evaluate the parasitamia of the blood. To detect the red blood cells that are infected by malarial parasites, statistical based approach is used. To separate automatically the parasites (trophozoites, schizonts and gametocytes) from the rest of an infected blood image, color, shape and size information are used and later the image is compared with infected images after transformation of image by scaling, shaping to reconstruct the image. The images returned are statistically analysed and compare to generate a mathematical base. Also the evaluation of the size and shape of the nuclei of the parasite is also considered.

3. Proposed System

There is problem with identifying the malaria diseases manually through the microscope and with the process of Giemsa the method is not so accurate. To solve this Problem I have come with automatic algorithm that uses blood cell images to identify whether the patient is affected by malaria or not.

The objective is to develop an algorithm to identify the given blood image is affected by malaria or not. So, to achieve this Problem I will develop an Algorithm which serves as the preprocessing tool for the image analysis. A prototype consisting of existing software packages such as Mat lab is used for feature extraction and classifier implementation.
Study of existing methods.
Experimental data Collection and observations.
Development of an algorithm for feature extraction and different classifier.

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 [9].

3.1 Working Methodology

The test algorithms illustrated above give an insight about the algorithm to be used for each stage. The process is given below.
1.) Image Acquisition and database collection
2.) Image Analysis
3.) Image Segmentation
4.) Feature Generation
5.) Classification of Parasite and result verification

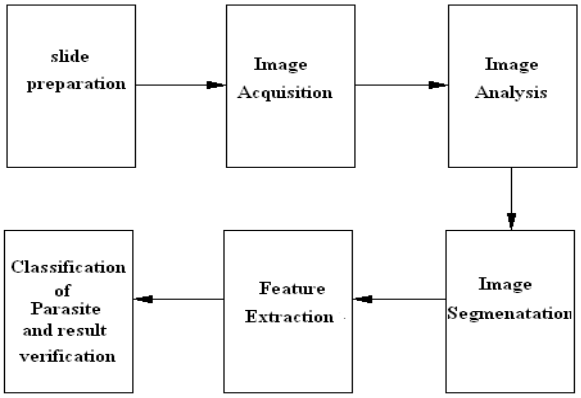

Figure 1: Process flow

1) Image Data Collection

The JSB stain is a rapid staining method for the detection of malarial parasites. This stain is superior to the Field's stain as the parasites stain clearer and the morphology of the parasites is visible even in thick smear. The JSB stain constitutes of JSB solution 1(methylene blue (Medicinal) 0.5 gm, sulphuric acid (H2SO4) 1% 3.0 ml, potassium dichromate (K2Cr2O7) 0.5 gm, disodium hydrogen phosphate dihydrate (Na2H PO4 2 H2O) 3.5 gm, distilled water 500 cc) and Solution 2 (eosine 1.0 gm, distilled water 500 cc). The preparation of stain procedure was followed as recommended National Vector Borne Disease Control Programme (NVBDCP). Chromatin (part of the parasite nucleus) is usually round in shape and stains deep red. Cytoplasm occurs in a number of forms, from a ring shape to a totally irregular shape. It always stains blue, although the shade of blue may vary between the malaria species [1]. Images were acquired using microscope system - Leica DM1000 which is interfaced to a Leica DFC 295 camera using IEEE 1394. The slides are examined under oil immersion with 1000x magnification maintaining a constant image size of 640X480 pixels.

2) Image Processing

An image from JSB stained sample (thick) is prone to differ widely in the foreground / background color due to several conditions. This may be due to difference in the light source or filters, cameras, slide preparation. In order to have an analysis towards constant color characteristics, the images are normalized. The different Pre-Processing Techniques such As Filtering, Noise Removing and etc can be applied

3) Feature Extraction

A total of 60 samples were used for training. Each samples had number of normal and infected cells along with artefacts. The objects extracted from these samples are Parasites, WBC and artefacts. In order to classify the detected objects, twenty three image features were extracted from the detected objects for training the system. The feature includes intensity based Histogram features and shape measurement features. These features are extracted for different channel of color spaces namely gray, hue, saturation and luminosity (standard deviation).

First Order Statistical Features / Histogram Features:

The histogram counts and the bin locations are pixelcounts and bin (256) respectively. The first order features are defined by the following equations,

$$Mean = M = \frac{sum\ (bin\ .*pixelcounts)}{Total\ Number\ of\ pixels}$$

$$Variance = V = \frac{sum\ \left((bin-M)^2.*pixelcounts\right)}{Total\ Number\ of\ pixels-1}$$

$$Standard\ Deviation = SD = \sqrt{V}$$

$$Skewness = sk = \frac{sum\ \left((bin-M)^3.*pixelcounts\right)}{Total\ Number\ of\ pixels-1}$$

$$kurtosis = kr = \frac{sum\ \left((bin-M)^4.*pixelcounts\right)}{Total\ Number\ of\ pixels-1}$$

$$Fifth\ standard\ moment = M5 = \frac{sum\ \left((bin-M)^5.*pixelcounts\right)}{Total\ Number\ of\ pixels-1}$$

$$sixth\ standard\ moment = M6 = \frac{sum\ \left((bin-M)^6.*pixelcounts\right)}{Total\ Number\ of\ pixels-1}$$

3.2 Shape Measurement Features:

Since these features are independent of color spaces, the following equations were directly applied to the binary mask image. Shape measurements can detect the changes in the size. The advantage of shape measurements is straightforward interpretation of the calculated feature values.

$$Convexity(R) = \frac{Perimeter(ConvexHull(R))}{Perimeter(R)}$$

$$Compactness(R) = \frac{2\sqrt{\pi Area(R)}}{Perimeter(R)}$$

$$FormFactor(R) = \frac{4\pi Area(R)}{Perimeter(R)^2}$$

$$Area(R) = Total\ Number\ of\ pixels(R)$$

Neural Network

To implement neural network Classifier neural network tool box (Mat lab 7.1) is used. The description of process can be easily got from mat-lab help [7]. To implement the Neural Network classifier the data set of table (5.2) is used from which 70% for training 15%Test and 15% for validating the network is used.

SVM

A Support Vector Machine (SVM) performs classification by constructing an *N*-dimensional hyper plane that optimally separates the data into two categories. SVM models are closely related to neural networks. In fact, a SVM model using a sigmoid kernel function is equivalent to a two-layer, perceptron neural network shown by Fig.

Support Vector Machine (SVM) models are a close cousin to classical multilayer perceptron neural networks. Using a kernel function, SVM's are an alternative training method for polynomial, radial basis function and multi-layer perceptron classifiers in which the weights of the network are found by solving a quadratic programming problem with linear constraints, rather than by solving a non-convex, unconstrained minimization problem as in standard neural network training.

In the parlance of SVM literature, a predictor variable is called an *attribute*, and a transformed attribute that is used to define the hyper plane is called a *feature*. The task of choosing the most suitable representation is known as *feature selection*. A set of features that describes one case (i.e., a row of predictor values) is called a *vector*. So the goal of SVM modeling is to find the optimal hyper plane that separates clusters of vector in such a way that cases with one category of the target variable are on one side of the plane and cases with the other category are on the other size of the plane. The vectors near the hyper plane are the *support vectors*. The figure below presents an overview of the SVM process.

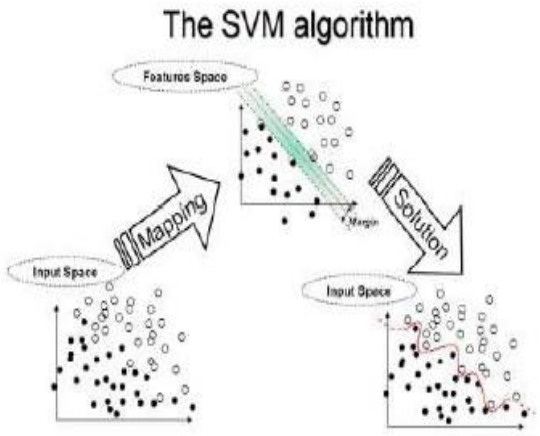

Figure 2: SVM Concept

4. Result Analysis

The performance of classifier is defined by the feature used to train the classifier. The results for the experiment are given in table. For the malaria images database the result obtained are as follows.

Table 1: Shows accuracy of algorithm for different methods of classification

Method	Neural Network	ANFIS	SVM
Accuracy	78.53%	89.63%	98.25%

Computational Time

Table 2: Computational Time

Method	Time Required (Secs)
Neural Network	6.58
ANFIS	4.329
Support Vector Machine	3.852

In total, 20 images of blood cells were classified into categories of affected by malaria or unaffected. The performance of system is defined by a classifier used with existing set of a database. The result for the experiment is given in tables which shows the accuracy of algorithm for different classifier in terms of percentage. Among 20 images for Test 15,17 and 19 are correctly classified by Neural Network, ANFIS and SVM.

The use of parameter extracted using GLCM and Other method work good with Neural Network better with ANFIS and finally best by using SVM as classifier.

5. Conclusion

This project addresses how the identification of malaria diseases is possible using image processing by effectively analyzing various parameter of blood cell image by using GLCM as Energy and other like Skewness, Kurtosis, Standard Deviation. The experimental results indicate that the proposed approach is a valuable approach, which can be significantly support an accurate identification of malaria diseases in a little computational effort. There can be mistake in counting manually the number of RBC & WBC (process of Giemsa) as the boundaries are not clearly defined or visible which lead us to the error in wrong decision. So to solve this problem the developed algorithm

be more helpful the other techniques. As this system can meet the real time application requirements, so we can easily have the standalone working version of this system.

References

[1] F. Sadeghi an, Z. Seman and A. R. Ramli, "*A Framework for White Blood Cell Segmentation in Microscopic Blood Images Using Digital Image Processing*" Biological Procedures online, vol. l l, no. l, pp. lg6-2o6,Dec. 2009.

[2] Shiff C. "*Integrated approach for malaria control. Clinical Microbiology*" Rev.15, 278193.

[3] *World Health Organization what is malaria?* Factssheetno94. http :/ /www.who. Int / mediacentrefactsheetsfs094 / en/./ factsheet

[4] V. V. Makkapati and R. M. Rao, "*segmentation of malaria parasites in peripheral blood smear images* "Proceedings of IEEE International Conference on Acoustics, Speech and Signal Processing,I CASSP 2009, pp. 136l -1364, Apr. 2009.

[5] S. Ravi raja, G. Bajpai and S. Sharma, "*Analysis of Detecting the Malaria Parasite Infected Blood Images Using Statistical Based Approocft* " IFMBE Proceedings, 3rd Kuala Lumpur International Conference on Biomedical Engineering 2006,vol. 15,p art 12,pp.502- 505,2007.

[6] Di Ruberto, A. Dempster, S. Khan and B. Jarra, "*segmentation of blood Images using morphological operators* ", Proceedings of I 5th International Conference on Pattern Recognition Barcelona S, pain, vol.3, pp. 3401, 2000.

[7] S. S. Savkare, S.P.Narote, "*Automatic Detection of Malaria Parasites for Estimating Parasitemia* ", lnternational Journal
of Computer Science and Security (IJCSS), Volume (5), Issue (3), 2011, Page 310-315

[8] Vishnu V. Makkapati and Raghuveer M. Rao "*segmentation of malaria Parasites in peripheral blood smear images* ", IEEE 2009.

[9] S. Ravirajal, Gaurav Bajpail and Sharma S "*Analysis of Detecting theMalaria Parasite Infected Blood Images (Ising Statistical Based Approoch*" Proceedings1 5, pp. 502-505, 2007

[10] Sio, W.S.S "*Malaria Count: An image analysis-based program for the accurate determination of parasitemia*" Journal of Microbiological Methods, 2006.

[11] S.P.PremaratneaN, D. Karuna weerab, and S. Fernandoc," *A Neural Network Architecture for Automated Recognition of Intracellular Malaria Parasites in Stained Blood Films*"International Journal of Image, Graphics and Signal Processing (IJIGSP) I SS N: 2074 - 9074(Print)I,S S N: 2074 -908 2 (Online).

[12] C. Pan, X Yan and C. Zheng "*Recognition of Blood and Bone Marrow Cells using Kernel-based Image Retrieva*l" IJCSNS International Journal of Computer Science and Network Security, vol.6 no.l0, October 2006

[13] S. K. Lee, C-S. Lo, C-M. Wang and P-C. Chung, "*A Computer- Aided Design Mammography Screening System for Detection and Classification of Micro calcifications* "International Journal of Medical Informatics, vol. 60, pp. 29-57,2000.

[14] J. Arrgulo, G. Flandrin , "*Automated detection of working qrea of peripheral blood smears using mathematical morphologt*", U. S. National Library of Medicine, Analytical cellular Pathology2 s(l), pp 39-47, 2003.

[15] T. Markiewicz, S. Osowski, "*Data mining techniques for feature selection in blood cell recognition*", European Symposium on Artificial Neural Networks, Bruges (Belgium),26-28 April, pp 407-412,20A6

[16] G. Diaz et al., "*A semi-automatic method for quantification and classification of erythrocytes infected with malaria parasites in microscopic images*", Journal of Biomedical I nformatci s 42, science Direct,p p 29G307, 20;09.

[17] Pallavi T. Suradkar, o' *Detection of Malarial Parasite in Blood Using ImageProcessing*'

[18] erilit Kuurar, Prof. Arun Choudhary,Prof. P. U. Tembhare, Prof. C. R. Pote "*Enhanced identification of Malaria Infected Objects using Otsu Algorithm from Thin Smear Digital Images* ".

[19] B. D. Ripley, "*Neural Networks and Related Methods for Classifieation*" Journal of the Royal Statistical Society. Series B (Methodological), Vol . 56,No. 3 (1994), pp 409-456, Blackwell Publishing for the Royal Statistical society stable http://wwwj stor.org/stable/234 6 r l 8.

[20] Vikramaditya Jakkula "*Tutorial on Support Vector Machine*" school of EECS, Washington State University, pullman.

Author Profile

Varsha Waghmare pursuing Master of Engineering in Software Engineering in Aditya Engineering College Beed, from Dr. Babasaheb Ambedkar Marathwada University.