Malaria Disease Identification And Analysis Using Image Processing

Sneha Narayan Chavan
Department of Electronics and Tele-Communication Engineering
MIT College Of Engineering, Pune, Maharashtra, India

Ashok Manikchand Sutkar
Department of Electronics and Tele-Communication Engineering
Walchand College Of Engineering, Sangli, Maharashtra, India

Abstract- Malaria is a serious infectious disease. According to the World Health Organization, it is responsible for nearly 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 an infectious disease and causes serious health problems; half of the world's population, particularly in the developing countries is at risk of malaria. According to the World Health Organization (WHO), malaria causes approximately nearly million deaths and over 250 million infections every year and is caused by parasites of the genus Plasmodium, of which Plasmodium falciparum contributes 98% of deaths. The diagnosis of the infections due to P. falciparum is still carried out via manual procedures especially in developing countries. Although there are advanced methods of diagnosis, manual microscopy of blood films on slides is still considered to be the gold standard. Manual microscopy has advantage over other techniques in that it is both sensitive and specific. One of the disadvantages of diagnosis using manual microscopy methods is that it requires extensive human intervention during the diagnostic process which can often lead to late and sometimes erroneous diagnosis. The microscopist requires extensive training to gain expertise in the diagnosis, and because of the sheer volume of the samples that need to be analysed, the method is not consistent and is dependent upon blood smear and stain quality, microscope quality and the expertise of the microscopist.

Some of the problems of manual microscopy can be overcome by exploring computer based, specifically image-based, diagnostic methods. The aim of this study is to outline a semi-automatic diagnosis method based on image processing and one that provides a reliable and consistent solution. The literature contains descriptions and details of several computer vision or image based algorithms. However, most of these algorithms are supervised and complex, that is they need manual intervention or calibration. Considering the high fatality rate and huge volumes of samples that need to be analysed we need a sensitive, practical and robust method with minimum human intervention. In this context, computer based diagnosis can help in the rapid, accurate and consistent identification of true malaria cases, ensuring that only those patients with malaria are treated. Manual microscopy is carried out by examining thin blood films on slides under the microscope and reporting the percentage of parasitaemia (i.e. number of infected red blood cells (iRBCs) for over 100 microscopic fields). Microscopists also need to identify parasite morphology by various life cycle stages for speciation, described in The WHO practical microscopy guide. Giemsa staining is most widely used to highlight the parasites. The disadvantage of Giemsa is that it also stains other blood film features, such as white blood cells, platelets, and slide artefacts, such as dust particles. This problem of other stained objects needs to be considered carefully when comparing results of automated image-based diagnosis with manual microscopy.

It is proposed that the method presented here be mainly used as a consistent screening tool to identify patients who are likely to have parasitaemia. This would significantly reduce load on medical technologists who can then

focus their attention on those patients with positive tests to confirm presence of parasites and the level of parasitaemia with manual slide examination. Each image as discussed below may not represent one complete microscopic field. Instead each image is considered as a segment of a field. The focus of this study is on the application of image analysis on low resolution images, which directly implies that smaller segments can be drawn from a larger field and analyzed separately for accurate results. This approach mimics the procedure that a pathologist would carry out as most pathologists or microbiologists would examine a section of a larger field to obtain accurate result. In general thick smear screening is more sensitive than thin smear to detect parasites with a human microscopist. In endemic areas the thick smear is examined first and the thin smear secondarily used for speciation and to assess parasitemia. In general due to time constraints and visual human fatigue only 100-300 high power fields (hpf) are examined on a thin smear- that is only a small fraction of the fields present on a traditional glass slide are actually examined. The method proposed in this manuscript presents an unsupervised screening method for thin smear analysis, which has potential to be integrated into a diagnostic platform. For the proposed method to have clinical utility, close to 1,000 hpf would need to be analysed- this could happen on a traditional glass slide or on a yet-tobe- developed substrate. The image capture technology has yet to be developed suitable for a tropical laboratory. A 10-20 parasites/µL would be feasible on a thin smear generated with 10 µL of blood and > 1,000 hpf analysed.

The rest of the paper is organized as follows. Proposed support vector machine algorithm is explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

II. PROPOSED ALGORITHM

A. Support vector machine –

Support Vector Machine (SVM) is used in this paper for classification of the affected or not affected images by malaria. The statistical learning theory provides a framework for studying the problem of gaining knowledge, making predictions, making decisions from a set of data. In simple terms, it enables the choosing of the hyper plane space such a way that it closely represents the underlying function in the target space.

In statistical learning theory the problem of supervised learning is formulated as follows. We are given a set of training data {(x1, y1)... (xl, yl)} in Rn * R sampled according to unknown probability distribution P(x,y), and a loss function V(y,f(x)) that measures the error, for a given x, f(x) is "predicted" instead of the actual value y. The problem consists in finding a function f that minimizes the expectation of the error on new data that is, finding a function f that minimizes the expected error: .In statistical modeling we would choose a model from the hypothesis space, which is closest (with respect to some error measure) to the underlying function in the target space.

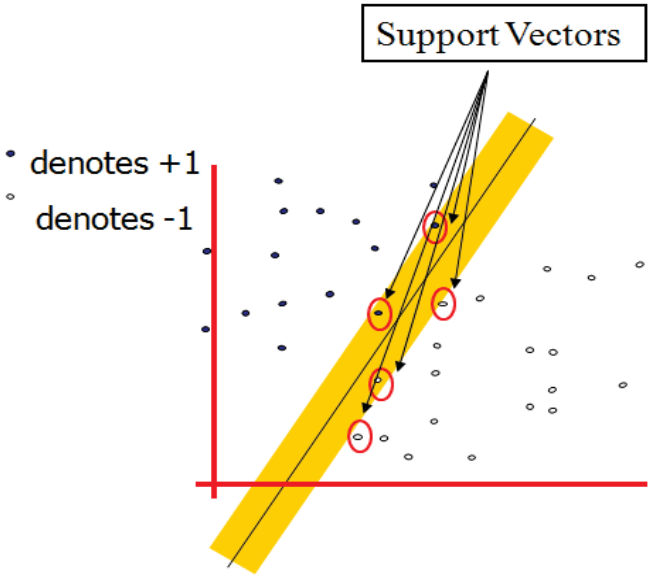


Figure 1. Representation of support

Using these formules we can calculate the parameters value:

Mean $S_M = \bar{b} = \sum_{b=0}^{L-1} bP(b)$ (1)

Standard deviation $$S_D = \left[\sum_{b=0}^{L-1}(b - \bar{b})\right]^{-\frac{1}{2}} \quad (2)$$

Skewness $$S_S = \frac{1}{\sigma_b^3}\sum_{b=0}^{L-1}(b - \bar{b})^3 P(b) \quad (3)$$

Kurtosis $$S_K = \frac{1}{\sigma_b^4}\sum_{b=0}^{L-1}(b - \bar{b})^4 P(b) - 3 \quad (4)$$

Energy $$S_N = \sum_{b=0}^{L-1} P(b)^2 \quad (5)$$

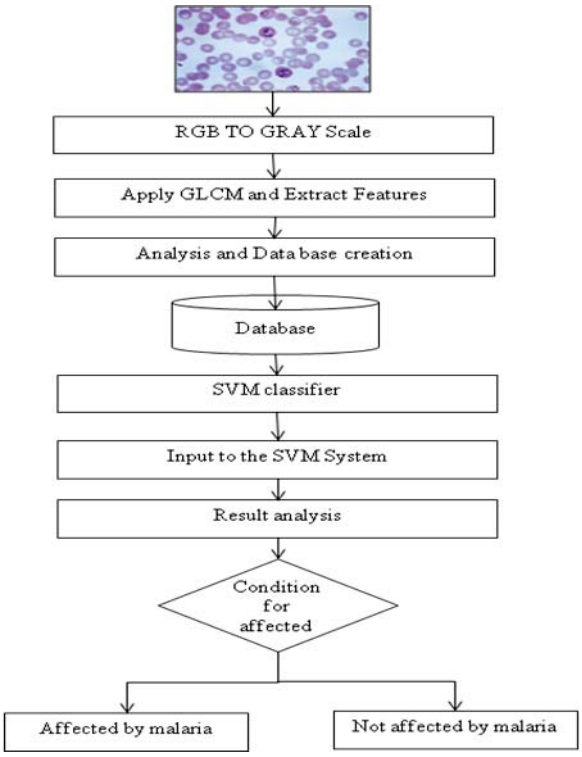


Figure 2. SVM algorithm Block Diagram

On the basis of such considerations & formules, the algorithm uses a different fatures by the weighting coefficients of different ways to solve the visual distortion. Training SVM becomes quite challenging when the number of training points is large.

B. Neural Network algorithm –

Neural networks are composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. As in nature, the connections between elements largely determine the network function. You can train a neural network to perform a particular function by adjusting the values of the connections (weights) between elements. Typically, neural networks are adjusted, or trained, so that a particular input leads to a specific target output.

Neural networks have been trained to perform complex functions in various fields, including pattern recognition, identification, classification, and speech, vision, and control systems. Neural networks can also be trained to solve problems that are difficult for conventional computers or human beings. Artificial neural networks are computational networks which attempt to simulate the networks of neurons. This simulation is neuron by neuron simulation. A neural network is a system composed of many simple processing elements operating in parallel whose

function is determined by network structure, connection strengths, and the processing performed at computing elements rnodes.

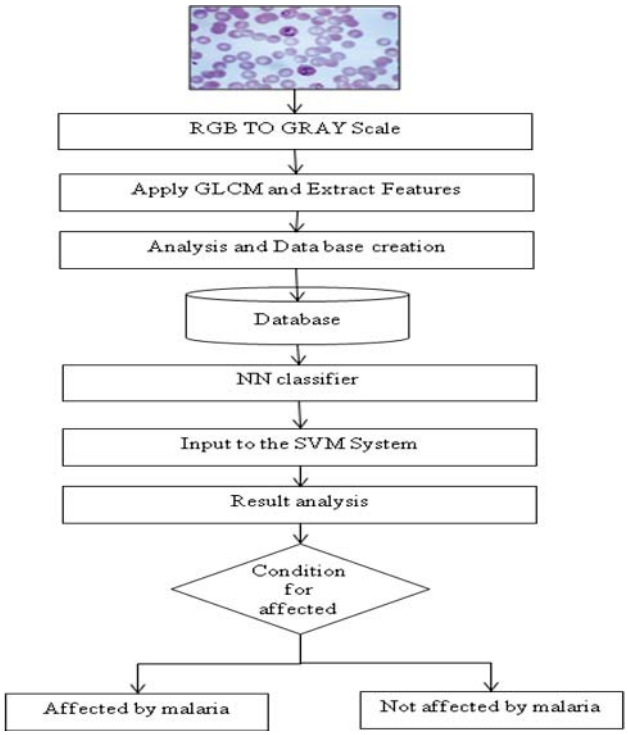


Figure 3. Neural network algorithm Block Diagram

.

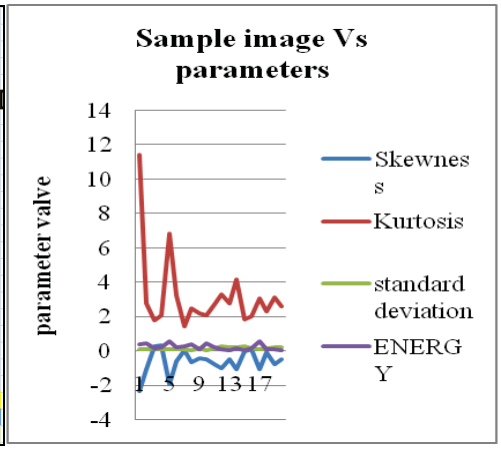
III. Experiment and Result

The test set for this evaluation experiment malaria disease color image randomly selected from the internet. Matlab 13 software platform is use to perform the experiment. The PC for experiment is equipped with an Intel P4 2.4GHz Personal laptop and 2GB memory.

The proposed scheme is tested using ordinarily image processing. From the simulation of the experiment results, we can draw to the conclusion that this method is robust to many kinds of malaria disease.The image based method is tested over more than 30 images from two independent laboratories. The aim is to distinguish between positive and negative cases of malaria using thin smear blood slide images. Due to the unsupervised nature of method it requires minimal human intervention thus speeding up the whole process of diagnosis. Overall sensitivity to capture cases of malaria is 100% and specificity ranges from 50-88% for all species of malaria parasites.

Images	Skewness	Kurtosis	Std	Energy
For not Affected images	-2.33158	11.41209	0.101356	0.418505
	-1.05379	2.785143	0.092253	0.461512
	0.25247	1.801433	0.138752	0.161675
	0.305202	2.082076	0.109513	0.213483
	-1.95057	6.828676	0.08351	0.573091
	-0.59863	3.248551	0.103029	0.224987
	-0.00851	1.455434	0.11191	0.304597
	-0.68088	2.489777	0.057329	0.424923
	-0.43092	2.2322	0.135943	0.112798
	-0.47869	2.074422	0.07067	0.45825
for Affected images	-0.77172	2.755637	0.14145	0.235728
	-0.98477	3.285878	0.240115	0.114415
	-0.47004	2.806247	0.183123	0.068736
	-1.09039	4.189564	0.182176	0.169848
	-0.06437	1.863338	0.25255	0.050478
	0.092649	2.062773	0.16621	0.175552
	-1.0474	3.092403	0.098995	0.553743
	-0.07078	2.322458	0.172404	0.128377
	-0.76714	3.145267	0.179682	0.090911
	-0.47861	2.593785	0.204835	0.045447
Min	-2.33158	1.455434	0.057329	0.045447
Max	0.305202	11.41209	0.25255	0.573091
Average	-0.63142	3.226358	0.14129	0.249353

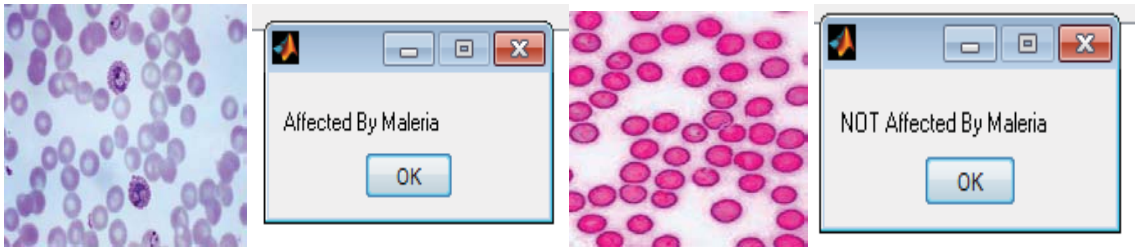
Table 1 -: Image and its parameter value.



Graph 1: Parameters value.

The table 1 shows the parameters value of Skewness, Kurtosis, Standard Deviation and Energy. In which first 10 values is for not affected Malaria Images and next 10 for the affected images by malaria. And Showing over all Min, Max and Average Values following is the graph which shows response of different parameter with respect to images.

From graph 1 come to Know that the valve of where the value of parameters limits for affected and where for Not Affected.



(a) (b) (c) (d)

Figure 4. (a) Affected input image (b) Affected by malaria (c) Not affected input images (d) Not affected by malaria

Table -2 Experiment Result

Method	**Support Vector Machine (SVM)**	**Neural Network (NN)**
Accuracy	**98.25%**	**78.53%**

Table 2 show the performance of classifier is defined by the feature used to train the classifier.

IV.CONCLUSION

REFERENCES

[1] Yashasvi Purwar, Sirish L Shah, Gwen Clarke, Areej Almugairi and Atis Muehlenbachs, "Automated and unsupervised detection of malarial parasites in microscopic images", Purwar et al. Malaria Journal 2011, 10:3641,Department of Chemical and Materials Engineering, University of Alberta, Edmonton, Canada.

[2] Amit Kumar, Manjunatha M, J Chatterjee and Ajoy K Ray, "Segmentation of Blood Smear Images using Normalized Cuts for Detection of Malarial Parasites" Dept. of Electronics & Electrical Communication Engineering, Annual IEEE India Conference (INDICON) 2010.

[3] Saowaluck Kaewkamnerd, Apichart Intarapanich, Montri Pannarat, Sastra Chaotheing, Chairat Uthaipibull and Sissades Tongsima, "Detection and Classification Device for Malaria Parasites in Thick-Blood Films" The 6th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications 15-17 September 2011, Prague, Czech Republic.

[4] Matthias Elter, Erik Haßlmeyer and Thorsten Zerfaß Fraunhofer, "Detection of malaria parasites in thick blood films", Institute for Integrated Circuits IIS Image Processing and Medical Engineering Department Am Wolfsmantel 33, 91058 Erlangen, Germany, 33rd Annual International Conference of the IEEE EMBS Boston, Massachusetts USA, August 30 - September 3, 2011.

[5] S.Kareem, I.Kale and R.C.S Morling, "Automated Malaria Parasite Detection in Thin Blood Films:- A Hybrid Illumination and Color Constancy Insensitive, Morphological Approach", IEEE Trans.on Applied DSP and VLSI Research Group University of Westminster London, United Kingdom, 2012.

[6] A.S.Abdul Nasir, M.Y.Mashor and Z.Mohamed, "Segmentation Based Approach for Detection of Malaria Parasites Using Moving K-Means Clustering", Department of Medical Microbiology & Parasitology, School of Medical Sciences, Health Campus, Universiti Sains Malaysia, IEEE EMBS International Conference on Biomedical Engineering and Sciences, Langkawi , 17th - 19th December 2012.

[7] D. Anggraini, A. S. Nugroho, C. Pratama, et al., "Automated status identification of microscopic images obtained from malaria thin blood smears," in 2011 International Conference on Electrical Engineering and Informatics (ICEEI), Bandung, Indonesia, 2011.

[8] Isha Suwalka, Ankit Sanadhya, Anirudh Mathur and Mahendra S Chouhan, "Identify Malaria Parasite Using Pattern Recognition Technique" Geetanjali Institute of Technical Studies Dabok, Udaipur, India,2011.

[9] Sriram R., Meenalochani Chandar and Kota Srinivas, “Computer Aided Malarial Diagnosis for JSB Stained White Light Images Using Neural Networks", Inte-rnational Journal of Advanced Research in Computer Science and Software Engi-neering, Volume 3, Issue 8, August 2013, CSIR-CSIO, Chennai, India.

[10] Pallavi T. Suradkar, “Detection of Malarial Parasite in Blood Using Image Processing”, International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 10, April 2013.