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# Detection of Malaria using Machine Learning

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***Abstract: Malaria is a parasitic infection caused in humans by the parasite belonging to the genus Plasmodium. The traditional approach of diagnosis by the use of microscopy, considered to be the "gold standard method" has at times proved to be inefficacious and inefficient as it is time consuming, needs more expertise and is erring at times. This raises a need for better alternatives for the diagnosis of the parasitic infection. This paper highlights the advancement in the field of machine learning and its beneficial applications in the detection, identification and diagnosis of the malarial infection via the use of smartphones. It uses a pre trained CNN for the detection of the parasite. The experimental results excelled in the relevant attributes of accuracy, efficiency and sensitivity of this technique, making this outperform the traditional means of detection.***
***Keywords: Malaria detection, machine learning, image processing, CNN***

## I. INTRODUCTION

Malaria is a baneful parasitic infection caused in humans by the Plasmodium parasite. There are five species which infect humans namely *P. falciparum, P.malariae, P. vivax, P. ovale* and *P.knowlesi*. Out of the five species, the *P.falciparum* and *P. vivax* possess a fatal infection consequence. The first ever case of malaria was detected and discovered in 1870's ever since which the disease has been a prominent cause of death in most of the Sub Saharan African region with a rise of 90% cases annually as of the year 2020. According to the UNICEF annual survey, the malaria accounts for 1 million deaths and around 300-600 million people diagnosed per year. India is also predominantly affected by the parasitic infection with 15 million cases registered annually according to the World Health Organization.

The disease spreads by the bite of the female Anopheles mosquito species, commonly known as mosquito vectors. The mechanism of infection involves the spread of sporozoites through the salivary glands of the mosquito into the bloodstream. Even after the defeasance by the immune system, some of these sporozoites succeed in affecting the hepatocytes. The infection spreads by reproduction and multiplication of these parasites inside. Some of the most common symptoms include fever, chills, fatigue, nausea and headache. Some of the severe cases with fatal infection can also result in jaundice, coma or death of the infected individual.

The detection and diagnosis of malaria parasitic infection is even more necessary to be efficient, reliable and accurate in order for us to tackle the endemic and control or reduce the number of deaths annually. The "gold standard method" used for the diagnosis involves the manual assessment through microscopy.

This is one of the oldest approaches and is highly reasonable, reliable and cost efficient. Though this method is considered to be achievable, it has certain obvious drawbacks. The manual approach of diagnosis is considerably time consuming as it has number of steps for conducting the tests. It is also very much prone to human errors even when conducted by expert individuals in microscopy. Moreover, in places such as the Sub Saharan African regions, due to the economic conditions, there might be a lack of such facilities.

This raises a requirement to search for other alternatives for the diagnosis of malaria keeping the efficiency, the consistency, the accuracy, the sensitivity and the specificity as some of the relevant attributes.

This paper establishes the importance towards the new approach of diagnosing the disease, that is, through the use of machine learning. The parasitic detection using semi-automated diagnosis increases the efficiency as well as the consistency of the tests. The applications of deep learning which include models such as the ANN and the CNN have various advantages over the manual testing and diagnosis.

This paper briefly introduces the concept of machine learning and how it can be thoughtfully applied for the detection of the malaria through the blood samples. The concept has taken smartphones into account which will act as a handy, reliable, mobile and easily accessible tool for the detection in contrast to the microscopes or the Rapid Diagnosis Kits. The approach described is very much practical for the use in the clinics, hospitals or even by individuals at home. It requires minimal basic training. The digitization of the entire process increases the efficiency, accuracy and consistency to a greater value.

## II. LITERATURE REVIEW

Ahmedelmubarak Bashir , Zeinab A.Mustafa , Islah Abdelhameid , Rimaz (2017) This paper, highlighting the drawbacks of the traditional ways of detecting malarial infection in cells through microscopy, focuses on the new advancements in the diagnosis through the application of Digital Image processing. They focussed on the relevant features of the plasmodium as well as the erythrocytes. The features help distinguish between the infected and non infected cells in the sample by the evaluation and processing carried out by an Artificial Neural Network. The classification and detection of the plasmodium was done by putting ANN (Artificial Neural Network) to work. The accuracy of the system was found to be 99.68%. While designing this testing procedure keypoints from this paper was kept in mind.

Mahdieh Poostchi, Kamolrat Silamut, Richard Maude, Stefan Jaeger, George Thoma(2017), The main objective of the paper involves the reviewing of certain recent developments in the technologies such as machine learning algorithms and deep learning techniques applied to smartphones and other devices and how they can be applied for the malarial infection diagnosis. It briefly explained the mechanism and working of the microscopy and highlighted the drawbacks. Likewise, it has also briefed the reader about the various types of stains being applied to the different types of microscopy including fluorochrome staining procedure but stating the drawbacks along. The paper has also mentioned the recent advancements in the approach of using smartphones for diagnosis of malaria, mentioning several papers along with their applications. In conclusion, the paper gives an overview of the current advancements and help the readers understand the applications of machine learning, deep learning as well as smart phones as potential approaches for the detection of the infection.

## III. METHODOLOGY

Five major factors were kept in mind while designing the application. They are as follow: -

1) *Modularity:* The algorithm, is design in a such a manner that it can do multiple tasks. i.e., is able to detect different types of infection or disease depending upon the user need.
2) *Cost to the Consumer:* The average cost ranges from 60 rupees to 360 rupees depending upon the type of the test as well as on the region where the test is carried. In cities the cost is relatable low as compared to the rural areas. So, the process of testing must be economically feasible to everyone.
3) *Reusability:* There are already rapid testing kits available in the market which costs around 36 rupees per test and is very compact and mobile. The only drawback of such kit is it creates plastic waste and also can be used only for a single test. This problem can be solved using digitization of the entire process of testing using this algorithm.
4) *Easy Interface:* It is very important to have a user-friendly interface to have a handy, reliable, mobile and easily accessible tool for the detection. The algorithm developed doesn't need any kind of special specialization when it comes to operator.
5) *Compact and Mobile:* The process of testing must be compact and mobile so that it can be easily carried to different places. Digitization of the entire process of testing enable us to carry the testing procedure anywhere any time.

### *A. System Overview*

A Smartphone (Small camera-equipped computing devices) is attached to a magnifying device which allows the true optical magnification of the sample to detect the parasite automatically, using image detection and machine learning. Android phones are relatively cheap and most of the people already possess one.

In the Image acquisition step, a multi-scale Laplacian of Gaussian filter is applied. As we don't have much to detect from the colour of the image acquired, it is then converted into a Gray scale image. In order to improve the quality of the image and to reduce the variations in the images, it was important to remove the noise, improve the contrast, illumination and staining. To remove the noise Gaussian Blur filter is used.

Due to the image being in Gray scale it normalizes the image illumination.

The white blood cells being a larger in shape as compared to the red blood cells make their segregation much easier. But we intend to identify the white blood cells and not to process or classify it further.

The detection of the parasite is important than the segregation of the blood cell. Therefore, the image is passed through Otsu threshold in combination with morphological operations followed by edge detection in order to detect the red blood cells and so the parasite.

The parasites being stained, colour features are most prominent and can be used for the detection. The idea is simple, in case of an infected cells, these features appears to be in ring like structures with visible cytoplasm and unique parasite characteristics. The image is passed to contour detection filter of feature extraction which can detects such structures.

A non-infected human cell should have only one contour i.e. no infection in the cell on the other hand if the cell is infected it will develop some pigmentation inside the human cell and hence resulting in formation of contour more than one.

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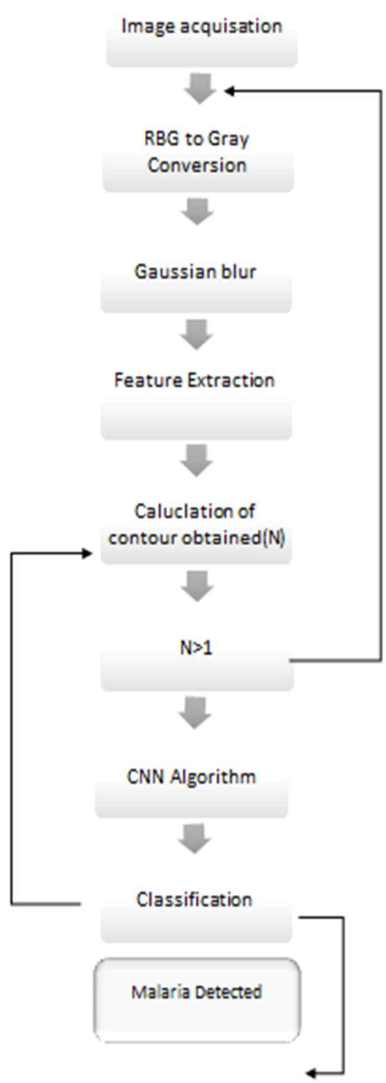


Using this principle, based on the no of contour formed the image is segregated, if the number of contours is 1, it flags the cell un infected. And if the no. of contour is more than 1 then it passes the image through an CNN Algorithm which predicts whether the cell is infected by malaria or not.

## IV. ALGORITHM IMPLEMENTATION

Processes in Algorithm implementation: -

### *A. Image Acquisition*

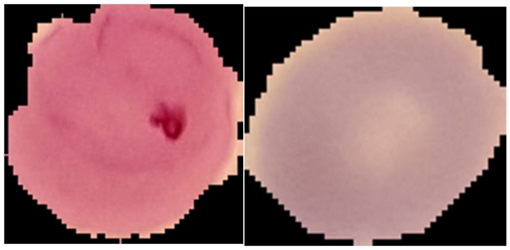

Fig 1. Image Acquisition

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*B. RBG to Gray Conversion*

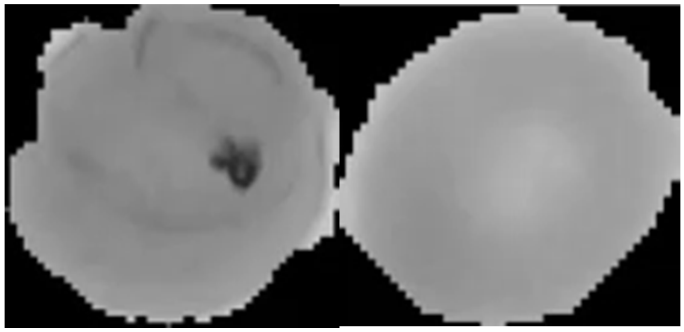

Fig 2. RGB to Gray

*C. Gaussian blur*

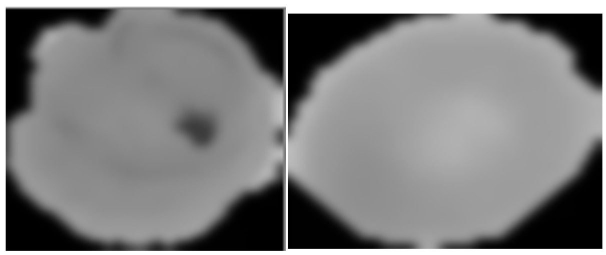

Fig 3. Gaussian blurred image

*D. Edge detection*

Fig 4. Edge Detection

*E. Thresholding*

Fig 5. Threshold picture

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### F. *Feature Extraction*

Fig 6. Feature extracted image

### G. *Contour Detection*

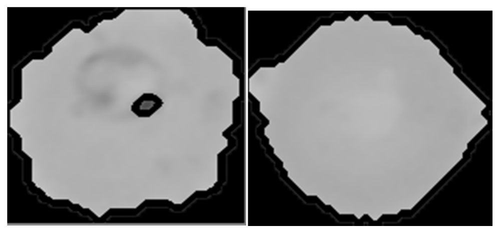

Fig 8. Contour Detection

### H. *CNN Algorithm*

Classification

## V. RESULTS

The co-efficient of performance of the employed algorithm method, was evaluated based on the following parameters:

### A. *Sensitivity*

$$\delta_s = \frac{100\, t^p}{t^p + f^p}$$

$where,$ $t^p$= true positive
$F^p$= false positive

$$\delta_s = \frac{64}{64 + 5} * 100$$

$$\delta_s = 96.96\%$$

### B. *Specificity*

$$\delta_p = \frac{100\, t^n}{t^n + f^n}$$

Where,
$T^n$= true negative
$F^n$= false negative

$$\delta_p = \frac{384 \times 100}{384 + 2}$$

$$\delta_p = 99.65\%$$

### *C. Accuracy*

$$A = \frac{100(t^p + t^n)}{t^p + f^p + t^n + f^n}$$

$$A = \frac{100(64 + 384)}{64 + 5 + 384 + 2}$$

$$A = 98.46\%$$

It is clear that from the performance evaluation, the accuracy is 98.46 %, which means that the artificial neural network gives more accurate result for the data used in this study

## VI. CONCLUSION

The paper revolves around the novel approach of automated system for the malaria diagnosis and states the advantages of the state-of-the-art technique. The experiment conducted by the system resulted in 98.46% accuracy with a specificity of 99.65% and sensitivity of 96.96%. The system outperforms the traditional method of microscopy for detection in many ways and can be seen as a promising approach for a regular diagnosis practice worldwide. The acceptance of this method makes the diagnosis of the malarial infection as cost efficient, viable and also help reduce the usage of plastics for the RDTs hence making it environment friendly. The future of the application of the automated systems for diagnosis can be considered as an overall solution for a better efficiency and consistency.

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## BIOGRAPHIES

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