# Malaria Diagnosis Using Image Processing

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***Abstract:***

The parasite of the Plasmodium genus that causes malaria is fatal and spreads to people through the bite of female Anopheles mosquitoes.As the disease is life-threatening, the process of detection should be more time efficient and accurate. Conventional methods include a stained blood sample placed on a slide and observed under a microscope, a great amount of concentration and experience is required. A veteran technician with great knowledge is essential. The detection and diagnosis of malaria depend on the knowledge and experience of the technician. Automation in the field of medicine will boost the speed of diagnosis and detection resulting in less time consumption with accurate results. This paper aims to build an image processing for the early detection of malaria using microscopic blood smear images.

**Keywords:** Malaria, Lethal, Detection, Blood Smear, Image Processing
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## Introduction

Malaria is a lethal disease brought on by a parasite of the Plasmodium genus that is transmitted to people through the bite of female Anopheles mosquitoes.The disease is life-threatening but curable; early detection holds the key. Globally, there are anticipated to be 241 million cases of malaria and 627,000 malaria-related deaths in 2020, according to the WHO's most recent World Malaria Report. In 2020, there were 69,000 more fatalities and approximately 14 million more cases compared to 2019. The African continent is the most affected region. The parasites mature and reproduce in unhygienic environmental conditions like dirty water and poor economic conditions. Blood smears examined under a microscope are one of the traditional ways to find malaria.The process is tedious, time-consuming, and expensive. Lack of experience can be fatal and the method also is prone to human errors. To make the processing time efficient and cost-efficient automation is recommended. We aim to incorporate a system capable of detecting malaria and classifying the cells into two categories as infected and uninfected cells. Henceforth, reducing the screening time and increasing consistency. The research looks into the use of image processing to detect malaria parasites using microscopic images.

## Related Work

Several studies have been done for malaria diagnosis using image processing and machine learning. Few papers are reviewed in this paper.

In this paper [1], the authors have presented a technique to detect the parasite using image processing with an enhanced segmentation algorithm and Support Vector Machine classifier (SVM), and also developed a graphical user interface to facilitate the use of the system.The authors proposed a system to detect parasites with the help of a threshold selection technique, future extraction, and a two-stage tree-based selection classifier. The tree classifier is used to classify the parasite type if the parasite is detected.

In [2], the authors proposed a system to detect parasites with the help of a threshold selection technique, future extraction, and a two-stage tree-based selection classifier. The tree classifier is used to classify the parasite type if the parasite is detected.

This study proposes the watershed algorithm along with an image enhancement process for the extraction of important information in detail. A two-phase future extraction process is used, the phases are (1) the Training phase and (2) the Recognition phase. The recognition phase helps in recognizing the malaria parasite [3].

Furthermore, C. D. Ruberto, designed an updated algorithm [4]that makes use of hemispherical disk-shaped structural elements to enhance the roundness and the compactness of the red blood cells, increasing accuracy. Two different classifying methods were introduced, one based on morphological operations and the other based on colored histogram similarities. The efficiency of the segmentation algorithm reduces with the degree of clustering of erythrocytes. Similarly, the color histogram similarity for parasite classification will also perform differently depending on the imaging settings and lighting conditions used to obtain the image being examined. It is considered that the claimed detection accuracy for parasitemia is low, at just about 50%.



In this work,the authors have developed a device for the early diagnosis of malaria [5]. The device named Gazelle uses hemozoin as a biomarker. Hemozoin is a by-product of Haemoglobin. The device detects the presence of hemozoin in blood samples with the help of a magneto-optical malaria detection technique. The device works on the magneto-optical principle, under the influence of strong (~.55T) and weak magnetic fields, a beam of polarised light is transmitted through the lysed diluted blood sample. The alignment of the hemozoin crystals, which prevents light from passing through when the magnetic field is applied, is proportional to the amount of hemozoin present in the sample. The presence of any hemozoin indicates malaria. The presence or absence of malaria is displayed on the reader (device) within one minute. Due to the fact that all five malaria parasite species make hemozoin, this test can identify them all.

[6] Faster Region-based Convolution Neural Network is a machine learning model that the authors have presented (Faster R-CNN). The model is adjusted with data and contrasted with the starting point. The author’s proposed Morphology analysis [7] is used to examine the malaria blood pictures. In addition to employing regional maxima to find parasite nuclei, the approach employs color and size inflammation to automatically identify parasites. [8], [9] Paper presents an enhanced technique for Malaria Parasite Detection, where the cell segmentation process consists of various steps such as image binarization using Poisson’s distribution-based Minimum Error Thresholding, followed by Morphological Opening for refinement. Seed point localization is done by a multiscale LoG filter.

[11], [12] The authors discussed various segmentation methods in the paper. In this study [13], a model for diagnosing malaria, the technique makes use of the intensity characteristics of erythrocytes and Plasmodium parasites and significant features were extracted from images; ultimately, a diagnosis was performed using the features derived from the images. An artificial neural network (ANN) classifier was used to test the performance of a set of intensity-based characteristics on samples of red blood cells from the newly constructed database. The authors of

this paper [14], mainly focused on the best and most accurate technique Rapid test technique and compared the result with several malaria detecting techniques practiced in the world. [15] The authors evaluated a novel method named rotating-crystal magneto-optical detection (RMOD). When it comes to detecting Plasmodium vivax, RMOD has an 87% sensitivity rate and an 88% specificity rate. It also has an 82% sensitivity rate for detecting any type of malaria infection.

## I. Methodology

### A. Database Attainment

The dataset of blood smear images was obtained from the “Broad Bioimage Benchmark Collection” Annotated biological image sets for testing and validation. The images were contributed by Jane Hung of MIT and the Broad Institute, Cambridge, MA.

### B. System Framework

The proposed architecture concentrates on detecting infected malaria RBC cells. Figure 1 shows the framework of the produced algorithm.

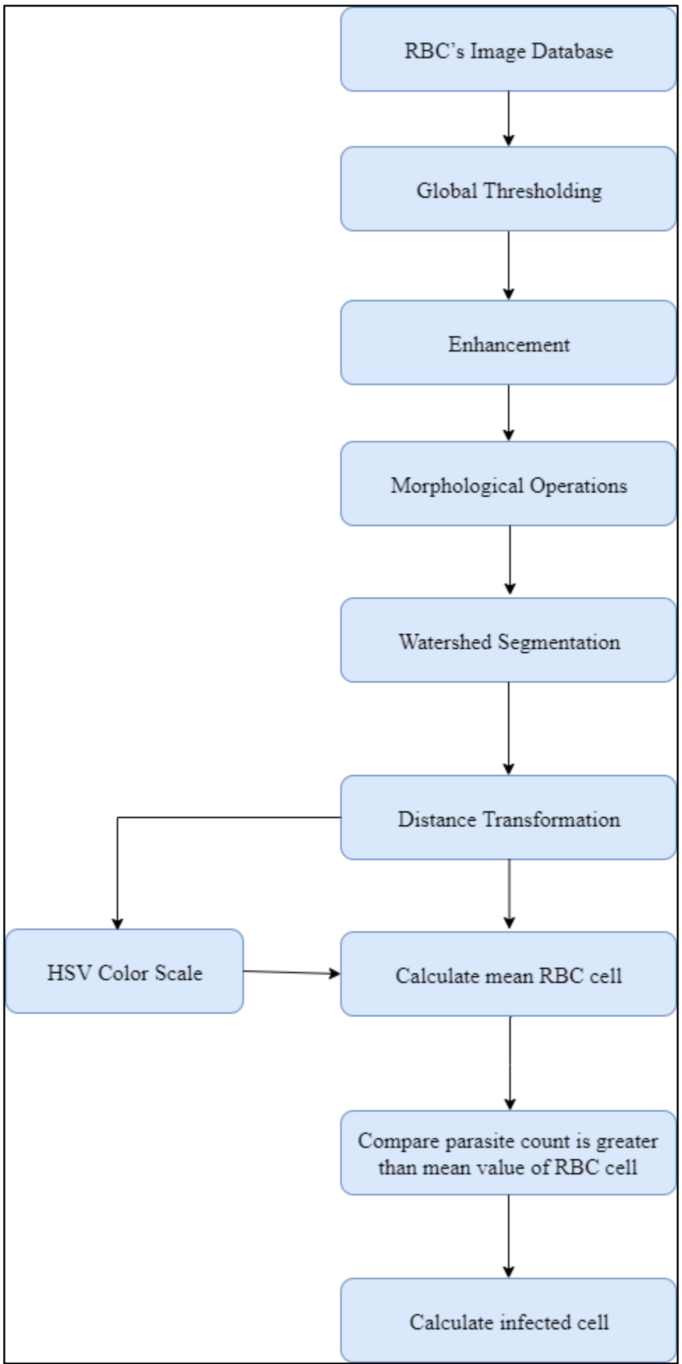


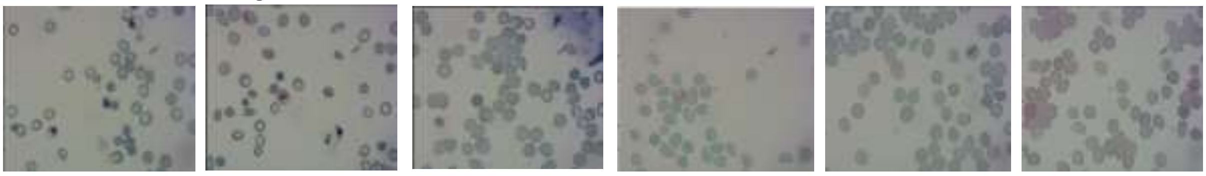
Fig 1. System framework flow chart

*1. RBCs Image Database*

The acquired image has both infected RBCs and uninfected RBCs. Further, the image is tested for malaria parasite. We have tested some images and random 6 test images (Input images) have been attachedto this paper.

Fig 2. Input images of Blood Smears

*2. Global Thresholding*



The global thresholding has been incurred to make use of a single threshold value. With the help of Global Thresholding, we can extract the ROI from the object from the image as every image provided will have the same threshold value. It also creates the binary image from a grey-level image by tuning all pixels below some threshold value (T) to zero, and all pixels with a Threshold value greater than providing value to one.

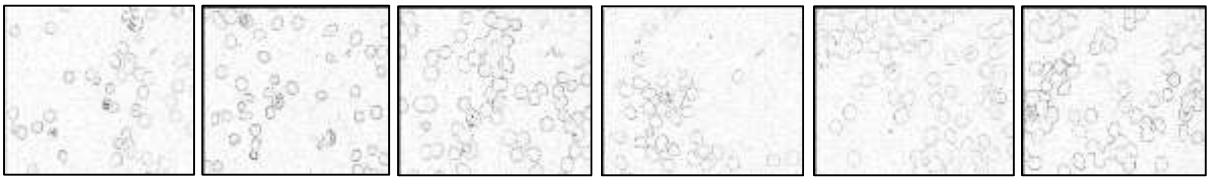


Fig 3. Threshold grey-scale image



*4. Enhancement*

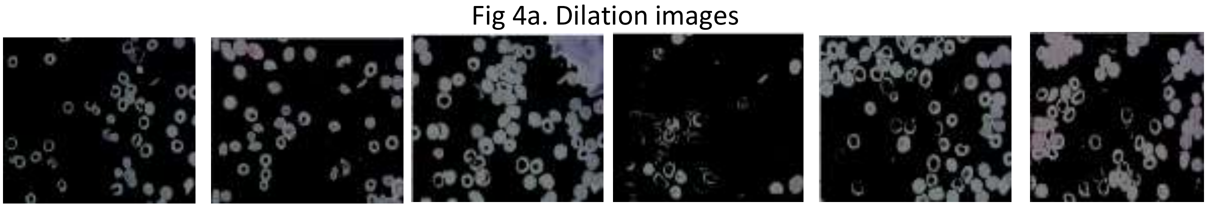
Image enhancement is carried out on the threshold image to extract more important features from the original image. The technique aims to process digital images in a way more information can be extracted and unnecessary information has been removed resulting in an easier-to-interpret image. In this paper, the enhancement is used to extract the information of our region of interest (ROI) i.e., the infected cell. This process will help process the image by enhancing its contrast and other features.

*5. Morphological Operations*

Digital images are processed depending on their shapes using a variety of image processing techniques known as morphological operations. Each image pixel in a morphological process corresponds to the value of another pixel in its neighborhood. The two fundamental morphological operators are Dilation and Erosion. According to the expected result, the dilation or erosion is performed. This results in reducing the noise present in the image. Reduction of noise helps in detecting the objects. In this paper, the operators are used to make the shape of the cell more visible by filling and eroding respectively. the outer and inner holesfor identification of the cells. By doing so we also reduce the noise present in the image resulting in easy information extraction from the image Fig 4a and Fig 4b represent diluted and eroded images respectively.

**Dilation**

Fig 4a. Dilation images



**Erosion**

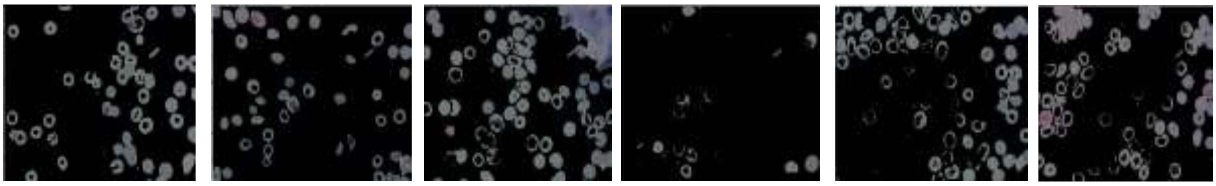
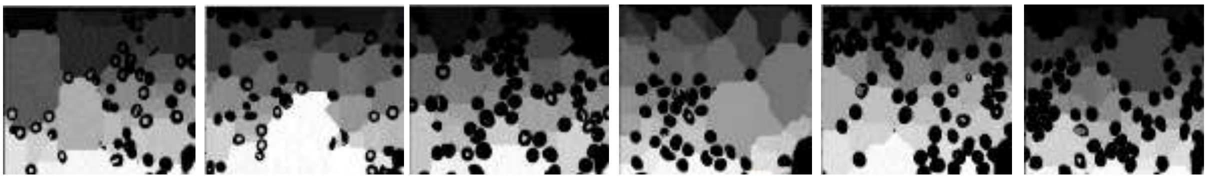


Fig 4b. Erosion images

*6. Watershed Segmentation*

The watershed algorithm is based on extracting sure background and foreground, which are then used as markers to enable the watershed to run and discover the precise boundaries.In this paper, we have used the watershed technique to separate overlapped RBCs. Separating overlapped RBCs will help ease the counting of the infected cells Fig 5.

Fig 5. Segmentation images



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*7. Distance Transformation*

The distance transform offers a metric or measure of how far apart the points in the image are from one another. Higher values are returned for pixels that are further away from the boundary. In this case, we are referring to distance in terms of Euclidean distance. The distance between two pixels in a straight line is referred to as the Euclidean distance. We ensure that there are no overlapping items in the image by using the distance transformation to map the distance between the pixels.Figure6a represents how the euclidean matrix works and figure 6b shows distance images of input blood smear.

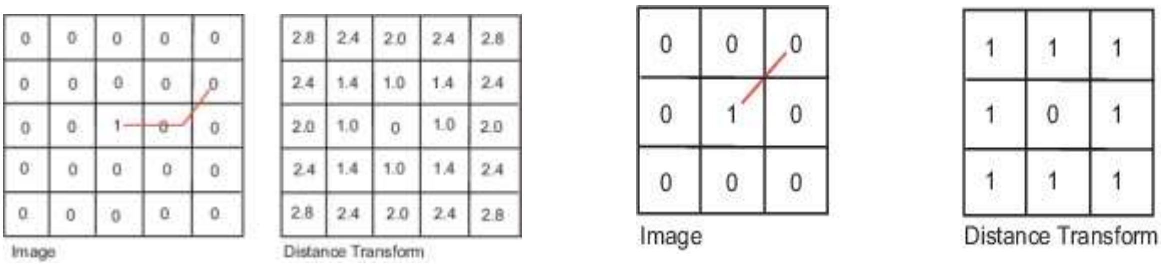


Fig 6a. Distance transformation Euclidean matrix

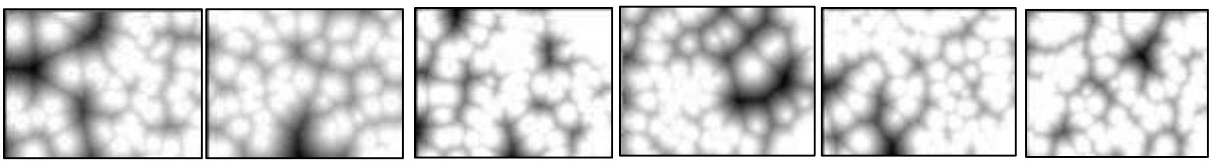

Fig 6b. Distance transformed images

*8. HSV Color Scale*

The HSV (Hue Saturation Value) scale provides a numerical readout of the image. HSV color scale is used because it makes it easier to differentiate infected RBCs from normal RBCs. In figure 6the normal cells aresky blue whereas the infected cells can be with a change in color i.e., the combination of pink and purple making easier to spot the cells and classify them.

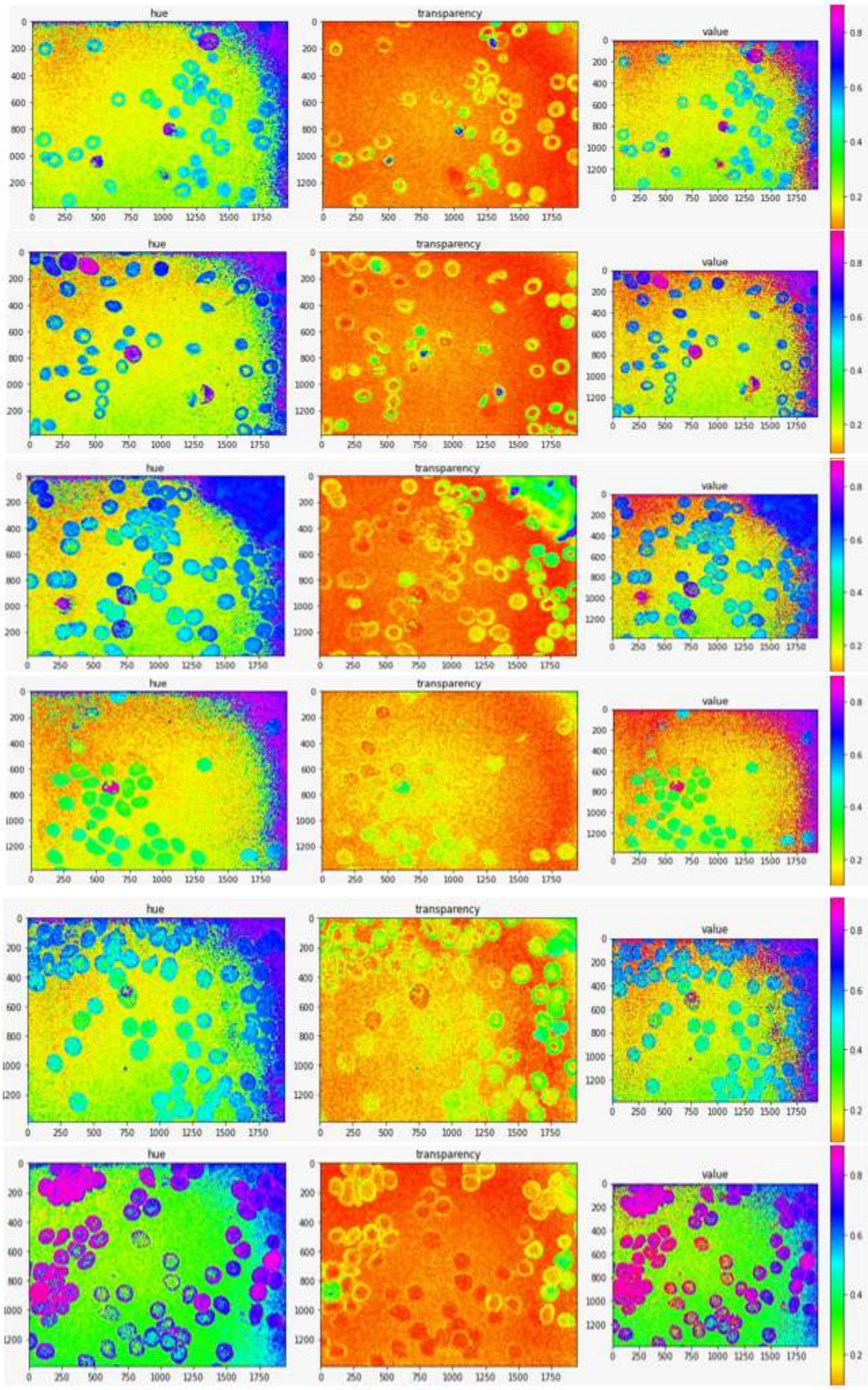


Fig 7. Hue Saturation Value image of input Blood Smear



9. *Cell Count*

The mean perimeter of RBC and perimeter of the parasite are calculated. The perimeter of the parasite is compared with the mean perimeter of RBC if the parasite perimeter is greater mean RBC perimeter indicatesthe presence of malaria and the cells are counted in figure 8.

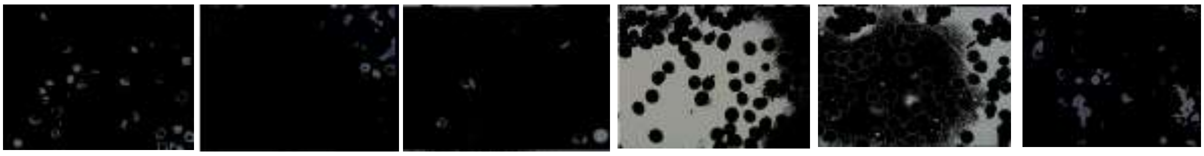

Fig 8. Infected cell count

**Conclusion**

In order to identify malaria, automate malaria detection, and quantify malaria infection, we have offered a technique and developed an image processing algorithm. The test's images were selected at random, and the outcomes were reliable. HSV scale is also used to study and recognize the presence of the infected cell. The algorithm recognizes the infectious parasite in the blood smear sample with accuracy.

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