Detection of Malarial Parasites in RBCs

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ABSTRACT

This project uses image analysis studies aiming at automated diagnosis or screening of malaria infection in microscope images of thin blood film smears. Malaria is a mosquito-borne infectious disease of humans and other animals caused by parasites (a type of microorganism) of the genus Plasmodium. Infection is initiated by a bite from an infected female mosquito, which introduces the parasites via its saliva into the circulatory system, and ultimately to the liver where they mature and reproduce. The disease causes symptoms that typically include fever and headache, which in severe cases can progress to coma or death. Malaria is widespread in tropical and subtropical regions in a broad band around the equator, including much of Sub-Saharan Africa, Asia, and the Americas

INTRODUCTION

Malaria is a mosquito borne disease caused by parasites of genus plasmodium. The person gets affected by malaria when malaria parasites are introduced into circulatory system by infected female anopheles mosquito bites. Approximately, 40% of the world's population, mostly those living in the world's poorest countries, is at risk of malaria. A child dies of malaria every 30 seconds. 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.

GOAL

The biggest detraction of microscopy, namely its dependence on the skill, experience and motivation of a human technician, is to be removed. The objective of the project is to 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.

Input: Digitalized malaria blood smear image

Output: The count of total RBC and parasites infected cells.

OVERVIEW

Loading the image is the first phase, later the image is being preprocessed to remove unwanted noise and brightness. Feature extraction and successive segmentation techniques are then applied on the image to focus on important parts of the image. Finally, Morphological operations are carried out to differentiate parasite cells from the RBC cells and their respective count is determined.

ALGORITHM AND SYSTEM ARCHITECTURE

The architectural steps and details for the proposed project are as follows:

1.) Preprocessing

2.) Segmentation

3.) Morphology Operations

4.) Cell Counting

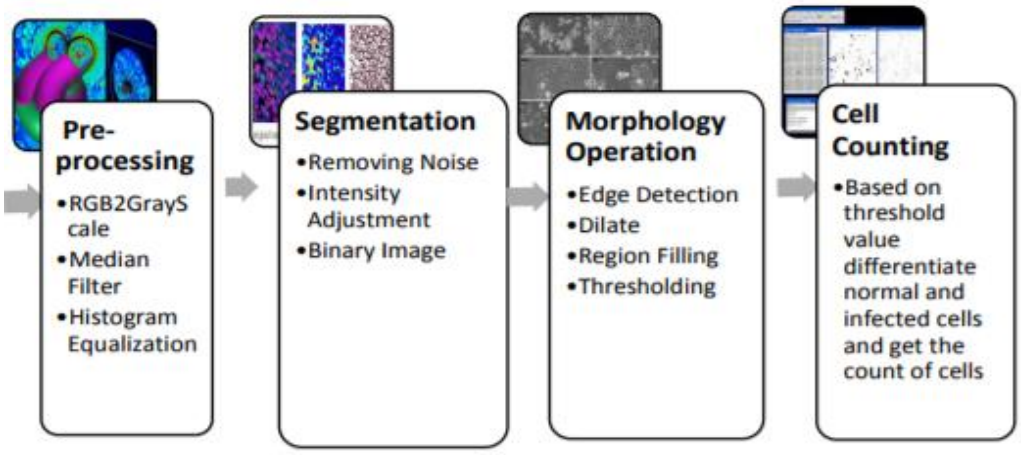
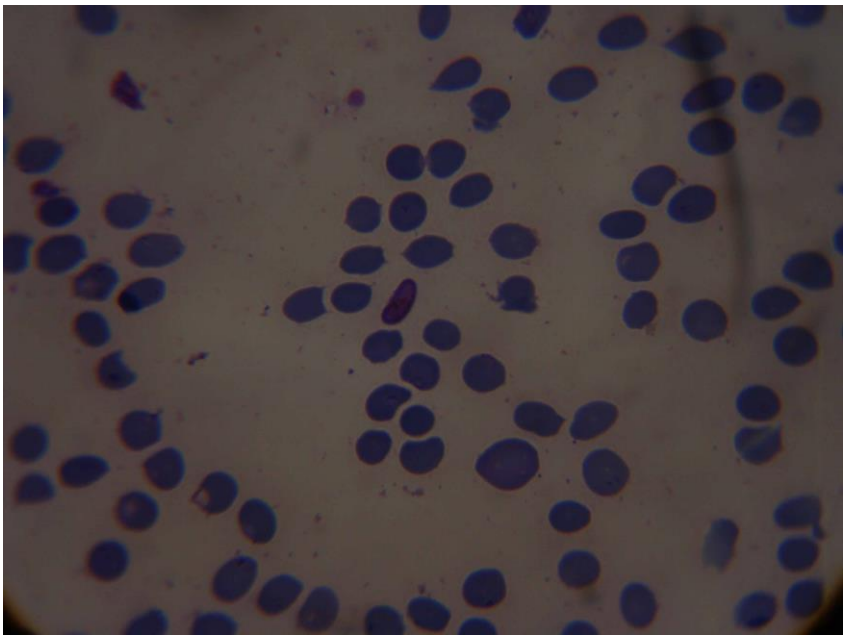


Figure1: System block architecture

SYSTEM RUN ON AN INSTANCE

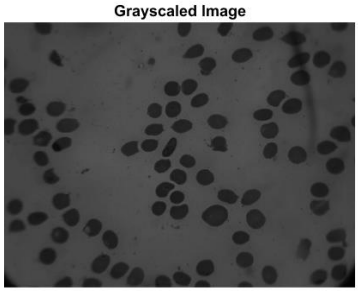
LOADING

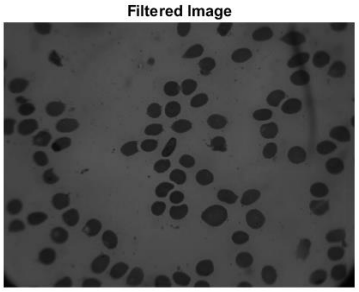
Microscope images of thin blood film smears are loaded in.

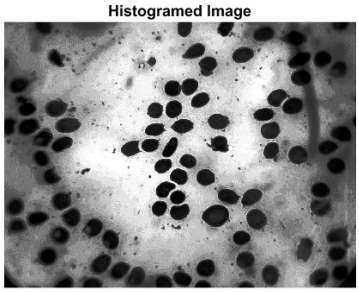


PRE-PROCESSING

Real-world images are highly susceptible to noisy, missing, and inconsistent data. The input image may have low brightness and contrast. Also, Low-quality data will lead to low-quality results. Hence it is essential to pre-process the data. There are a number of pre-processing techniques. In our project, we mainly aim at conversion to Grayscale, median filter and histogram equalization.



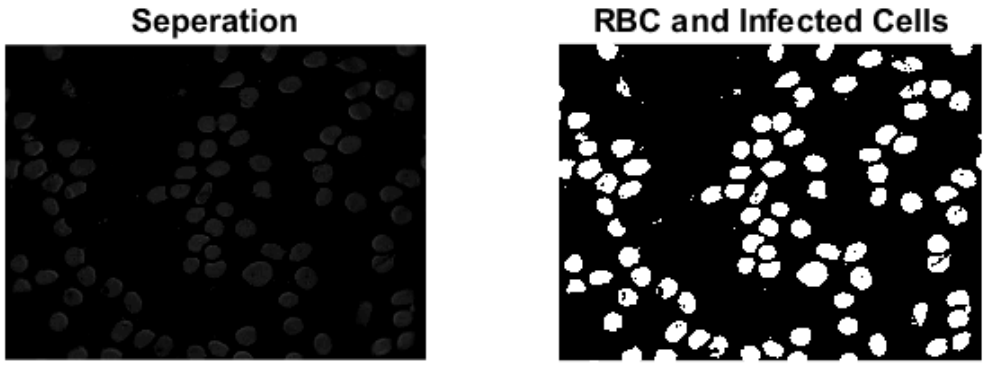




SEGMENTATION

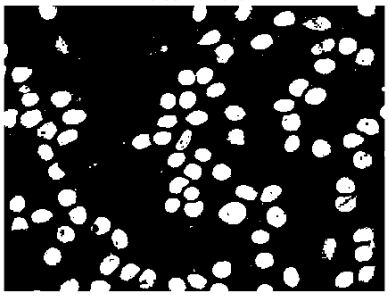
Segmentation divides the image into its constituent regions or objects. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries in images. In our project, we first extract the RBC and the infected cells by using the blue plane thresholding. Then we remove noise, adjust intensity of the image, perform gray threshold and convert the image to binary form.

STEP1 – Separation of blue plane and the RBC and Infected cells extraction.

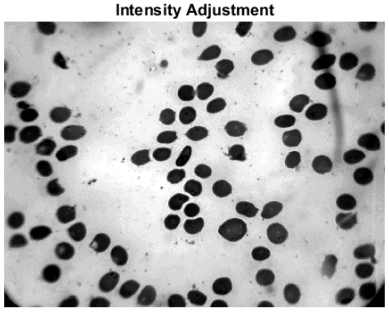


STEP2 - Removal of noise, intensity adjustment of the image, perform gray threshold and convert the image to binary form

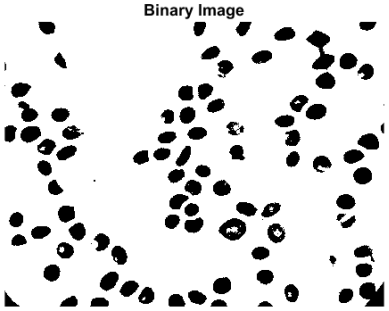
Noise Removal



Intensity Adjustment

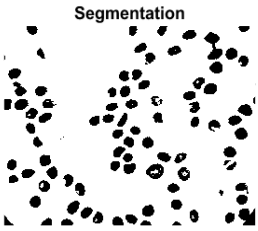


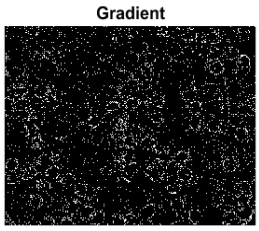
Binary Image

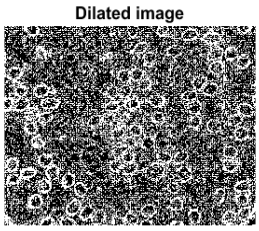


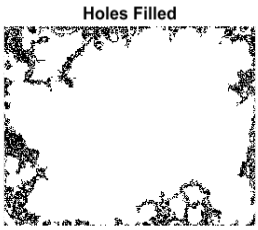
MORPHOLOGICAL OPERATIONS

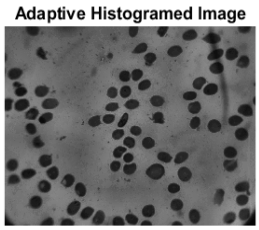
Morphological operations are image processing operations which processes images based on shapes. It applies a structuring element of specific shape and size on input image. The output image is created by comparing the value of each pixel with its neighbours. These operations are sensitive to the shape of the structuring. Further operations such as holes filling, overlaying is carried out which helps in detection of infected cells.

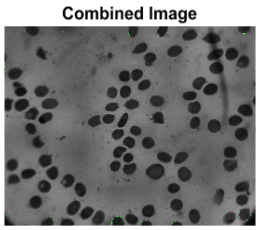


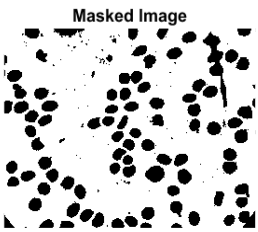






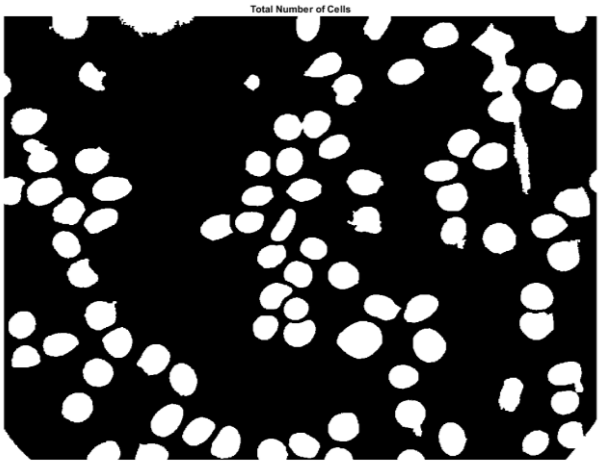






CELL COUNTING

By taking the complement of the masked image formed in the morphological process, we now can label each individual connected component of image which are in fact our total RBCs. By comparing the overlay of original image and masked image and based on the intensity profile, differentiation between the normal and infected cells is carried out.



OBSERVATIONS AND CONCLUSIONS

The experiment was conducted by collecting blood samples of patients suffering from malaria. The 10 images were used as raw data for malaria parasite count.

The dosage prescribed to the patient is directly proportional to the ratio of the RBC that contains the malarial parasite to the total number of the counted RBCs.

Image No	Manual RBC Count	Image Processing Approach RBC Count	Manual count of malaria parasite	Image Processing approach count of malaria parasite	Difference in algorithmic count and manual count (abs ratio difference)
DSC04019.JPG	85	88	2	2	0.000802
DSC04015.JPG	123	115	4	4	0.002260
DSC01517.JPG	103	98	5	5	0.002470
DSC04034.JPG	62	76	7	9	0.005517
DSC01521.JPG	91	85	4	3	0.008660
DSC04054.JPG	91	100	12	17	0.038131
DSC04043.JPG	90	88	11	15	0.048232
DSC01541.JPG	75	59	7	10	0.076150
DSC01543.JPG	69	64	17	22	0.097375
DSC01545.JPG	58	54	9	13	0.085568
AVERAGE ABSOLUTE RATIO DIFFERENCE					0.0365165

Hence the average % dosage error = 0.0365165*100 = 3.65165 which is a pretty decent value.

Justification of error: According to article the dosage for patients suffering malaria is "Primaquine phosphate: 52.6 mg po qd x 14 days = 736.4mg". If overdose occurs due to the treatment by image processing algorithm, it will be 3.6% of 736.4mg = 26.87. Now the dosage is per day is 736.4+26.87/14 = 54.519mg which is still in safety limits, which is 56mg.

After implementation of the proposed approach for the available image database, it is found that the parasites count is near about matching with the manual count while in the RBCs count, some more differences are observed.

FUTURE SCOPES

1. Support Vector Machine (SVM) techniques can be used to analyze and classify the parasite species.

1. The system which is at present developed using MATLAB software can further be implemented in android platform.

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