DETECTION OF MALARIA PARASITE IN BLOOD USING IMAGE PROCESSING

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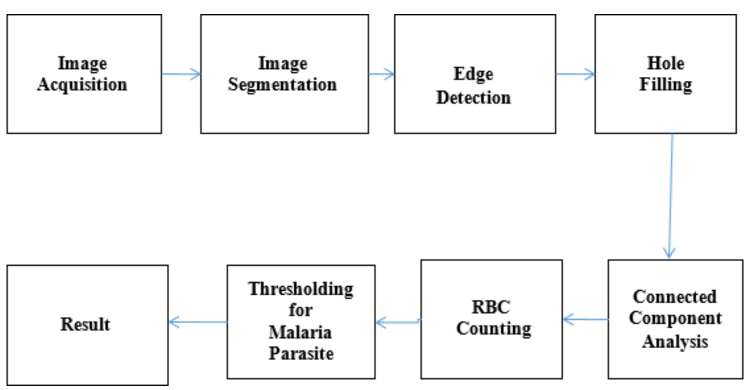
SYNOPSIS

Malaria is a fatal parasitic disease found all around the world particularly in tropical and subtropical countries. The parasite undergoes a complex life cycle inside the human body, using the red blood cells (RBCs) as hosts. The infections of malaria are diagnosed manually by pathologists who observe the microscopic images of strained blood files on glass slides and count the infected blood cells. If sample size of patient is large, there is always a chance to detect inaccurately. There is human error possibility, hence computer based classification using digital image processing techniques gives better results than the manual diagnoses of Malaria. 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 processing system to positively identify malaria parasites present in thin blood smears. The algorithm generated will be helpful in the area where the expert in microscopic analysis may not be available. Input is Digitalized malaria blood smear image and Output is count of total RBC and parasites infected cells. We are using MATLAB for processing the blood smear sample. The steps are as follows: Preprocessing, Extraction, Segmentation, Morphology Operations, and Cell Counting. This approach once digitized will reduce the time taken for screening the disease. This will improve the consistency in diagnosis. This study investigates the use and application of digital image processing for detecting malaria parasites using microscopic color images. An efficient method is proposed for parasite detection based on intensity and texture features. Parasite detection is the fundamental function of this semi-automated diagnosis.



18BCE0586

WHAT YOU OR YOUR GROUP HAS DONE IN REVIEW 0 (FIRST)?

Firstly we tried to find out a suitable topic of our interest. After the topic (Use of image processing in medical field) was decided we read many research papers and thus finalized what we were going to do. In Review 0, we formed a team with good understanding, decided the topic, told about the base paper from which we got the idea, drafted our problem statement, thought about how we are going to proceed, and finally decide which platform or tool we are going to use.

WHAT YOU OR YOUR GROUP HAS DONE IN REVIEW 1 (SECOND)?

Now we had a better understanding of the topic and knew what we were doing. We started the coding part as well using matlab. Thus in review 1, we gave detailed introduction, synopsis containing background and objective of our problem. After this we gave a complete explanation of our methodology (proposed method) including each and every steps that we are going to do such as preprocessing, image segmentation, etc. with the help of system architecture diagrams and block diagrams. Now after our method was well understood we showed what results we were expecting after completion of the system. This image would even be helpful for validating our work. Lastly we ended by giving conclusion which included all the things we achieved in the project, uses of this project and the things that we could do in future to improve this project.

REVIEW 3 (LAST)

1. INTRODUCTION

Malaria is a very serious infectious disease caused by a peripheral blood parasite of the genus Plasmodium and is transmitted through the bite of a female Anopheles mosquito. Inside the human body, the parasite undergoes a complex life cycle in which it grows and reproduces. During this process, the red blood cells (RBCs) are used as hosts and are destroyed afterwards. Hence, the ratio of parasite-infected cells to the total number of red blood cells called parasitaemia can be used as a measure of infection severity and is an important determinant in selecting the appropriate treatment and drug dose. Malaria is a serious global disease and a leading cause of morbidity and mortality in tropical and sub-tropical countries. According to the World Health Organization statistics, in 2000, it was estimated that there were 262 million cases of malaria globally, leading to 839.000 deaths. By the year 2015, it was estimated that the number of malaria cases had decreased to 214 million, and the number of deaths decreased to 438.000. Majority of these deaths are children from Sub-Saharan Africa. This is due to the fact that, the environmental conditions are suitable for mosquitoes, in addition to the poor socio-economic conditions which make access to health care and disease prevention resources difficult. 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. As mentioned, this manual approach of diagnosis is time consuming and may lead to inconsistency. Thus, this demand trained and experienced technicians or pathologists. This approach once digitized will reduce the time taken for screening the disease. This will improve the consistency in diagnosis. This study investigates the use and application of digital image processing for detecting malaria parasites using microscopic color images. An efficient method is proposed for parasite detection based on intensity and texture features. Parasite detection is the fundamental function of this semi-automated diagnosis.

2. LITERATURE SURVEY

Reference	Methods Used	Evaluation	Merits and Demerits
1) Detection of Malaria Parasites Using Digital Image Processing by Ahmedelmubarak Bashir, Zeinab A.Mustafa, Islah Abdelhameid, Rimaz Ibrahem	Artificial neural network (ANN)	This method would be helpful for an educated person but might be hard for students.	Less time consuming, improves consistency in diagnosis. Need good technical knowledge to implement.

2) Recent Advances of Malaria Parasites Detection Systems Based on Mathematical Morphology by Andrea Loddo, Cecilia Di Ruberto and Michel Kocher. D Ruberto	Automatic thresholding and morphological operates, typical pipeline of a computer-aided image analysis process	Very effective but need a big time frame as it is time consuming	A Morphological approach to cell segmentation which is more effective was proposed. More time is consumed due to Microscopic activities
3) Detection of Malaria Parasites in giemsa blood sample using image processing by Kishor Roy, Shayla Sharmin, Rahma Bintey Mufiz Mukta, Anik Sen.	An unsupervised approach in which color and segmentation based algorithms are put together to formulate an algorithm for Plasmodium parasite detection from thin smear slide.	For images contains intensity of light at a standard and equal value, it gives best possible results.	Comparative higher predictability and lower false positive rate. Chances of false detection due to human error, false detection due to changes in light intensity

3. BACKGROUND OF YOUR PROJECT WORK

Malaria is a fatal parasitic disease found all around the world particularly in tropical and subtropical countries. The parasite undergoes a complex life cycle inside the human body, using the red blood cells (RBCs) as hosts. The infections of malaria are diagnosed manually by pathologists who observe the microscopic images of strained blood files on glass slides and count the infected blood cells. If sample size of patient is large, there is always a chance to detect inaccurately. There is human error possibility, hence computer based classification using digital image processing techniques gives better results than the manual diagnoses of Malaria.
In this project we are going to use the following image processing techniques: Image acquisition, pre-processing, segmentation, morphological operation, and cell counting.

4. Proposed Work

We are using MATLAB for image processing.
The steps are as follows:

1. *Image Acquisition*: Thin blood smear images will be acquired from the Centre for Disease Control (CDC) website. All Images Giemsa stained blood films captured using a binocular microscope mounted with a digital camera.

2. *Pre-Processing:* The pre-processing block is designed, to remove unwanted effects from the image and to adjust the image as necessary for further processing. The microscopic input image is converted from RGB to gray scale to reduce the processing time. RGB to gray conversion is done by averaging all the three components i.e. R, G and B which results in gray scale image. Filtering operation using a square median filter is performed to images. This operation served to remove spurious noise present in the images.

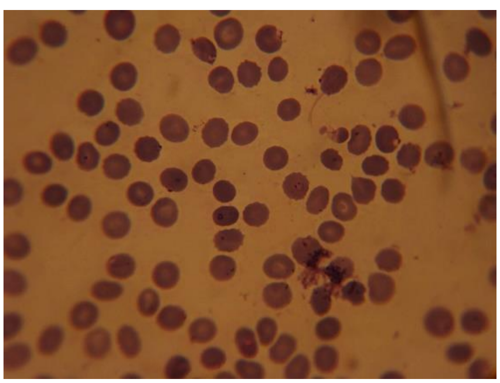
3. *Segmentation:* Segmentation divides the image into its constituent regions or objects. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries 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.

4. *Morphological Operation:* 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 neighbors. 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.

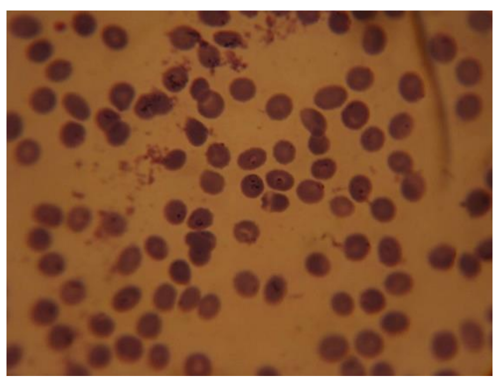
5. *Cell Counting:* By taking the complement of the masked image formed in the morphological process, we now can label each individual connected component of image which are in fact our total RBCs. By comparing the overlay of original image and masked image and based on the intensity profile, differentiation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

5. Evaluation and Results Analysis

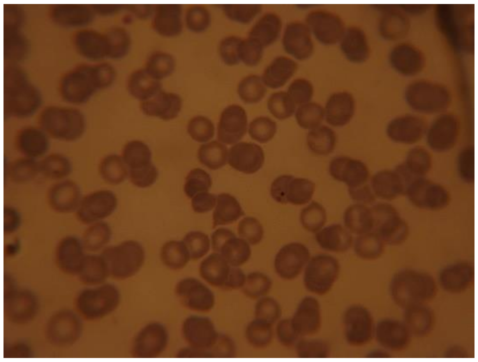
Blood Sample Images:



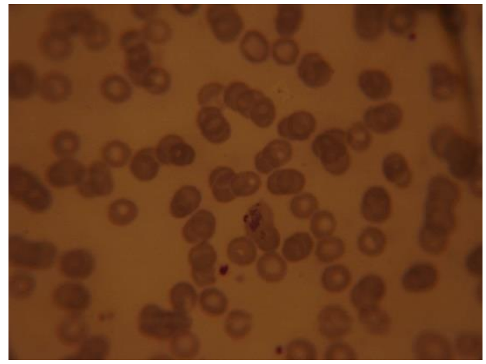
DSC01517



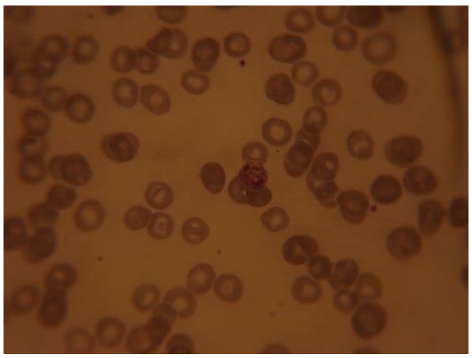
DSC01521



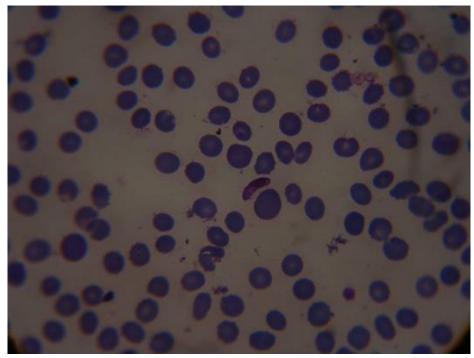
DSC01541



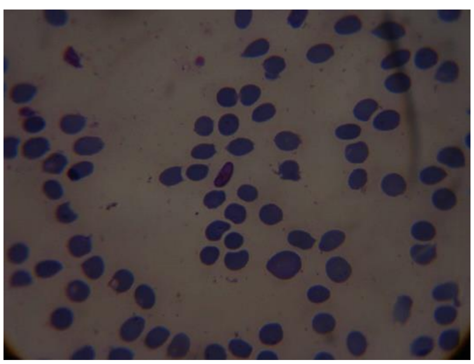
DSC01543



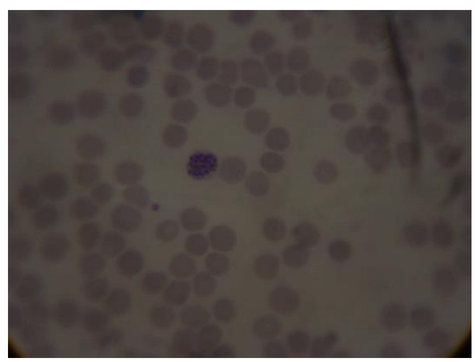
DSC01545



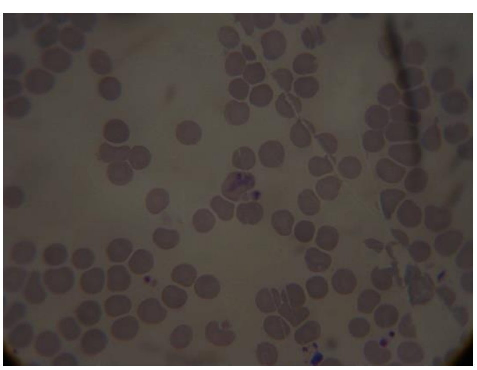
DSC04015



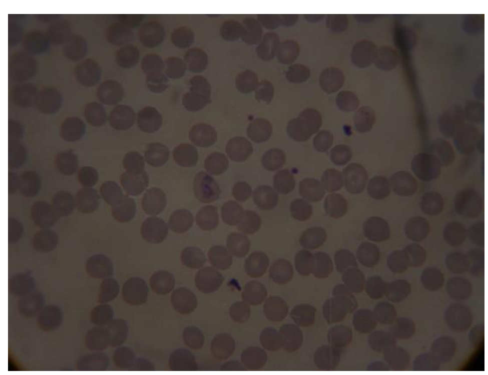
DSC04019



DSC04034

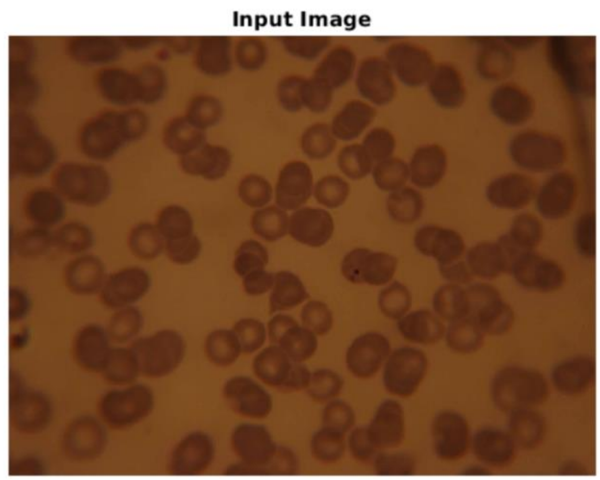


DSC04043

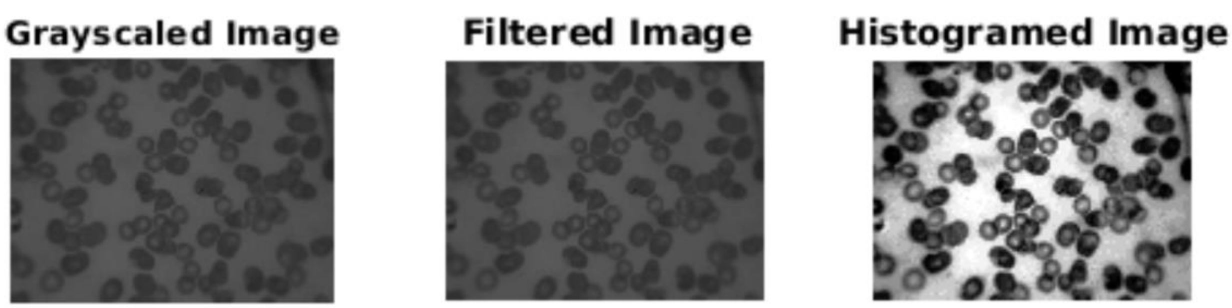


DSC04054

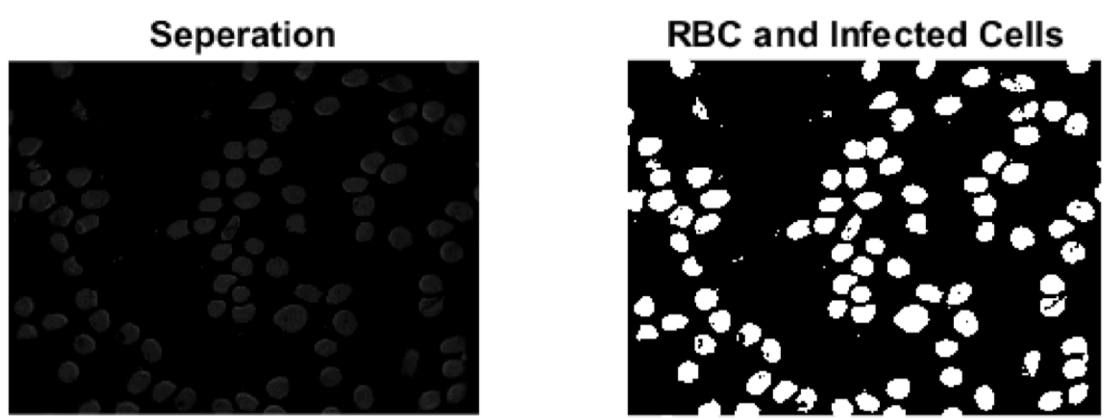
STEP 1: Take a sample image as input. (Here we took DSC01541)



STEP 2: After Pre-processing.

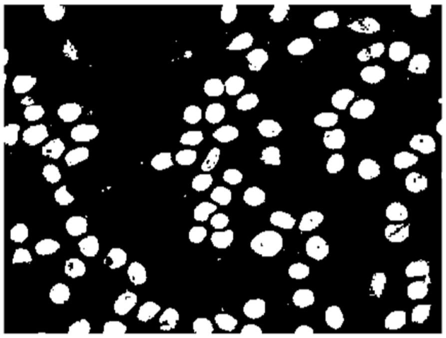


STEP 3: Seperating Out the Infected Cells. (Blue Plane)

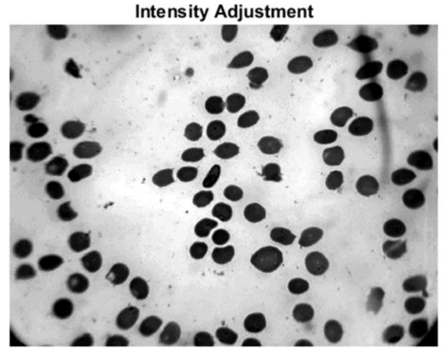


STEP 4: After Noise Removal.

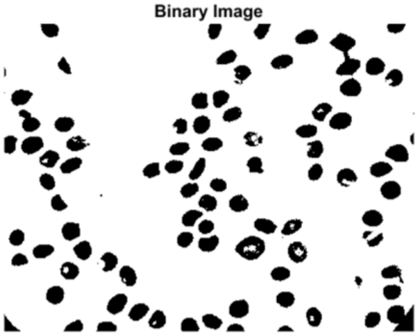
Noise Removal



Intensity Adjustment

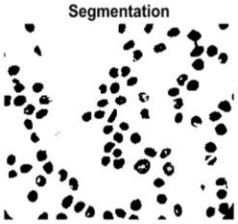


Binary Image

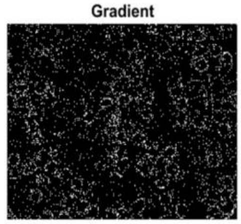


STEP 5: After Morphological Operations.

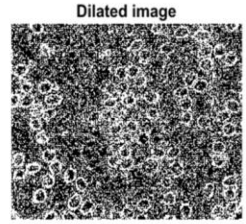
Segmentation



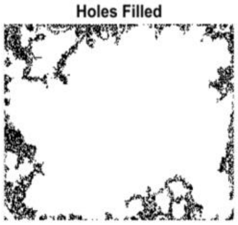
Gradient



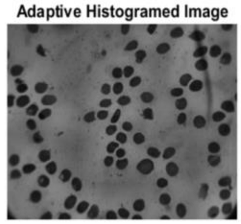
Dilated image



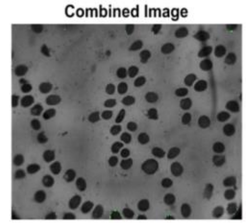
Holes Filled



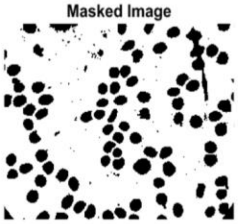
Adaptive Histogramed Image



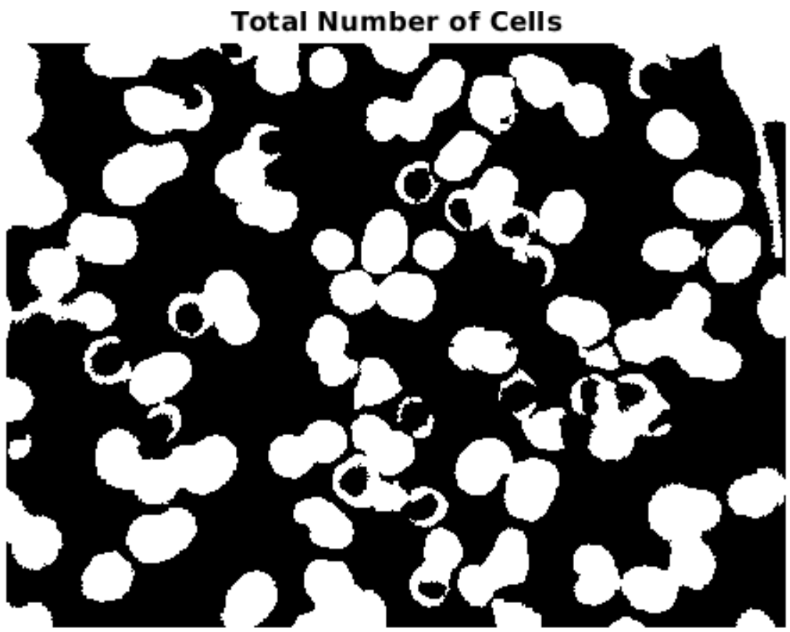
Combined Image



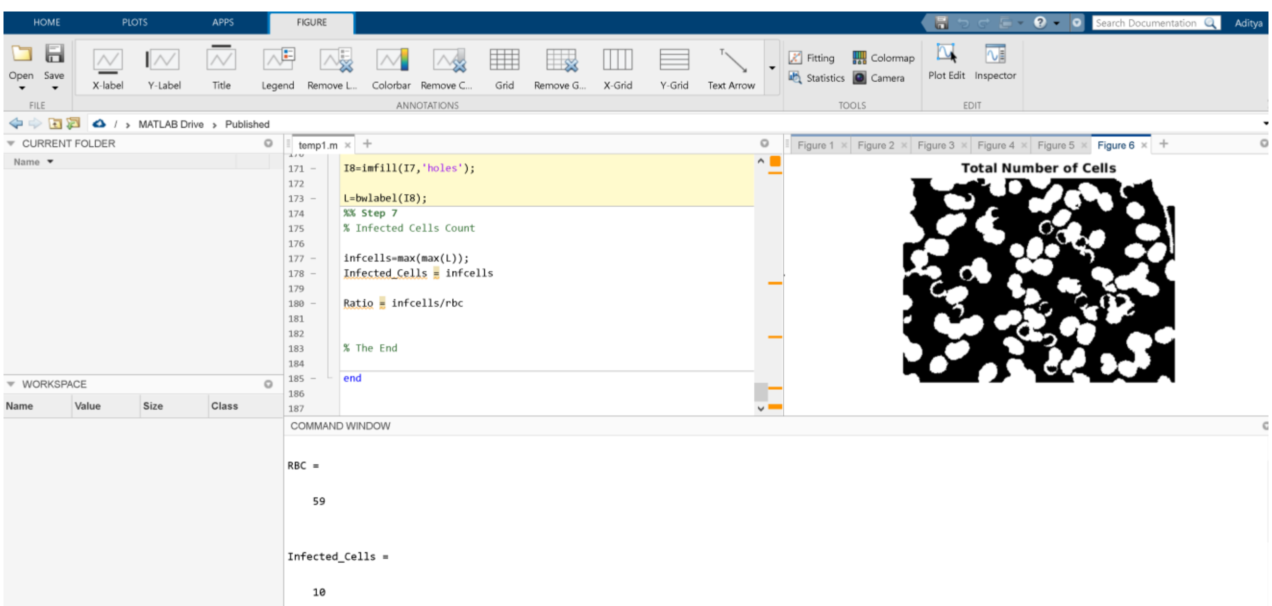
Masked Image



STEP 6: RBC Count.



STEP 7: Infected Cell count.



We can clearly see RBC Count and Infected cell count in the above figure. We can even calculate the ratio. 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.

Results from all samples:

Image No	Image Processing Approach RBC Count	Image Processing Approach count of malaria parasite
DSC04019.JPG	88	2
DSC04015.JPG	115	4
DSC01517.JPG	98	5
DSC04034.JPG	76	9
DSC01521.JPG	85	3
DSC04054.JPG	100	17
DSC04043.JPG	88	15
DSC01541.JPG(seen above)	**59**	**10**
DSC01543.JPG	64	22
DSC01545.JPG	54	13

6. Tabular Comparison with Existing Work

Image No	Manual RBC Count	Image Processing Approach RBC Count	Manual count of malaria parasite	Image Processing approach count of malaria parasite
DSC04019.JPG	85	88	2	2
DSC04015.JPG	123	115	4	4
DSC01517.JPG	103	98	5	5
DSC04034.JPG	62	76	7	9
DSC01521.JPG	91	85	4	3
DSC04054.JPG	91	100	12	17
DSC04043.JPG	90	88	11	15
DSC01541.JPG	75	59	7	10
DSC01543.JPG	69	64	17	22
DSC01545.JPG	58	54	9	13

We can clearly see from above that the counts that we get from image processing are much more accurate and are calculated much faster without any errors.

7. Conclusion

This project positively identify malaria parasites present in thin blood smears. It is cheaper than other malarial test kit. This system does not require any special technical skills. So, this can be used by the people of remote places with very basic level of education. It may reduce the probability of wrong treatment which happens due to non-availability of diagnosis systems in remote and economically backward areas. The system in a robust manner so that it is unaffected by the exceptional conditions. 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. Thus this project helps to determine which patient must be given which amount of medicine.

8. References

[1] Detection of Malaria Parasites Using Digital Image Processing
Authors: Ahmedelmubarak Bashir, Zeinab A.Mustafa, Islah Abdelhameid, Rimaz Ibrahem
Publisher Information: IEEE
Publication Year: 2017
Link: https://ieeexplore.ieee.org/abstract/document/7867644

[2] Recent Advances of Malaria Parasites Detection Systems Based on Mathematical Morphology
Authors: Andrea Loddo, Cecilia Di Ruberto and Michel Kocher. D Ruberto
Publisher Information: Multidisciplinary Digital Publishing Institute
Publication Year: Feb 2018
Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5856187/

[3] Detection of Malaria Parasites in giemsa blood sample using image processing
Authors: Kishor Roy, Shayla Sharmin, Rahma Bintey Mufiz Mukta, Anik Sen
Publisher Information: International Journal of Computer Science & Information Technology (IJCSIT)
Publication Year: Feb 2018
Link: http://aircconline.com/ijcsit/V10N1/10118ijcsit05.pdf

[4] Image Detection and Classification of Malaria in Thin
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Authors: Hassan Abdelrhman Mohammed, Iman Abuel Maaly Abdelrahman
Publisher Information: IEEE
Publication Year: 2017
Link: https://ieeexplore.ieee.org/abstract/document/7866700

[5] Machine aided malaria parasitemia detection in Giemsa-stained thin blood smears
Authors: Naveed Abbas, Tanzila Saba, Dzulkifli Mohamad, Amjad Rehman, Abdulaziz S. Almazyad & Jarallah Saleh Al-Ghamdi
Publisher Information: SpringerLink
Publication Year: July 2016
Link: https://link.springer.com/article/10.1007/s00521-016-2474-6

[6] Detection of Malarial Parasites in Blood using Image Processing
Authors: Neha C Poojari, Pallavi K, Prapthi P Rai, Rahil Abdullah and Mrs. Ankitha K
Publisher Information: International Journal of Engineering Research & Technology (IJERT)
Publication Year: 2019
Link: https://pdfs.semanticscholar.org/001c/21985256fac9b8c877e4cab94034b1d43a9e.pdf

[7] Automated identification & classification of malaria parasites in thin blood smear images
Authors: Soumya Das, Sony P, Jyothi R L
Publisher Information: International Research Journal of Engineering and Technology (IRJET)
Publication Year: May 2018
Link: https://www.irjet.net/archives/V5/i5/IRJET-V5I5900.pdf

Appendix for Acronyms

Each Appendix appears on its own page.

DL	Deep Learning
DIP	Digital Image Processing
IP	Image Processing
RBCs	Red blood cells
CC	Cell count
ICC	Infected Cell Count
Seg	Segmentation

Appendix for Individual Contribution Details in Group

Sr No	Reg No	Role and Responsibility	Digital Signature
1	18BCE0582	Matlab coding, Documentation	Aditya Ruhatiya
2	18BCE0586	Gather resources, research work, gathering samples	Aditya Agrawal
3	18BCE0601	Literature survey, presentations, comparing our work with existing methods	Akhilesh Gawade