Malaria Cells Image Analysis Using Image Processing Filters and Naïve Bayes Classifier

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Abstract: Malaria is a most widely spread dangerous blood disease that caused by a mosquito parasite which is called plasmodium. It transmitted into a human's blood via a female Anopheles mosquito so the life cycle of malaria starts and destroy the RGB cells. It affects pregnant women and 37% of adults and 79% of children under five year's i.e. taking life of a child at every minute. Symptoms for this disease usually appears in 10 days to 3 weeks after a bite of an infected mosquito. The common symptoms of this disease are fever, headache, vomiting, muscle pain that may reason of death and coma. So In this research work, we propose detection algorithm for malaria disease by using matlab tool. We use image processing filters and techniques to identify the malaria disease along with the Naive Bayes Classifier. In this research, the proposed method detect the normal cell and abnormal cell. Parameters are used like circularity, Area, Perimeter, Mean and also find the number of parasites if cell is normal no parasite found but if cell is abnormal then it will find the number of parasites. The aim of this research is to detect the malaria cell that either it is infected or not and in last we got the efficient results with the high accuracy.

Keywords: *Median Filter, RGB to Gray, Intensity, Feature Vectors, Naive Bayes Classifier.*

1. Introduction

Malaria is a most widely spread dangerous blood disease that caused by a mosquito parasite which is called plasmodium. It transmitted into a human's blood via a female Anopheles mosquito so the life cycle of malaria starts and destroy the RGB cells. It affects pregnant women and 37% of adults and 79% of children under five year's i.e. taking life of a child at every minute. Symptoms for this disease usually appears in 10 days to 3 weeks after a bite of an infected mosquito. The common symptoms of this disease are fever, headache, vomiting, muscle pain that may reason of death and coma. It is assessed that yearly lion's share of passing happens because of intestinal sickness in helpless nations where contamination is high. Intestinal sickness is known to be probably the most life-stringing infections on the planet for the last numerous years. Intestinal sickness is additionally called as "lord of infection", proposed by Warhurst, D.C, and J.E (1996). As per the yearly perception of the World Wellbeing Association WHO, malaria cases surpasses 200 million every year reported by W.H.O (2017).

Different types of plasmodium are given, but only five types cause malaria disease in humans that are: PF (Plasmodium Falciparum), PV (Plasmodium Vivax), PO (Plasmodium Ovale), PM (Plasmodium Malariae), PK (Plasmodium Knowlesi)

The most widely recognized approach to analyze jungle fever is that you allude to the specialist. The specialist takes some blood tests first and afterward, he prescribes a few prescriptions to analyses malaria. Those blood tests help your PCP in realizing that: Are the parasites present in the blood are of intestinal sickness? Which sorts of jungle fever parasites are available? From that point forward, prior to beginning clinical treatment, the specialist should know the age of the patient and if she is pregnant? Subsequent to knowing this, specialists start the treatment and prescribe some enemy of malarial medications to patients.

1.1 TYPES OF MALARIA

An intestinal sickness parasite in people comprises of four kinds of species (D.AI, 2011). These four intestinal sickness types have been examined beneath in short alongside certain highlights.

a) Plasmodium Falciparum

It is answerable for most malaria passing internationally and it happens particularly in sub-Saharan Africa. This is quite possibly the most extreme infection that may likewise prompt demise, the majority of the instances of intestinal sickness illness happen of this species. It is answerable for about half of all intestinal sickness cases around the world.

b) Plasmodium Vivax

After Plasmodium falciparum, this sort of species is otherwise called a day-to-day existence treating infection. This kind of species normally happens in Southeast Asia and America. This sort of intestinal sickness parasite is with

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the largest geological circulation and assessed to cause 43% of all malaria cases everywhere in the world.

c) Plasmodium Ovale

This kind of malaria is for the most part causes less genuine diseases. When an individual chomped by a tainted mosquito its parasites will endure in the liver for a long time up to numerous years. Step by step the parasites in the liver will develop and shows the presence of disease.

This sort of species is moderately once in a while experience.

d) Plasmodium Malaria

This kind of parasite is liable for just 7% of malaria cases. Also, typically it was found in Africa.

1.2 REASONS OF MALARIA

Malaria is moved from the nibble of a contaminated mosquito. In people regularly, five kinds of parasites are found. On the off chance that an individual is now contaminated and the other mosquito chomps that tainted individual that it gets contaminated. From that point onward, the contaminated mosquito nibbles someone else. So from here, the disease spread. Nonetheless, jungle fever disease can't spread straightforwardly starting with one individual then onto the next. Whenever you are nibbled by a tainted mosquito then its parasites go through into the liver of an individual and attacking the red platelets. The parasite develops and gets experienced. At that point, Parasites replicate the disease in red platelets and afterward the number of tainted cells becomes increments in the blood (Buke D, 2015). Jungle fever is spread by blood, so it tends to be sent through: An organ relocates Utilization of shared needles or needles.

For the most part, malaria fever happens where contamination is high, that is the reason all of that happened in our nations. Jungle fever is happening there, where there isn't clean in any way.

1.3 SIGNS OF MALARIA

Signs and manifestations of intestinal sickness contamination that happen in the human body are:

- Headache
- High fever
- Shaking chills
- Vomiting
- Diarrhea
- Nausea
- Profuse sweating
- Muscle pain
- Bloody stool

When a tainted mosquito nibbles an individual its manifestations start in an extremely restricted time.

Notwithstanding, a few side effects of jungle fever disease can live in the body for a long time or years.

2. Related Work

In this Part, we define the related work in this area. Many algorithms and techniques have been implemented and used in this research area, but the accuracy is not up to the point.

In 2020, Pundir suggested an automatic identification of infected cell of malaria disease using deep learning Convolutional neural network .It automatically learn from input data.

In 2019, Murk Hassan Memon suggested a detecting the Malaria disease, though Filtering Image edges and SVM classifier in this technique the images are used for pre-processing and SVM Classifier is used for detection of infected cells to the rest of the rest of the blood cells so the overall accuracy of the system is 97%.

In 2018, Mahdieh Poostchi et al., suggested an automatic diagnosis malaria disease using light microscopy and deep learning methods that detect thin blood smears and Thick blood smears.

In 2018, Alba Pages-Zemora et al., define a procedure for detection of specific structures of images of Malaria collected through the crowdsourcing methodology. This procedure is based on two steps, one for clustering and other for detection by using EM algorithm.

In 2017, Young Dong, et al., defines the automatic detection of mosquito parasite plasmodium by explaining the Neural Network algorithm through convolution neural network including LetNET, AlexNET, and GoogLeNET. In this technique, the deep learning algorithms extract the features from the training dataset and generate the histogram.

In 2016, Salam Shuleenda Devi et al., design a computer based report to detect the malaria infection that is depend on the classification with hybrid classifiers through nanoscopic blood cell images of smears. In this work, other 54 dimensional features had done by the set of features. Different techniques have been used for feature selection, such as BhattacharyYa distance measure with IFS and ANOVA distance measure with IFS method and Hybrid Classifier is used for better performance. Also generate the histogram of Red color and Green color in RGB images.

3. Methodology

1. Collect the Datasets of Malaria Disease.
2. Load the Cells Images in MATLAB TOOL.
3. Resize the images of cells because we maintain the size of all images.
4. Apply Median Filter to remove the noise from them because it is a non-linear filter smoothing technique.
5. Convert these images into Gray Scale Images.
6. Feature Extraction is applied due to a better result of the infected cells of Malaria.

7. Feature Vectors such as size, shape, Area and roundness of cells are used to detect the infected cells.
8. After that, we divide a cell into four quadrants at 0 degree, 90 degree, 270 degree and 360 degree.
9. Calculate Intensity value that clearly shows that which area of a cell is infected of malaria disease.
10. After, we find that particular area of that cell and calculate the pixel value, co-ordinates and distance of origin to that particular infected area.
11. Naive Bayes Classifier Algorithm is use for detection of Plasmodium Parasites Disease.
12. If the person is infected with this Disease this algorithm gives the Identification of Stage.
13. If not then it just say that this person is not infected with Plasmodium Parasites.

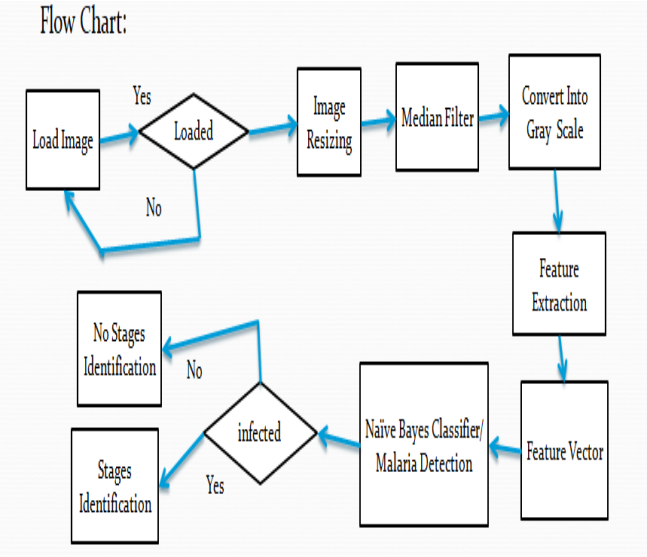


Figure1.Steps of proposed Methodology

3.1 IMAGE PROCESSING

Image processing is a strategy to change over a picture into a computerized shape and play out a certain procedure on it, to get an upgraded picture or to extricate some helpful data from it.

3.1.1 Pre- Processing

To load the images in the initial step. The image processing involves the activity that has numerous fundamental highlights. It assists with resizing the picture to keep up the standard size, all things considered, to accelerate handling. In this work the dataset is taken from kaggle online datasets library that contain 27,558 images. Dataset contain different size of images so it is necessary to resize all of them with standard size 300*300.
https://www.kaggle.com/iarunava/cell-images-for-detecting-malaria

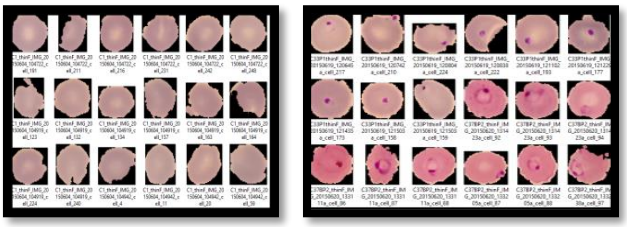


Figure2. (a) Show uninfected cells of malaria. (b) Show infected cells of malaria

3.1.2 RGB TO GRAY CONVERSION

Gray-scale conversion is performed in these images. Gray-scale images are convert into binary image with 0.6 intensity value shows in Figure 3(a) and Figure 3(b).

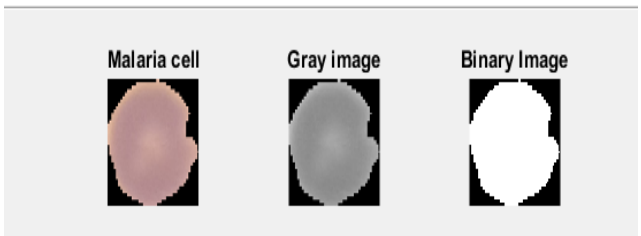


Figure3.(a)Original Image (b)RGB to Gray Scale Conversion Figure3.(c) Gray Scale to Binary conversion with 0.6 intensity value.

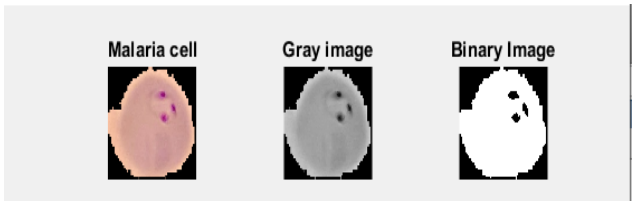


Figure3.(a)Original Image (b)RGB to Gray Scale Conversion Figure3.(c) Gray Scale to Binary conversion with 0.6 intensity value.

After that, Complement the binary image and after that remove noise using bwareaopen shown by Figure 4. This activity is utilized to eliminate the little items whose qualities are under 300 pixels.

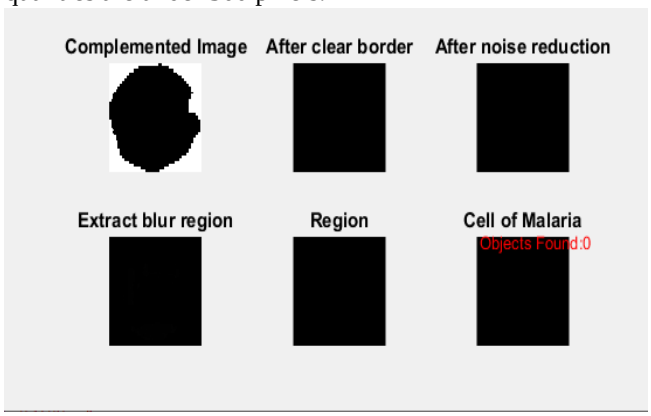


Figure4.(a)shows complemented of a normal cell ‘s image (b)shows result of after clear border using imclearborder (c)shows result after remove noise (d) Extract the blur region (e) shows that region (f)

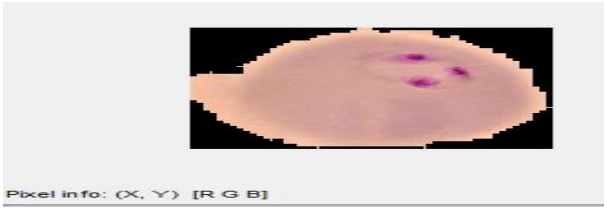


Figure 5. Shows pixel value of image using impixelinfo command in matlab.

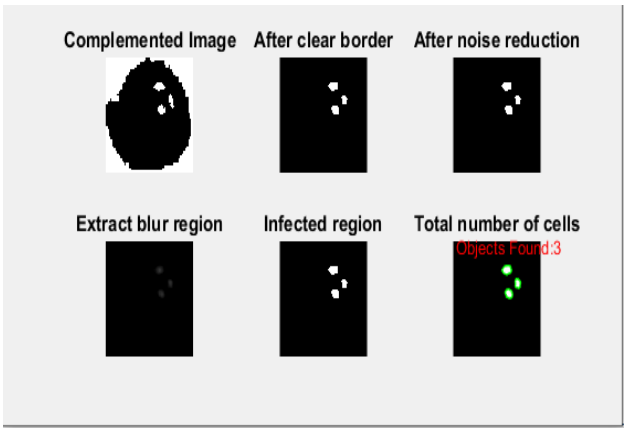


Figure 6. (a)Complemented Image of Binary Image (b) Apply some operation to clear Gray Scaled Image after clear border using imclearborder (c) Remove noise (d) shows some blur infected area of a cell (d) Shows clear extraction of infected area of a cell. (e) Shows the infected number of parasites which is 3 it defines that this image is an abnormal cell.

Figure 7.Multiply original image and detected infected cells image using immultiply command.

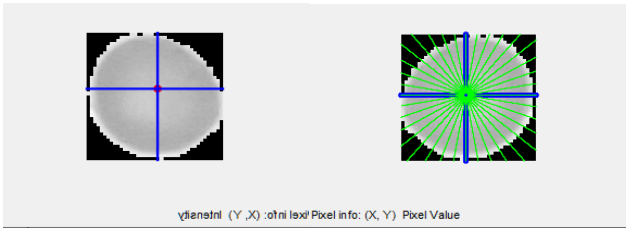


Figure8. (a) Shows the center of a normal cell and four Quadrants of an image. (b) Shows the rays of all four Quadrants.

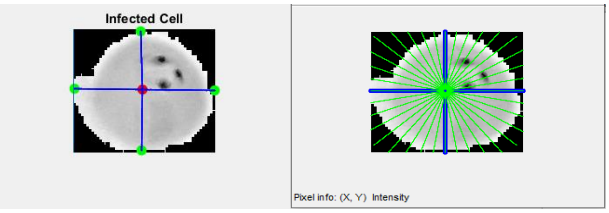


Figure8. (a) Shows the center of an abnormal cell and four Quadrants of an image. (b) Shows the rays of all four Quadrants.

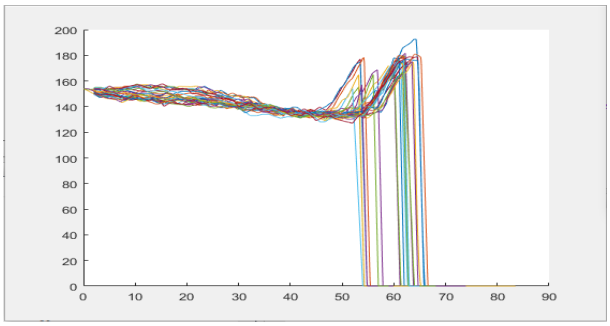


Figure9.shows the Intensity graph of a normal malaria cell.

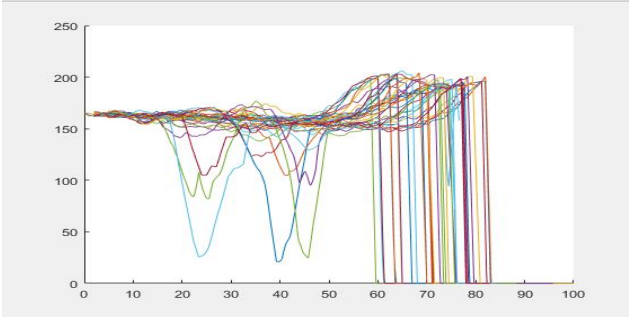


Figure10. Shows the Intensity graph of an abnormal malaria cell.

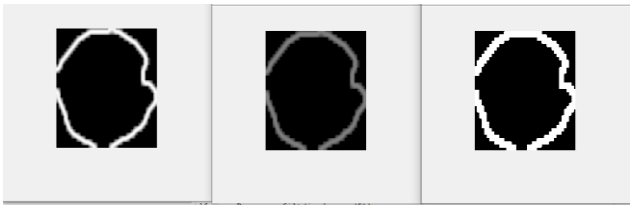


Figure11. (a) Shows the texture of a normal cell using entropyfilt command (b) shows the texture of a normal cell using stdfilt command. (c) Shows the texture of a normal cell using rangefilt command.

Figure12. (a) Shows the texture of an abnormal cell using entropyfilt command (b) shows the texture of a normal cell using stdfilt command. (c) Shows the texture of a normal cell using rangefilt command.

3.1.3 FEATURE VECTOR

For the detection, feature vectors have been used to find the infected cells, which are Form factor, Roundness and Area; those are discussed in Table 1.

Table1. Feature Vector Parameters with Definition and Equation

Name	Definition	Equation
Area	The state of a cell is inflexible because of the presence of disease. The size of an infected cell is smaller than uninfected cell so area of an infected cell is also small than the normal cell.	Area=regionprops(BW2,' area')
Circularity	Typical red platelets are round fit as a fiddle and strange cells are having various varieties in size. For an ideal circle, the worth should be equivalent to 1.	Roundness= 4*area / (MajorAxisLength^2*pi)
Form Factor	The form factor is utilized to gauge the shape metric. Structure factor limit is fixed; its worth is equivalent to 1 for perfect circle. For all other non-circular cells its value varies and is less than 1.	Form Factor= (4*pi*area) / (Perimeter^2)

3.1.4 PLASMODIUM DETECTION

The malaria cell detection has been performed by using Naive Bayes Classifier. This classifier is trained with some feature vectors, which are discussed in section 3.1.5, those feature vectors found to be the most suitable method to detect the malaria cell parasites. This method count number of objects in infected cell.

3.1.5 EXPECTED VALUE OF INFECTED CELL

The normal value of a cell is approx. Equal to 1 and found 0 objects (Parasites) and in infected cell found more than 0 object (Parasites).The parasites are normally high in abnormal cells and approx. 0 in normal malaria cell. The Red Blood Cells (RBC) should be low in malaria disease patients and WBC is also low. RBC cells destroy due to bite of mosquito.

According to the malaria disease the normal cell having 0 parasites and abnormal cell having more than o parasites. Due to circularity, the value must be equal to 1 so it called a normal cell but 0.9 is also changeable form. Malaria's normal cells are circle in shape calculated the circularity which 0.8-0.9 are also include in normal cell calculation. The surface zone of ordinary cells is smooth, when cells having even a limited quantity of disease the territory of those cells become rigid. The infected cells are also round in shape but having 0.8-0.2 roundness value.

4. Results and Discussion

By using software MATLAB 2016(a), the execution and outcomes has been accomplished bit by bit to calculate the results. In this section, Total 27,558 images taken from the kaggle images dataset website. Consistent with this dataset, some feature values have been applied to that dataset images .There are four types of malaria disease and four stages of that disease so the all results are given below in Table 2.3 that shows the results of normal cells and abnormal cells.

NORMAL CELLS:

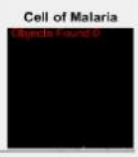
Images	Mean	Circularity	Area	Centroid Co_ ordinates	Perimeter	Infected Objects
	122.9516	0.87	11755	[63 ,62]	411.884	
	118.4494	0.76	17502	[77,74]	539.0610	
	144.6575	0.71	21522	[82,81]	559.4041	
	124.4492	0.82	20544	[80,86]	562.5168	

Figure13. Shows the results of normal cells

Table2.1 Results of Normal cells

Normal cells					
Images	Mean	Circularit	Area	Perimete	no:of parasites
N1	122.9516	0.87	11755	411.884	0
N2	118.4494	0.76	17502	539.061	0
N3	144.6575	0.71	21522	559.4041	0
N4	124.4492	0.82	20544	562.5168	0

ABNORMAL CELLS:

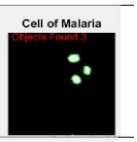
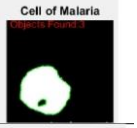
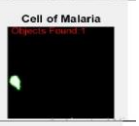
Images	Four Stages	Circularity	Area	Mean Value	Centroid	Perimeter	Infected objects
	Ring Stage	0.57	16450	127.3859	[83 ,75]	603.9239	
	Trophozoite Stage No of objects found 3	0.61	13519	115.1210	[67, 65]	526.3675	
	Gametocytes Stage No of objects found 1	0.58	14418	111.2592	[83 ,74]	554.3675	
	Schizont Stage No of objects Found 14	0.59	39789	101.6935	[116 ,107]	917.9239	

Figure14. Shows the results of abnormal cells

Table2.2 Results of Normal cells

Images	Mean Val	Circularity	Area	Perimeter	No: of parasites	Four Stages
AbN1	127.3859	0.57	16450	603.9239	3	Ring Stage
AbN2	115.121	0.61	13519	526.3675	3	Trophozoite Stage
AbN3	111.2592	0.58	14418	554.3675	1	Gametocytes Stage
AbN4	101.6935	0.59	39789	917.9239	14	Schizont Stage

Table2.3 Results of Normal cells V/S Abnormal Cells

Images	Area	Circularity	Mean Val	Perimeter	No: of parasites
N1	11755	0.87	122.9516	411.884	0
N2	17502	0.76	118.4494	539.061	0
N3	21522	0.71	144.6575	559.4041	0
N4	20544	0.82	124.4492	562.5168	0
AbN1	16450	0.57	127.3859	603.9239	3
AbN2	13519	0.61	115.121	526.3675	3
AbN3	14418	0.58	111.2592	554.3675	1
AbN4	39789	0.59	101.6935	917.9239	14

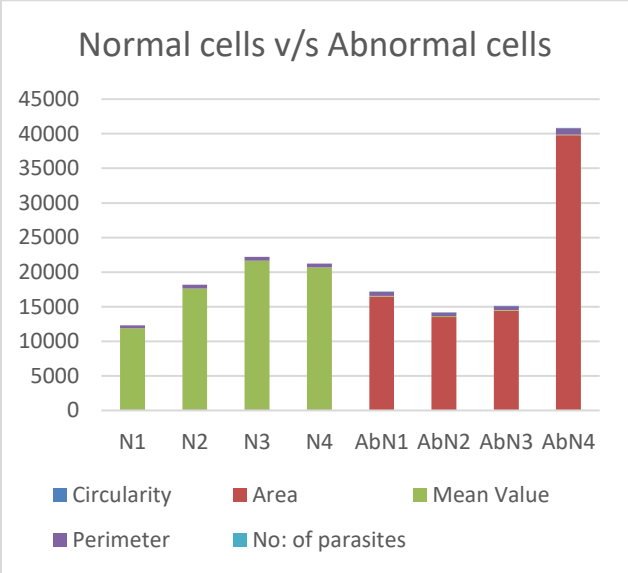


Figure15.Shows the graph of normal v/s abnormal cells of malaria using different parameters

	N	A
N	160	40
A	8	92

Figure16.Shows the confusion matrix of a Naive Bayes classifier.

According to the Naive Bayes classifier we use total 300 images 200 normal images and 100 abnormal images .In this paper 160 images are normal and 40 are abnormal images and according to results the 8 images are abnormal but these images are normal and according to this research perception 92 were abnormal so 160 were normal images and 92 were abnormal cells images. Calculate the accuracy that is given below:

$$\text{Accuracy} = \frac{NN+AA}{\text{Total Images}}$$

$$\text{Accuracy} = \frac{160+92}{300}$$

$$\text{Accuracy} = \frac{252}{300}$$

Accuracy = 84%

5. Conclusion

In this research paper, to detect the malaria cell through Naive Bayes classifier by using malaria cells images .The main aim of this research is to identify that either it is a normal cell or abnormal cell through feature vectors such as size Area shape circularity. Normal cells used the value of circularity is equal to 1, apart from that it differ for non-circular objects .Normal cells are mostly circle in shape with 1 or 0.9 circularity .Naive Bayes Classifier is trained with some feature vectors. Implementation has been done by almost 300 images 200 normal images and 100 abnormal images after that the accuracy of the proposed system is high. This research is mainly focused on the more efficient results with high accuracy for detection of the infected RGB cells of malaria disease from rest of RGB cells by using an image processing non-linear filters and Naive Bayes Classifier in MATLAB.

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