

# Classifying Deviations in Medical Microscopic Images Using Evolutionary Analysis

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**Abstract-** Most of the patient diagnosis revolves around in identifying abnormalities in their respective medical images. These images are of various types, likely Ultrasound, CT Scan, MRI and microscopic images like bio-chemical slides, micro-biological slides & pathological slides. Few abnormalities are fractures, bad cells in blood, tumors, fungal identification etc. Finding the abnormal portions in these images needs expertise by the physician; this apt identification promotes and guarantees healthy medication by the physician or surgeon to patient. In medical microscopic images normal portions and abnormal portions are mixed together. None of the abnormal portions are related to abnormal and normal portions of image i.e. deviations are scattered among normal portions of image. These deviations are not present in some portions for specific area in the images. None of these deviations are overlapped nor can be grouped together into a single portion physically in the image. Deviations can be isolated along with normal portions of images. Identifying such deviations partially comes under classification and clustering. This project identifies deviations in Medical Microscopic images. These deviations can be identified visually which reveals about the presence of deviation but to know the percentage of deviation in a sample image is imperative. In-order to achieve this all deviations must be connected. This project connects all deviations using evolutionary analysis, includes the mixture functionalities of classification and clustering. Also this project uses BFS, DFS and random tracking for connecting deviations in the image.

**Index Terms-** Deviation, Medical Images, Sickle cells

## I. INTRODUCTION

Medical Imaging is the technique and process of creating virtual representations of the interior of a body for clinical analysis and medical intervention, as well as visual representation of the function of some organs or tissues [5].

Different types of medical images are Scanned Images and Microscopic Images. Scanned images include MRI scan, CT Scan, PET, X-Ray, Ultrasound.

## Types of Medical images

### Magnetic Resonance Imaging (MRI)

MRI is a medical imaging Technology that uses radio waves and a magnetic field to create detailed images of organs and tissues. MRI is used to evaluate blood vessels, Abnormal tissues, Bones and Joints, Spinal injuries etc[3].

### Computed Tomography (CT)

Computed Tomography (CT), is a medical imaging method that combines multiple X-ray projections taken from different angles to produce a detailed cross-sectional images of areas inside the body. CT images allow doctors to get very precise, 3D views of certain parts of the body. CT is used to evaluate presence, size, location of tumors, Bone injuries, Organs in chest, abdomen etc [3].

### Position Emission Tomography (PET)

PET is a nuclear imaging technique that provides physicians with information about how tissues and organs are functioning. PET is used to evaluate Neurological diseases such as Alzheimer's and Multiple Sclerosis, Cancer etc [3].

### Ultrasound

Diagnostic ultrasound, also known as Medical Sonography, uses high frequency sound waves to create images of parts inside the body. It is used to evaluate Pregnancy, Abnormalities of heart and blood vessels etc[3].

### X-Ray

X-rays use ionizing radiation to produce images of a person's internal structure by sending X-ray beams

through the body. X-ray images are used to evaluate Broken bones, Cavities, Lungs etc[3].

### Microscopic Images

Microscopic images are used in medical diagnosis. They were made with a very high resolution of 4096 x 2160 pixels(4K), which is four times as many pixels as High-Definition image(1920 x 1080 pixels)[3].

The various types of microscopic images are:

- Biochemical slides
- Pathological slides
- Micro-biological slides

Finding the abnormal portions in these images needs expertise by the physician; This apt identification promotes and ensures healthy medication by the physician to patient.

## II. RESEARCH ELABORATIONS

### Anemia

The cellular part of blood molecule contains several different cell types like red blood cells, white blood cells and platelets. Anemia is the most common disorder of the blood.

“Anemia”, the name is derivative from the ancient Greek word anaimia, which means “Lack of Blood”. It is possible because of reduction in Red Blood Cells (RBCs) or resulting in lesser than normal quantity of haemoglobin in the blood. However, it can also include decreased oxygen-binding ability of each haemoglobin molecule due to deformity or lack in numerical development [2].

Anemia is actually a sign of a disease process rather than being a disease itself. It can be either classified as acute or chronic. In chronic anemia, symptoms typically begin slowly and progress gradually; whereas in acute anemia, symptoms can be abrupt and more distressing.

Among many factors, both nutritional (like vitamins and mineral deficiencies) and non-nutritional (like infection and haemoglobinopathies), that contribute to the onset of anemia; Iron Insufficiency and malaria plays a significant role[2].

For men, anemia is typically defined as hemoglobin level of less than 13.5 g/dl and in women as hemoglobin of less than 12.0 g/dl[2].

### Sickle Cell Anemia

Sickle cell disease is an inherited blood disorder. Red blood cells contain hemoglobin which carries the oxygen in the blood. They are round and flexible which enables them to travel through small blood vessels to deliver oxygen to all parts of the body. These cells normally live about 120 days[1].

Sickle cell disease causes red blood cells to become crescent shaped, which causes them to break apart easily. This ultimately causes anemia because the cells only live 10-20 days[1].

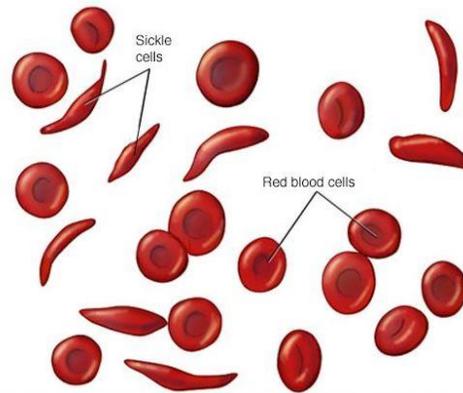


Figure 1: Sickle cells and Normal Blood Cells

### Characterization of Sickle-Cell Anemia:

When the abnormal sickle-shaped cells in the blood are identified, a diagnosis is made.

- Normal Cell: Normally blood cells are round and flexible and flow easily through blood vessels.
- Sickle Cell: In sickle cell disease, certain red blood cells become crescent-shaped. These abnormal red blood cells, carrying abnormal hemoglobin known as hemoglobin S, are fragile.

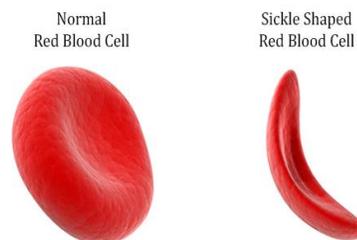


Figure 2: Normal RBC and Sickle Shaped RBC

In human health, blood health is very important, and the early diagnosis of diseases is necessary to prevent death and the worsening of disease.

With the development of information technology, image-processing technology is becoming an essential and effective tool in scientific research. It is especially widely used and effective in the field of biomedical engineering.

Finding a faster, more efficient methods to diagnose this kind of disease by using image segmentation so that sickle cells can be detected in blood samples is an essential part of detecting this disease. The goal of this thesis is to demonstrate how image processing technology can be useful in the detection of sickle cell disease.

### III. EXISTING SYSTEM

#### IV.

There have been many studies about sickle blood cell detection. One of them is the “Detection of Abnormal Blood Cells Using Image Processing Technique” by Malher Bhatt and Shashi Probha. In this study, the authors try to detect abnormal blood cells based on form factor and using image segmentation. The form factor they used calculates the circularity shape of the cell, and if the cell not circular, it is counted as an abnormal cell.

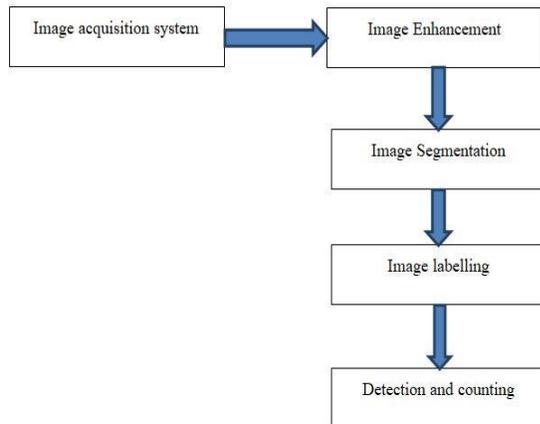


Figure 3: Block diagram for detecting abnormal cells

#### A. Image Acquisition

The digital microscope is interfaced to a computer. The microscopic images are obtained as digital images. The resolution of the digital image depends on the type of digital microscope used [6].

#### B. Image Enhancement

For better segmentation of the blood cells, the imported image has to be enhanced. This improves the quality of the image by enhancing the details [6].

#### C. Image Segmentation

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). 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 (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. [7].

#### D. Abnormal Blood Cell Detection

Form factor threshold is fixed for different abnormal cells. Based on the form factor, the abnormal cells are detected. [6] Malher and Probha started with reading the image and then converted it to a grayscale image. They then used edge detection to detect the abnormal cells. Edge detection is an image segmentation technique that determines the presence of an edge or line in an image and outlines the edge in an appropriate way. The main purpose of edge detection is to simplify the image data in order to minimize the amount of data to be processed [9]. Edge detection is followed by a labeling stage and then form factor calculation [6].

$$\text{Form Factor} = \frac{4 \cdot \pi \cdot \text{area}}{(\text{perimeter} \cdot \text{perimeter})} \quad [8][9].$$

V. PREPOSED ANALYSIS

A. Algorithm

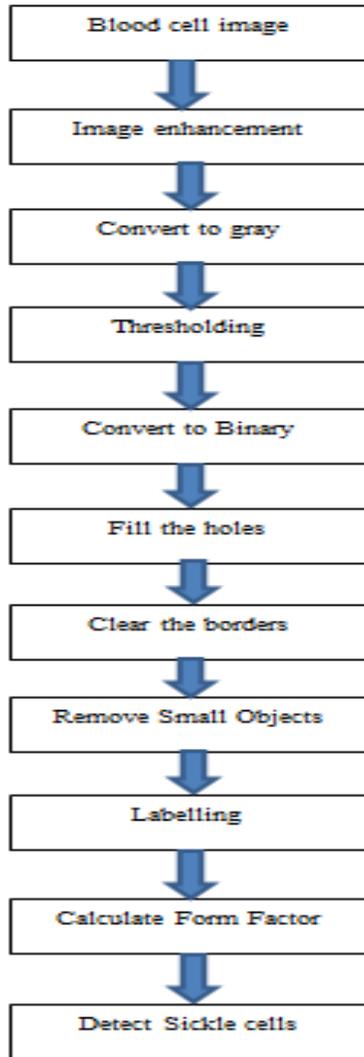


Figure 4: Flow Chart for Sickle Cell Detection

The figure shows the steps of new algorithm as follows:

- After the image is read, the image is converted to grayscale using "rgb2gray".
- Then the image is converted into black and white format for calculating the threshold using "graythresh."
- After that, the holes are filled using "imfill."

- Next, the borders are cleared and small objects are removed using "imclearborder" and "bwareaopen" respectively.
- Next, objects are labeled and the form factor calculated to detect the sickle cells[10].

B. Calculating Form Factor

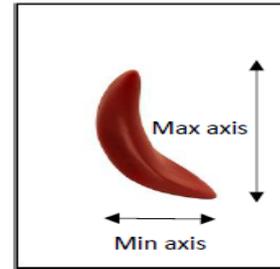


Figure 5: Calculating the Form Factor

To calculate the form factor,

- First, compute the major axis length and the minor axis length of the cell.
- Then calculate the difference between the major and minor axes.
- Finally, calculate the form factor using the following formula:

Form Factor= Major axis length / (difference between major and minor).

C. Detecting the Sickle Cells

By testing for the following conditions, sickle cells can be detected: if the form factor is less than the threshold then the cell will be counted as sickle cell [10].

VI. IMPLEMENTATION

MATLAB environment

To implement the new algorithm, the "MATLAB" tool is used. MATLAB has an image processing toolbox, which contains all functions that are used to analyze the image such as reading, enhancement, converting from one image type to another, segmentation, labeling and more. The functions that used to run the new algorithm are described below [4].

A. Reading Image (Imread)

MATLAB deals with the image as a two dimensional matrix. Imread reads the image into MATLAB's environment as a matrix[4].

Basic Syntax

Image=imread ('file-name');

MATLAB reads the image file "file-name" into an array image. Imread can read many different formats such as JPG, PNG, GIF and TIF[4].

B. Showing Image (Imshow)

Imshow displays images on the MATLAB desktop.

Basic Syntax

Imshow (I)

MATLAB displays the image I in a graphics figure, where I is a grayscale, RGB (truecolor), or binary image. For binary images, imshow displays pixels with the value 0(zero) as black and 1 as white[4].

C. Converting Colored Image to Gary (rgb2gray)

There are four types of image:

- 1- RGB image
- 2- Gray – Scale images
- 3- Binary image "Black and white"
- 4- Indexed images

Rgb2gray converts the image from RGB into a gray-scale image.

Basic Syntax

I =rgb2gray (RGB);

MATLAB converts the true color image RGB to the grayscale intensity image I. The rgb2gray function converts RGB images to grayscale by eliminating the hue and saturation information while retaining the luminance. If you have Parallel Computing Toolbox installed, rgb2gray can perform this conversion on a GPU[4].

D. Calculating Threshold and Converting Gray Image to Binary (im2bw)

Converting the image from RGB into a binary image first requires computing the threshold of the gray image using the "graythresh" function.

Basic Syntax

Level = graythresh (RGB);

MATLAB computes a global threshold (Level) that can be used to convert an intensity image to a binary

image with im2bw. Level is a normalized intensity value that lies in the range [0, 1]. The graythresh function uses Otsu's method, which chooses the threshold to minimize the intraclass variance of the black and white pixels. Then this threshold converts the image to black and white using "im2bw".

Basic Syntax

BW = im2bw (Grayimage, Level);

MATLAB converts the grayscale image Grayimage to a binary image. The output image BW replaces all pixels in the input image with luminance greater than Level with the value 1 (white) and replaces all other pixels with the value 0 (black). It specifies a Level in the range [0,1]. This range is relative to the signal levels possible for the image's class.

Therefore, a Level value of 0.5 is midway between black and white, regardless of class. If you do not specify Level, im2bw uses the value 0.5[4].

E. Filling Images Holes (Imfill)

Imfill fills image regions and holes.

Basic Syntax

Filled = imfill (BW, 'holes');

MATLAB fills holes in the input binary image BW. In this syntax, a hole is a set of background pixels that cannot be reached by filling in the background from the edge of the image [4].

F. Clearing the Border (Imclearborder)

This function clears any objects that touch the image borders.

Basic Syntax

Cleared = imclearborder (Filled);

MATLAB suppresses structures that are lighter than their surroundings and that are connected to the image border. Use this function to clear the image border. Filled can be a grayscale or binary image. For grayscale images, imclearborder tends to reduce the overall intensity level in addition to suppressing border structures. The output image, Cleared, is grayscale or binary, depending on the input. The default connectivity is 8 for two dimensions, 26 for three dimensions, and conndef (ndims(Filled),'maximal') for higher dimensions[4].

G. Deleting Small Objects (Bwareaopen)

This function deletes any object that's area is less than a specific value.

Basic Syntax

Deleted = bwareaopen (Cleared, Value);  
 MATLAB removes all connected components (objects) that have fewer Value pixels from the binary image Cleared, producing another binary image, Deleted. The default connectivity is 8 for two dimensions, 26 for three dimensions, and conndef(ndims(Cleared), 'maximal') for higher dimensions. This operation is known as an area opening[4].

H. Labelling the Objects (Bwlabel)

This function labels all objects in the binary image.

Basic Syntax

Labeled = bwlabel (BW);  
 MATLAB returns the label matrix Labeled that contains labels for the 8-connected objects found in BW. The label matrix, Labeled, is the same size as BW[4].

I. Calculating Region Properties (Regionprops)

Regionprops calculates the proprieties of image objects.

Some examples of proprieties:

- 1- Centroid: return the center of the object
- 2- Boundary box: return the smallest rectangle containing the object
- 3- Major axis length: return the length of the major axis of the ellipse
- 4- Minor axis length: return the length of the minor axis of the ellipse

Basic Syntax

Stats = regionprops (BW, properties)  
 MATLAB returns measurements for the set of properties specified by properties for each connected component (object) in the binary image, BW. Stats is struct array containing a struct for each object in the image. You can use regionprops on contiguous regions and discontiguous regions.

VII. ANALYSIS AND RESULTS

Sample1

Input Image

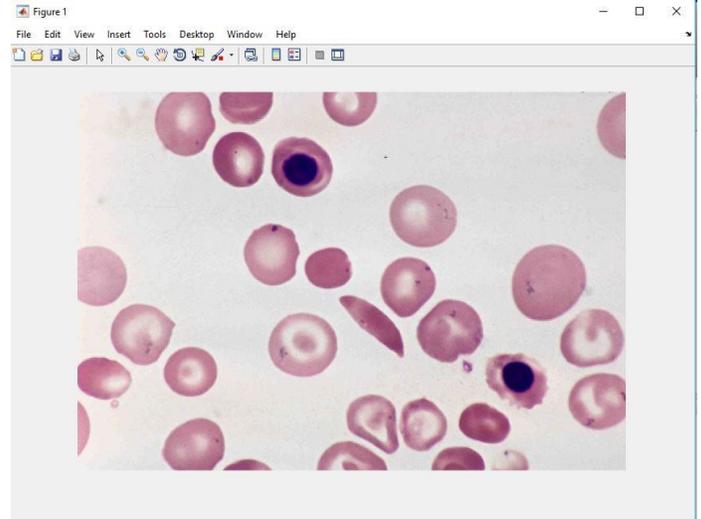


Figure 6: Results after reading input sample1.jpg file

Output Image

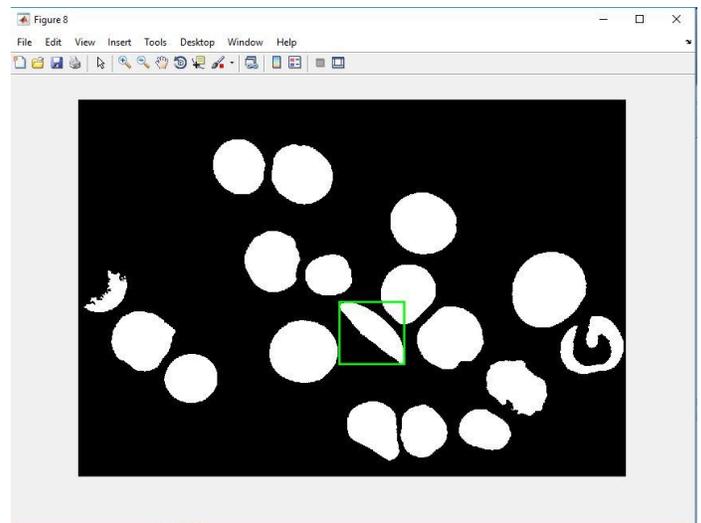


Figure 7: Results after detecting the sickle cells in sample1

Cell Id	Form Factor
Cell 1	1.4268

Table 1: Table showing the form factor values for sample1.

Table1 shows the values of form factor of detected sickle cells. In the above sample1 there is only one sickle cell and it is detected.

Sample2

Input Image

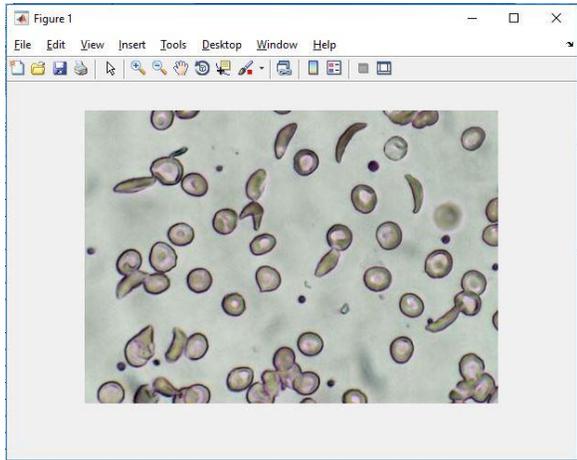


Figure 8: Results after reading input sample2.jpg file

Output Image

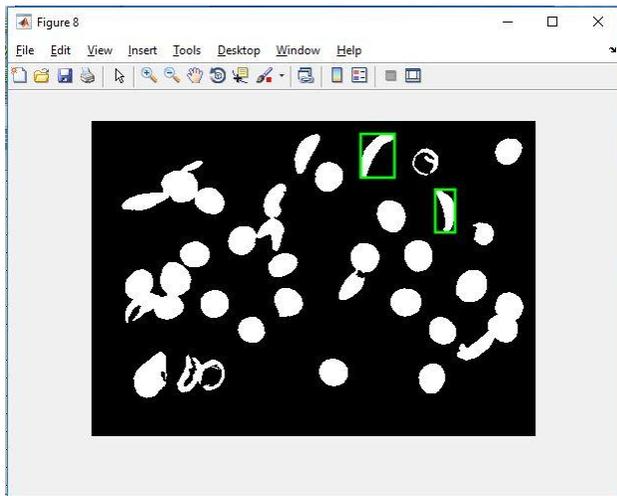


Figure 9: Results after detecting the sickle cells in sample2 when form factor is less than 1.50

Cell Id	Form Factor
Cell 1	1.3839
Cell 2	1.4713

Table 2: Table showing the form factor values for detected sickle cells with form factor less than 1.50 in sample2.

Table2 shows the values of form factor of detected sickle cells. In the above sample2 two sickle cells are detected with form factor less than 1.50.

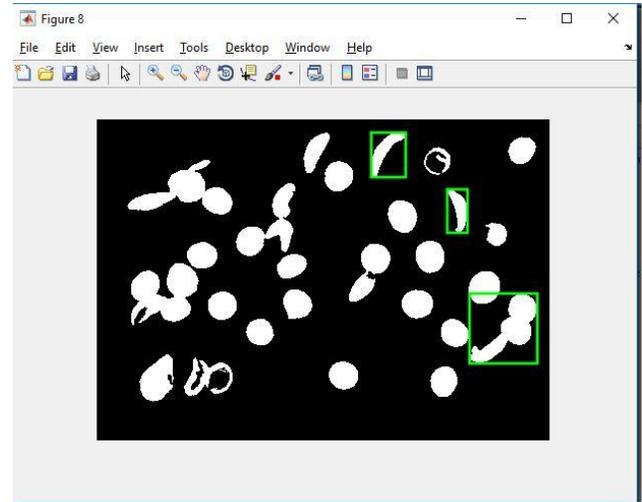


Figure 10: Results after detecting the sickle cells in sample2 when form factor is less than 1.58.

Cell Id	Form Factor
Cell 1	1.3839
Cell 2	1.4713
Cell 3	1.5718

Table 3: Table showing the form factor values for detected sickle cells with form factor less than 1.58 in sample2.

Table3 shows the values of form factor of detected sickle cells. In the above sample2 three sickle cells are detected.

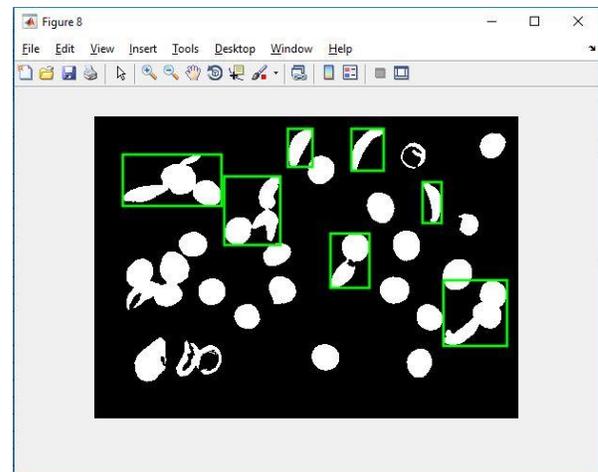


Figure 11: Results after detecting the sickle cells in sample2 when form factor is less than 1.90.

Cell Id	Form Factor
Cell 1	1.8377
Cell 2	1.8912
Cell 3	1.6219
Cell 4	1.5869
Cell 5	1.3839
Cell 6	1.4713
Cell 7	1.5718

Table 3: Table showing the form factor values for detected sickle cells with form factor less than 1.90 in sample2.

Table3 shows the values of form factor of detected sickle cells. In the above sample2 seven sickle cells are detected.

## VIII. CONCLUSION

The proposed algorithm identifies the deviations in the medical images with more accuracy than the existing methods. This algorithm helps in identifying any kind of deviations in any medical images with much effort.

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