Detection of Sickle Cell Anemia in Red Blood Cell: A Review

Menika Sahu, Amit Kumar Biswas, K. Uma

Abstract— **Blood is a connective tissue in which Red blood cells function to transport oxygen and it is normally in disk shape. The inherited disorder of blood includes hemoglobinopathies which are major public health problem in India. Sickle cell disease refers to a group of genetic disorders characterized by presence of sickle hemoglobin, anemia, acute and chronic tissue injury to blockage of blood flow by abnormally shaped red cell. Sickle cell disease is Sickle cell anemia. It is a disorder in which the body makes sickle-shaped red blood cells. "Sickle-shaped means the red blood cells are crescent shaped. Sickle cell anemia is also a serious disorder problem in chhattisgarh state. It is highly prevalent among scheduled caste, scheduled tribe and other back-word class. In Chhattisgarh the highest percentage of sickle cell diseases found in Sahu, Mahar, Gond, Devangan, Kurmi and Halba etc. This paper proposed a method to recognize the sickle shaped red blood cells present in the blood smear by using fractal dimension. Fractal Dimension is used to recognize the shape of the red blood cells and segmentation the sickle shaped red blood cells for shape analysis to find the percentage of sickle cell anemia. Results exhibit the future aspect of the technique, which overcome traditional shape recognition and analysis methods found in various literatures.**

Index Terms— **sickle cell; fractal dimension; image segmentation**

I. INTRODUCTION

Sickle cell disease (SCD), also known as sickle cell anemia, is a serious disease in which the body makes an altered form of hemoglobin, the protein in red blood cells that carries oxygen throughout the body. This genetic alteration causes the body to produce abnormal sickle- or crescent-shaped red blood cells. Unlike normal red cells that pass smoothly through the blood vessels, sickle cells are stiff and sticky and tend to form clumps that get stuck in the blood vessels and obstruct blood flow. The result is episodes of extreme pain ("crises"), as well as chronic damage to vital organs. SCD is an inherited disease. People who have the disease inherit two copies of the sickle cell gene— one from each parent. SCD is most common in people, whose families come from Africa, South or Central America (especially Panama), Caribbean islands and India.

There are various methods for counting and observing the different types of erythrocytes normal, sickle or other deformations. The manual counting is done by preparing slide of patient's blood using a microscope. This method is cheap but tedious, requires much concentration, time consuming and is more prone to errors. It does not accurately count the overlapped Cells. Most of the commercially available haematology analysers work on principle of electrical resistance, it is costly. These methods are not automatic. So for overcome this problem Image Processing using matrix laboratory (MATLAB) is the best option. By using this tool various techniques have developed which have different characteristics. We are using Fractal Dimension to recognize the shape of the red blood cells and segmentation the sickle shaped red blood cells for shape analysis to find the percentage of sickle cell anemia. Expected results exhibit the future aspect of the technique, which can overcome traditional shape recognition and analysis methods found in various literatures.

The proposed method requires careful designing of Algorithm, programming and its implementation. The proposed method deals with one of the great real world application such as medical. This method requires a Video Camera and PC. That means this is very easy, portable, less time consuming and is also cost effective.

II. LITERATURE REVIEW

Now a days, the automatic study of erythrocytes is done by using digital image, which is processed by image processing [1] using the mat lab. Previous study give information about evolution of the gene that produces sickle shaped haemoglobin [2] and research [3] how natural selection of human gene can provide increased adaptive fitness when exposed to an infectious disease.

In the previous study Blood disorders can be classified based on the comparison of feature related to shape, area, perimeter, diameter, deviation, area proportion, target flag, central pallor etc. with the threshold [4]. Other type of classification can be done using segmentation, feature extraction using artificial neural network [5].

Clustering based segmentation techniques are used to identify red blood cells, Sickle-cells [6] and Plasmodium parasites [7] present on microscopic slides. Image features based on color, texture and the geometry of the cells are generated and based on their feature classification of cells are done.

The shape of Sickle cells present in RBCs can be analyzed by finding the highest, lowest and mean radius of each type of cell by comparing it with standard cell size using various edge detection technique and mark the cells by a red circle for identification[8]. The clinical state of a patient involves counting the different types of erythrocytes based on their variable morphology: normal, sickle or other deformations. [9] The overlapped cells or incomplete blood cells on the boundary are first deleted then single blood cells were extracted from the image using edge detection algorithm. To overcome the previous studied method in which overlapping cells can't be measured, Circular Hough

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Transform techniques with form factor calculation [10] and based on morphological [11] can be used. This can detect overlapping blood cells accurately. If the form factor ranges from 0.5 to 1, the blood cells are normal, otherwise abnormal. This method of Sickle cell detection did not address half cell counting. It has 91% accuracy.

Manuel Gonzalez-Hidalgo et al. [12] proposed a method for determining the number of normal and elongated cells inside a cell group. It uses ellipse adjustment to detect cells in an efficient manner. It also incorporates a new technique for the efficient detection of concave or convex points of interest in a contour. It does not require pre-processing. The results obtained are excellent using method because it is capable of determining valid ellipses using the proposed criteria and the point-of-interest detection method is efficient.

There is a new technique for the shape analysis of any fractal object using fractal dimension techniques. This is mostly used when it is require detecting manmade object from image. Local Fractal dimension can be used to discriminate among object in gray scale imagery [13]. The box counting algorithm for computing local fractal dimension promises real time result [13] [14]. This method show ambiguities in the mass scaling technique based on shape and range. This shows basic idea or using fractal dimension as an important technique for object identification which can be used with image processing.

The fractal Dimension methods have various application areas such as for the face recognition using the fractal code which extract the important feature [15]. The method [14] can be developed further to recognize from parts of a face rather than the whole without a need for segmentation. The fractal analysis might be a promising tool for studying RBC aggregation [16].

There are presented methods of features evaluation, and data visualization [17] to recognize species of the tree based on the Fractal Dimension using box-counting is the simple, good for classification feature and fast. The Fractal Dimension using box-counting is also used for the determination of the leaf vascular system of tree [18].

III. Proposed Methodology

Sickle Cell Anemia is a blood disorder which results from the abnormalities of red blood cells and shortens the life expectancy to 42 and 48 years for males and females respectively. It also causes pain, jaundice, shortness of breath, etc. Majority of the sickle cells (whose shape is like crescent moon) found are due to low hemoglobin content. An image processing algorithm to automate the diagnosis of sickle-cells present in thin blood smears is developed.

The proposed method, recognize and segment the sickle shaped red blood cells present in the blood smear by using fractal dimension approach. Fractal Dimension is used to recognize the shape of the red blood cells and segmentation the sickle shaped red blood cells for shape analysis to find the percentage of sickle cell anemia.

Methodologies

- Median Filter
- K-means based segmentation
- Shape Feature extraction of area, solidity and all.
- Edge detection

Block Diagram:-

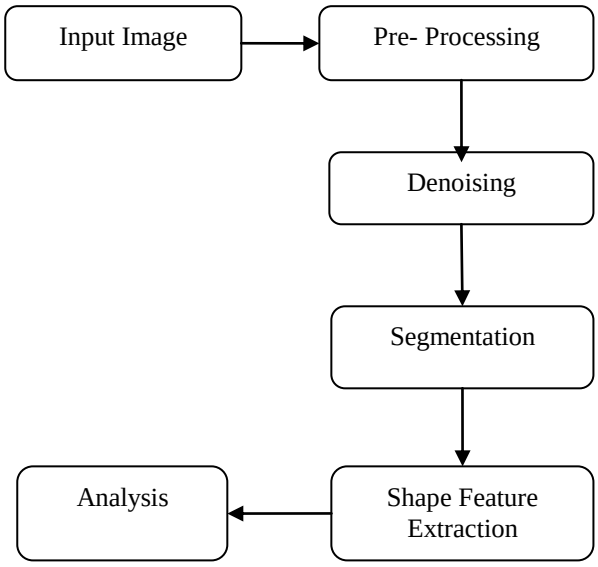

Fig.1- Flow Chart for the Sickle Cell Segmentation

a) **Data Acquisition: -** The images can be recorded with the help of glass slides and images get captured using microscopes. The blood smear image slides are examined under oil immersion. Images are captured in the JPEG format at the maximum resolution.

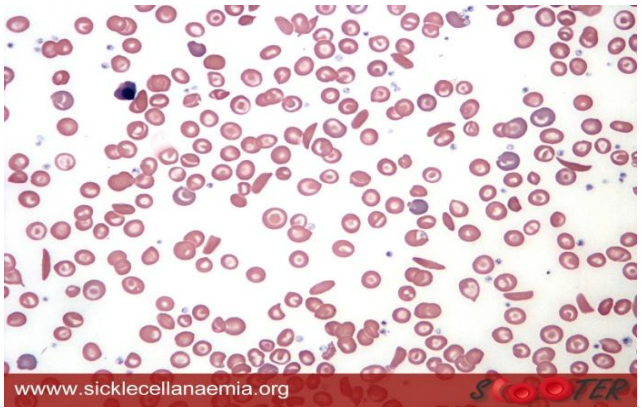

Fig.2- Blood Smear With Normal RBC and Sickle Cells

b) **Pre-processing: -** The purpose of the pre-processing stage is to remove unwanted effects such as noise from the image, and transform or adjust the image as necessary for further processing.

c) Segmentation:-Segmentation subdivides an image into its constituents regions or objects. The level to which the subdivision is carried depends on the problem being solved. That is, Segmentation should stop when the objects of interest have been isolated. Various types of segmentation used are:

Edge detection algorithm-It is a well-developed field on its own within image processing. Region boundaries and edges

are closely related, since there is often a sharp adjustment in intensity at the region boundaries. Edge detection techniques have therefore been used as the base of another segmentation technique.

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Cluster segmentation

The K-means algorithm is an iterative technique that is used to partition an image into *K* clusters In this case, distance is the squared or absolute difference between a pixel and a cluster center. The difference is typically based on pixel color, intensity, texture, and location, or a weighted combination of these factors. *K* can be selected manually, randomly, or by a heuristic. This algorithm is guaranteed to converge, but it may not return the optimal solution.

Clustering based segmentation techniques are used to identify red blood cells, Sickle-cells [6] and Plasmodium parasites [7] present on microscopic slides. Image features based on color, texture and the geometry of the cells are generated and based on their feature classification of cells are done. Further apply feature extraction process to determine the characteristics of affected RBCs and thus make an artificial neural network to automatically diagnose sickle-cells disease affected person.

Thresholding

Techniques which make decisions based on local pixel information are effective when the intensity levels of the objects fall squarely outside the range of levels in the background. Because spatial information is ignored however, blurred region boundaries can create havoc. This technique is mostly used for the classification of RBC and WBC.

Fractal Dimension

Fractal dimension is an important parameter of Fractal geometry that find Significant applications in various fields including image processing. Image analysis is a high-level image processing technique to identify the image features such as texture, roughness, smoothness, area and solidity.

Fractal dimension is an index for characterizing fractal patterns or sets by quantifying their complexity as a ratio of the change in detail to the change in scale. Several types of fractal dimension can be measured theoretically. Fractal dimensions are used to characterize a broad spectrum of objects ranging from the abstract to practical phenomena, including turbulence, river networks, urban growth, and human physiology, medicine, and market trend. Fractal dimensions were first applied as an index characterizing complicated geometric forms for which the details seemed more important than the gross picture. For sets describing ordinary geometric shapes, the theoretical fractal dimension equals the sets. There are various fractal dimensions measuring technique:-

Box counting method

The box counting method is analogous to the perimeter measuring method. In this case, we cover the image with a grid, and then count how many boxes of the grid are covering part of the image. Then we do the same thing but using a finer grid with smaller boxes. By shrinking the size of the grid repeatedly, we end up more accurately capturing the structure of the pattern. Using the box counting method, fractal dimension is again the slope of the line when we plot the value of $\boldsymbol{log(N)}$ on the Y-axis against the value of $\boldsymbol{log(r)}$ on the X-axis. The same equation is used to define the fractal dimension, $\boldsymbol{D}$. This time, N is the number of boxes that cover the pattern, and r is the magnification, or the inverse of the box size.

$$D_0 = \lim_{\epsilon \to 0} \frac{log N(\epsilon)}{log \frac{1}{\epsilon}}$$

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IV. FINDINGS

The blood consists of three type's blood particles red blood cells, white blood cells, and platelets. From the earlier discussed paper concluded that there are various types of techniques to classify, to count, to recognize the cells. Earlier discussed method uses the different techniques for the detection counting of object such as cells. Segmentation is most commonly used for blood cells recognition. The various types of segmentation is used for feature extraction, classification etc. Segmentation process gives better performance comparison to the other methods. This is highly accurate. From the previous discussion we found that the different edge detection techniques have been used that detect the sickle shape but it cannot be used to determine the overlapped cell [9]. The overlapped cell can be counted by using circular Hough transform technique but does not gives idea about the half cell [10]. The cluster based segmentation

method was used for feature extraction and using this many information related to shape, pixel, area, perimeter etc. are extracted which is most applicable for classification, shape recognition, counting of the normal and the deformed cells [6][7]. But ideal automated image processing has not yet been developed for recognition of sickle cell and other deformed cells. The Fractal dimension is also a technique for object detection which may be applicable to recognize normal and abnormal cells.

V. CONCLUSION

From the above literature survey it is proven that traditional method are very tedious, have less accuracy and depend on the patience of the human in pathology. Thus it may be possible to have many error. Therefore a rapid image processing method has been proposed. In this discussion the image analysis has been done on the digital image for improving the result of measuring sickle cell in human blood. Using the fractal dimension method to detect sickle cell is a new technique with image processing. The sickle cell analysis by using this method is advanced and better results are expected. This is rapid, cost effective method that can give approximate value and can further reduced than the methods proposed earlier.

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