DETECTION OF LEUKEMIA USING CIRCULAR HOUGH TRANSFORM

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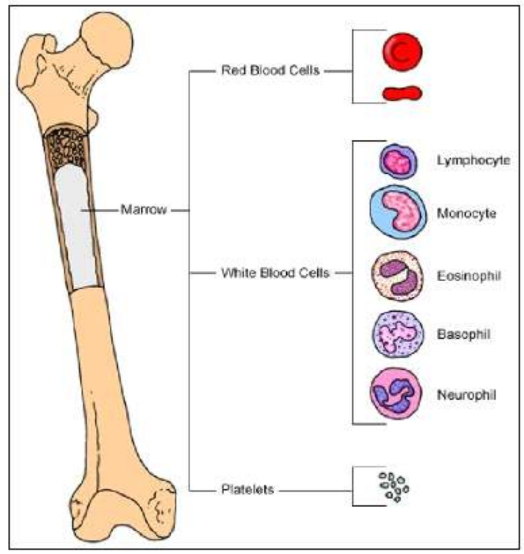
Abstract —
In this paper automated approach of leukemia detection is proposed. In a manual method of leukemia detection experts checks the microscopic image. This is lengthy and time taking process which depends on person's skill and not having standard accuracy. The automated leukemia detection system analysis the microscopic image and overcomes these drawbacks. It extracts the required parts of the images and applied CHT for finding circles and some filtering techniques . CHT uses single accumulator space to find different size circles. It is tested to be robust and able to detect partial circles or complete circle. Some of the features are extracted like WBC, defected cell, and background. The proposed system is tested on image data set and found accuracy by compare manual algorithm results and implemented algorithm results . The proposed system is successfully implemented in MATLAB.

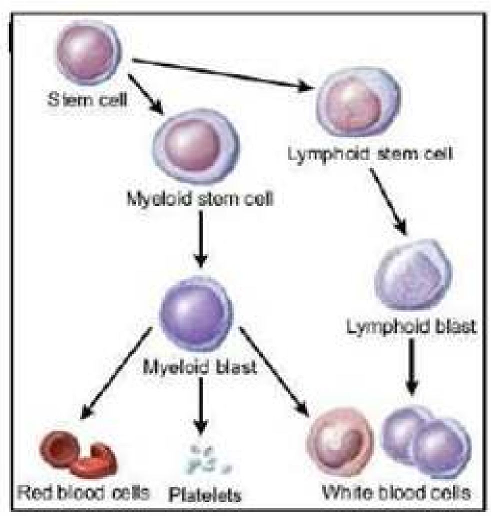
Keywords:- Image Processing, Leukemia detection, Hough Transform, Circle Detection.

Introduction:

The microscopic images of the blood cells are observed to find out many diseases. Changes in blood condition show the development of diseases in an individual. Leukemia can lead to death if it is left untreated. Leukemia originates in the bone marrow. Each bone contains a thin material inside it which is also known as a bone marrow which is shown in fig 1(a). The components of blood are RBC, WBC, and Platelet.

Leukemia is detected by analyzing the WBC. So our study is only focused only on the WBCs. There exists five types of WBCs in blood which are lymphocytes, myelocytes, neutrophil, basophil , and eosinophil. In leukemia , abnormal WBC are been procedure by the bone marrow.





This abnormal WBC should die after some time but they don't and thus they become numerous in count. This numerous abnormal WBC interrupt normal WBC in doing their work. Leukemia can be classified based upon how fast it becomes severe. It is classified as chronic or acute.

like normal WBCs and gradually increases Chronic Leukemia: Infected WBC perform and become severe . Chronic leukemia is sub divided into two types:

Chronic Lymphocytic Leukemia (ALL).
Chronic Myeloid Leukemia (CML).

Acute Leukemia: Infected WBC don't perform like normal WBC and they increases rapidly in count and becomes severe. Acute Leukemia is sub divided into two types:

Acute Lymphocytic Leukemia (ALL).
Acute Myeloid Leukemia (AML).

LITERATURE SURVEY :-

In the literature, some has done a valuable work in making the automated system for detecting the leukemia from pathological image. Piuri performed WBC segmentation using edge detection and trained a neural network by morphological features to recognized lymphoblast.

Ghosh introduced a technique to find out accurate threshold for the segmentation of the leukocytes. He used fussy diversions in that technique. He has used various functions like Gaussian, Gamma, Cauchy etc in that technique. This technique works well for segmenting the nucleus but the extraction of cytoplasm has not been taken care which is also an important as the nucleus extraction in cancer detection. Escalante invented a scheme for classifying the leukemia using the swarm model. The leukemia cells need to be isolated manually to make the system work. These isolated cells are then segmented by Markov random fields. This nucleus and cytoplasm are then used to find out features of the types of leukemia.

Dorini proposed a scheme for the nucleus extraction. The water shed transform has been used in this scheme which is based on the image forest transform. He has extracted cytoplasm by using the size distribution information. This system is not working well if the cytoplasm isn't round.

BASIC IMAGE PROCESSING:

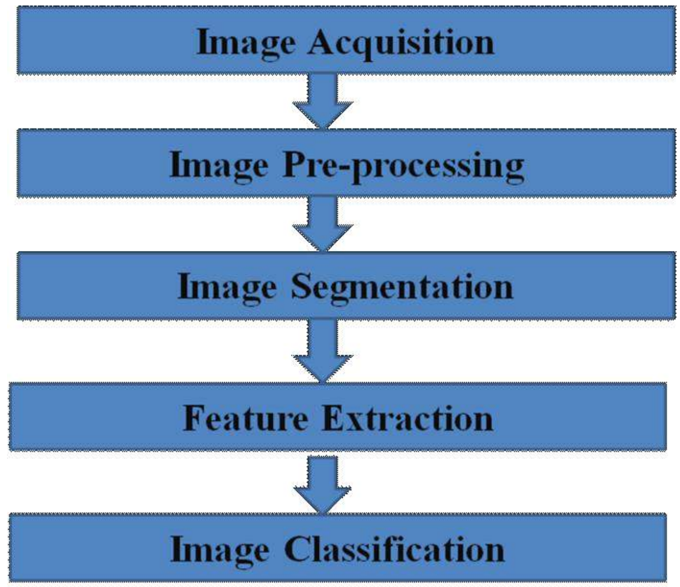


Figure: Basic Image Processing

IMPLEMENTED ALGORITHM:

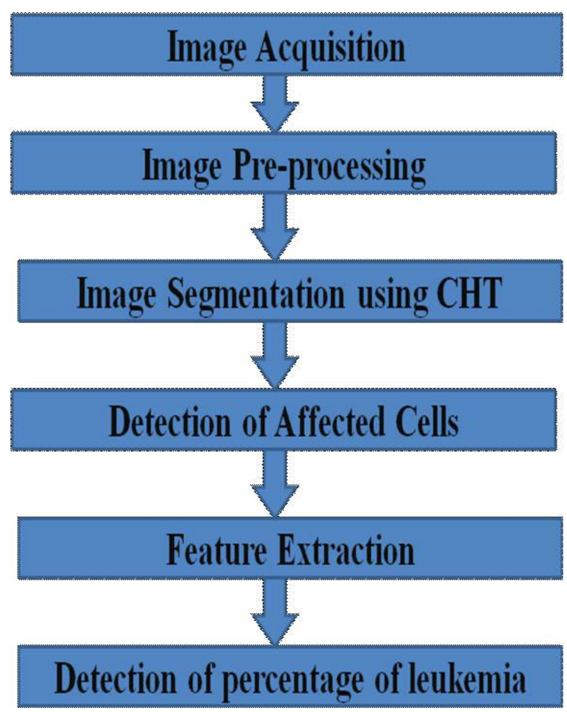


IMAGE ACQUISITION: In this module it consists of three main parts which are capturing image , cropping pathological image and storing image into system database.

IMAGE PREPROCEESING: In image preprocessing module we convert the RGB image into grey scale image or binary image and apply unsharp filters, median filter as per or requirement.

IMAGE SEGMENTATION: In image segmentation we have used the technique Circular Hough Transform.

CIRCULAR HOUGH TRANSFORM:

Circular objects occur often in real images and it is very important for many applications to detect these circular objects rapidly and accurately. The Circular Hough Transform (CHT) is the most widely used method for detecting circles. Different variations of the CHT have been introduced to reduce the high computation and high storage requirement of the CHT. These variations include methods that have made use of edge orientation; use of single accumulator space for different circle sizes, use of phase to code radii and use of Hough transform filters.

The classical Hough transform was introduced to detect lines in an image by a voting procedure. Duda and Hart modified the Hough Transform to detect arbitrary shapes like circles. Each edge pixel participates in the accumulator space by making a circle of votes around it with a radius equal to the radius of the circle that is being detected .

Another variation was introduced by Kimme which made use of the orientation of edge pixels in the voting process. This method saves a lot of computation and memory since each edge pixel makes only one accumulator space vote in the direction of the circle center .Minor and Sklansky proposed a method of using one accumulator space instead of many for detecting different size circles.

This is achieved by having each edge pixel set different votes in the direction of the circle center. The convolution between the image and a circle operator has been found to be equivalent to CHT. The accumulator space is the outcome of the convolution where the peaks are the location of the circle centers. This Generalized Hough Transform (GHT) was introduced by Ballard. Equation of Circle is given by:-

$$(x - a)^2 + (y - b)^2 = r^2$$

where, a &b represents coordinates of the circle , r represents radius. For each edge point,a circle is drawn with that point as origin and radius r .

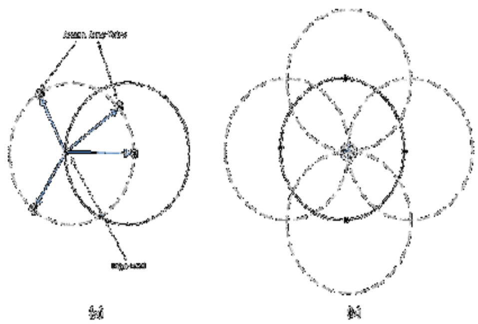
The CHT uses a 3D array along with 1D and 2D array representing the coordinates of the circle and the third specify the radii. The values in accumulator are increased every time a circle is drawn with desired radii over edge pixel. The accumulator keeps a count of how many circle passes through coordinates of each edge point proceed to a vote to find the highest count.CHT is used because of its robustness in the presence of noise and varying illumination. The CHT is not a rigorously specified algorithm; rather there are a number of different approaches that can be taken in its implementation. There are three essential steps which are common to all methods:-

Accumulator Array Computation.
Center Estimation.
Radius Estimation.

Accumulator Array Computation :-

Foreground pixels of high gradient are selected as candidate pixels and are allowed to cast 'votes' in the accumulator array. Basically Accumulator Array Computation is used to find distance transform between pixels and edge pixels in the images.

Each pixel participates in accumulator space by making a circle of votes around it with a radius equal to the radius of circle that is being detected. We can use single accumulator for detecting different size of circle by having each edge pixel set at different votes in the direction of circle center. It is represented by [a , b , r]=0.Figure shows the Classic CHT voting pattern:

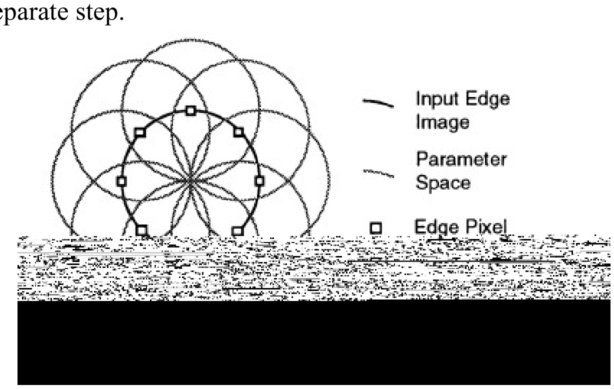


Center Estimation :-

The votes of candidate pixels belonging to an image circle tend to accumulate at the accumulator array bin corresponding to the circle’s center. Therefore, the circle centers are estimated by detecting the peaks in the accumulator array. Figure 1b shows an example of the candidate pixels (solid dots) lying on an actual circle (solid circle), and their voting patterns (dashed circles) which coincide at the center of the actual circle.

Radius Estimation:-

If the same accumulator array is used for more than one radius value, as is commonly done in CHT algorithms, radii of the detected circles have to be estimated as a separate step.



The CHT may be further enhanced by considering a range of radii simultaneously. This can convert the three dimensional accumulator arrays into two dimensional arrays. The circles in the three dimensional accumulator array around an edge point are considered together to form a truncated cone. This is done by using the edge direction circles this may collapsed to lines down the sides of this cone. Projecting these lines onto two dimensions, figure gives the "spoke" filter.

Figure: (a) 3D accumulator array (b) result of collapsing into 2D array.

The common computational features shared by algorithms are as follow:

- Use of 2-D Accumulator Array:

The classical Hough Transform requires a 3-D array for storing votes for multiple radii, which results in large storage requirements and long processing times.

Both the Phase-Coding and Two-Stage methods solve this problem by using single 2-D accumulator array for all the radii. Although this approach requires an additional step of radius estimation, the overall computational load is typically lower, especially when working over large radius range. This is a widely adopted practice in modern CHT implementations.

- Use of Edge Pixels:-

Overall memory requirements and speed is strongly governed by the number of candidate pixels. To limit their number, the gradient magnitude of the input image is threshold so that only pixels of high gradient are included in tallying votes.

- Use of Edge Orientation Information:- Another way to optimize performance is to restrict the number of bins available to candidate pixels. This is accomplished by utilizing locally available edge information to only permit voting in a limited interval along direction of the gradient.

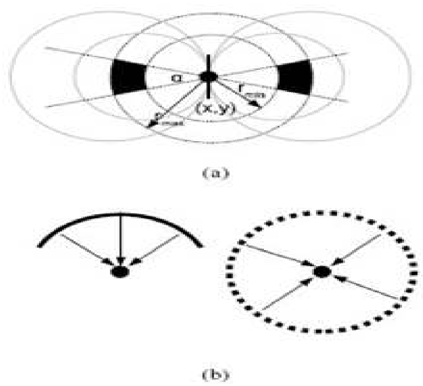


Figure: Accumulator Array Computation.

Methods used in CHT:-

There are two methods used by CHT to find the radii of circle-

- Two Stage
- Phase Coding

1. Two Stage method:-

This method uses a histogram to find the radius of circle. Pixels in the perimeter of the circle can participate in the detection of the circle. In CHT these pixels participate to the accumulator space by a set of votes around its location with a radius equal to the circle being searched. This is performed by finding the edge detection of the image. The edge map and the edge orientation can be found by the magnitude and angle of the gradient:

A threshold is set to convert the edge map into a binary image where the zero pixels represent the background and the ones represent the edges in the image that are stronger than the threshold value. Once the edge pixels have been identified, a distance transform is applied.

$$G=\sqrt{Gx^2+Gy^2} \quad , \theta = a\tan2(Gy\ Gx).$$

$$d(i,j)=\sqrt{(r-c)^2+(c-f)^2}$$

d(i,j)=distance between any two pixel.

(r,c).(r,c)=vectors of edge pixel location.

For each vector d(i,j) a histogram vector h is calculated.

$$h=\sum_{i=1}^{k} mi$$

where mi =counts the frequency of a value in an image. The histogram for each vector d(i , j) shows the frequency of the pixel distances

between the pixel (i , j) and all the edge pixels.

The number of pixels that share the same distance from (i,j) is used as the votes for the accumulator space. The same process is repeated for all pixels (i,j) in the image which results in an accumulator space.

2. Phase Coding:-

Atherton and Kerbyson introduced a complex phase coding (from 0 to 2∏) along the length of each spoke to give a complex accumulator space. The phase coding represents the size of the circle along the length of the spoke. Constructive accumulation occurs in the accumulator space when spokes intersect with the same phase, i.e. contributions to a point in the accumulator array are only in-phase if that point is the centre of a circle. This technique has superior noise response characteristics, increasing the detection rate over the above two techniques.

FEATURE EXTRACTION:

This module extracts the features which are region of interest which are as follow:

- WBCs(white circle).
- Defected dark circle.
- White background.

After extracting the above features we subtracted the detected WBCs(white circle) and white background portion from total pathological image and as a resultant we get the defected cell(dark circle).

RESULT AND CONCLUSION:

Median Filter			Unsharp Filter			Without Filter		
Manual	Algorithm	Relative % of detection	Manual	Algorithm	Relative % of detection	Manual	Algorithm	Relative % of detection
2.23	7.13	31.27	7.30	12.02	60.73	2.87	8.57	33.48
9.72	18.33	53.02	21.75	40.17	54.14	13.53	18.25	74.13
5.76	26.82	21.47	3.96	28.60	13.84	1.88	24.78	75.86
12.57	12.48	100	16.98	20.40	83.23	12.99	13.08	99.33
12.84	11.93	107	17.58	20.64	85.17	13.29	13.32	99.77
2.23	7.13	31.27	7.30	12.02	60.73	2.87	8.57	33.48
10.88	28.46	38.22	23.55	34.56	68.14	14.87	23.74	62.63

Sample Image

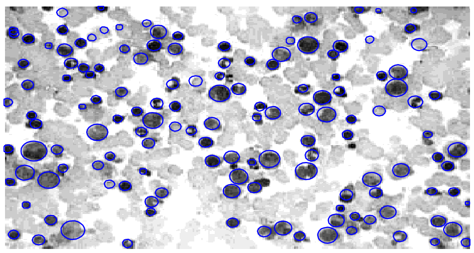


Fig:- **Finding Defected cells**

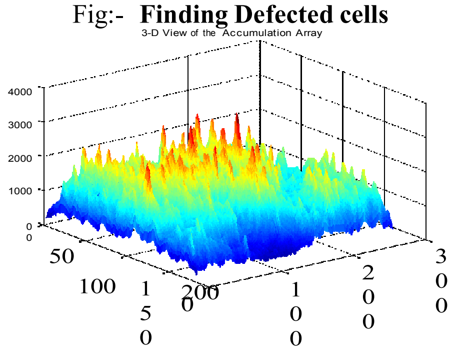


Figure : 3-D View of Accumulation Array

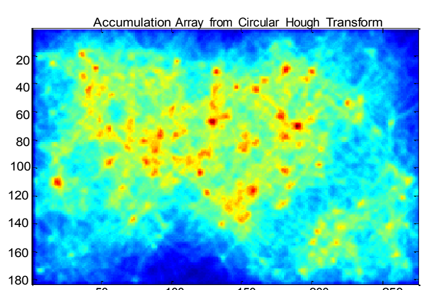


Figure : Accumulation Array from CHT

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