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SURVEY OF TECHNIQUES IN LEUKEMIA DETECTION IN DIGITAL IMAGE PROCESSING

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Abstract:

Leukemia is a blood cancer that begins in bone marrow. It should be treated at earlier stage and it leads to death if left untreated. AML is a subtype of acute leukemia, which is common in adults. The average age of a person with AML is nearly 60 years. The need for segmentation algorithm of leukemia detection arises since current methods involve manual examination of the blood smear as the first step towards diagnosis. This paper presents a general review of methods that have been used for the detection of leukemia.

Keyword: Enhancement, Feature extraction, Leukemia, Segmentation.

1. Introduction

Jagadeesh et al described about the detection of leukemia which is based on the count of the red blood cells, platelets, white blood cells and hematocrit [1]. Poornima and Karthikeyan classified the types of leukemia based on which type of cells get affected [2].

Leukemia leads to the increased production of White Blood Cells (WBC) which influx the blood stream. It can be identified with the variation of the count in blood cells. WBC count measures the number of white blood cells in a drop of blood. A high WBC count is the result of infection or leukemia. These abnormal White Blood Cells will not be able to fight infection and impair the ability of the bone marrow to produce Red Blood Cells and Platelets. Due to this effect, the count of RBC and platelets in leukemia patients is low. The ratio of volume of the red blood cells to the total volume of blood is called as hematocrit. Low level of hematocrit leads to

anemia, which further leads to leukemia. Leukemia can also be classified based on the type of white blood cell that is affected and how quickly the disease develops. Leukemia is either acute or chronic. It occurs when a hematopoietic stem cell undergoes malignant transformation into a primitive, undifferentiated cell with abnormal longevity. It is a fast growing leukemia that progresses quickly without treatment.

Chronic leukemia starts in blood-forming tissues such as the bone marrow, and causes large numbers of white blood cells to be produced and enter the blood stream. It is a slow growing leukemia.

Based on white blood cells leukemia is classified into two main types. They are lymphoid cells and myeloid cells. Lymphoid cells generally develop in the bone marrow and some times in the spleen. If these lymphoid cells get affected then that causes lymphoid leukemia. Leukemia that starts in myeloid cells is called myeloid leukemia.

Types of leukemia

Chatap and shibu expressed about variation in types of leukemia which may be acute or chronic which leads to the imbalance in the human blood system [3].

Acute myeloid leukemia (AML): AML is the most common type of leukemia. It usually starts in the cells of bone marrow and turns into white blood cells. However, in AML do not develop and they are unable to ward off infections.

Acute lymphocytic leukemia (ALL): ALL is a type of cancer of the blood and bone marrow. It progresses rapidly and creates immature blood cells rather than the mature blood cells.

Chronic myeloid leukemia (CML): CML is a type of cancer that affects the blood and bone marrow in which the bone marrow produces too many white blood cells called granulocytes. As the number of granulocytes increase in the bone marrow chronic myeloid leukemia get worse.

It usually occurs in adults and rarely occurs in children.

Chronic lymphocytic leukemia (CLL): CLL is the slow growing cancer. In this too many immature lymphocytes are found mostly in the blood and bone marrow which in the further stages, it is found that the cancer cells are seen in the lymph nodes.

2. Steps Involved In Image Processing:

2.1 Image Enhancement:

Bamothra and Radhawa described about the importance of enhancement in the image processing which involves the noise removal, histogram equalization and few factors [4].

It is one of the most important techniques in image processing. It enhances the quality and information of the image and it deals with the visualizations of the images. This technique is used to remove the background noise for the purpose of defining the focal areas like nucleus. In this, by using software we can manipulate the stored image. The software includes filters, image editors and tools for changing the other properties of an entire image. The techniques used for image enhancement are of various types.

Histogram equalization: Histogram equalization is used to enhance the contrast and for adjusting the image intensities. It can be applied to the images with dark or bright foregrounds and backgrounds so that it can show the better view of the affected area. The required image data for processing will be represented by the values of contrast. By adjusting the contrast value the intensities of the image can be increased. Due to the increase in the intensity values the low contrast areas will be changed into the high contrast areas. Probability Mass function (PMF) and cumulative distributive function (CDF) is calculated for all the pixels in the image by which we obtain a new gray values. These new gray values can be mapped with old gray values which results in the new histogram. The shape of the new histogram is obtained by stretching the old histogram.

Soile described that morphological image processing is completely based on pixel values which should be compared with the neighbouring pixel values, which forms a new image with the new pixel values [5]. Makandar and Halali determined about the low pass and high pass filtering techniques for noise removal [6]. Bamothra and Radhawa present the different techniques in histogram equalization for the image enhancement [4].

Morphological image processing: This image processing technique takes a binary image or grey scale images and a structuring element as input. Image is processed based on the shape which is encoded in the structuring element. This morphological operations are based on pixel values but not on the numerical values. The structuring element can be positioned in the binary image in all the possible locations and it will be compared

with the neighbourhood pixel values. It will check whether the neighbourhood values are intersecting with the structuring element values. This results in the formation of new binary image.

Noise removal using filtering techniques: Digital images are easily affected to various types of noises which results in the disturbance in the original image. Due to the noise the pixel values in the image can give the false intensities instead of the true intensities of an image. Noise removal algorithms can reduce the noise by smoothening and sharpening the entire digital image except the locations near contrast boundaries. Low pass and high pass filters can be used as noise removal algorithms. Smoothening is a low pass operation in the frequency domain which can be achieved by Gaussian low pass filter, Ideal low pass filter, Butterworth low pass filter.

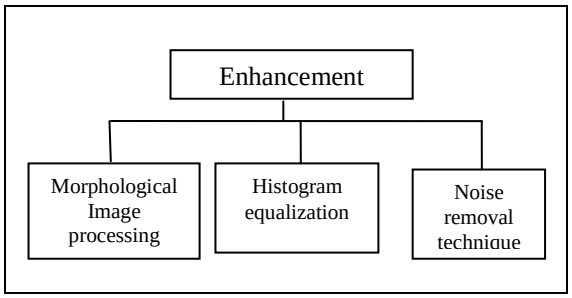

Fig 2.1 Image enhancement

2.2 Image Segmentation

Image segmentation is a process of dividing a image into multiple parts or segments (sets of pixels). This process can change the image to the easier form to analyze the properties. In this we can assign a label to each pixel, if it matches with the neighbourhood label then it can share the characteristics of that particular label. These characteristics such as colour, intensity or texture. These similar labels can be grouped together. There are several techniques in segmentation. They are edge based segmentation, region based segmentation, clustering based segmentation, threshold segmentation. The output of the image segmentation is a set of classified elements.

Edge based segmentation:

Mahisat fatma et al proposed about the edge segmentation techniques. He discussed about the different edge segmentation techniques for image processing. He also discussed about the canny edge detector and[7]. Muthukrishna and radha described about classical edge detectors[8].

It is a image segmentation technique in which it will find the boundary of an image within itself. It identifies the discontinues which are present in an image. The result of edge detection is to reduce the amount of data to be processed. Edge detection is the broadly used technique and it is a good feature extraction technique and hence used in various extraction and detection techniques. There are several methods in edge detection.

Gradient based operator: It detects the edge by finding the maximum and minimum in the first derivative of the image. It is also called as first order edge detector. The gradient detection is further divided into canny edge detectors and classical edge detectors.

Canny edge detectors: It is introduced by canny in 1983. It mainly focuses on the separation of the background noise and it also finds the effective edges for optimized solutions. It is a standard technique.

Classical edge detectors: It can be achieved by using some operators. They are Robert, Prewitt and Sobel operators.

Robert operator: It is simple and quick to operate on an image. In this the pixel values at each point in the output represent the absolute magnitude of the spatial gradient in the input image.

Prewitt operator: It is similar to sobel operator and it is used in the detection of vertical and horizontal edges in images. The advantage of this technique is to provide a better performance and higher responses for noisy images. Sobel operator: The approximate partial derivation in the gradient is determined by the sobel operator.

Laplacian based operator: It is also called as second order edge detector. This is used for finding

the second level gradients. This operator works only if both input and output images are gray scale images.

Clustering based segmentation:

Pise et al describes the importance of clustering in segmentation. He proposed about the k-Means clustering technique [9]. Nameirakpam also described about the k-means clustering and all that factors it is dependent on [10]. Mariena and sathiaseelan described about the fuzzy c-means clustering[11].

Clustering is an important technique when the application is data mining and data analysis. It is a method in which the objects are unified based on the characteristics of the image. A group of objects similar between them and are not similar when compared with the additional objects is called as a cluster. There are many types of clustering methods. In this paper we describe about two algorithms. They are k-means clustering algorithm and

Fuzzy c-means clustering algorithm. K-means clustering algorithm: This technique is used to partition the image into k-clusters. Every cluster in the partitioned image belongs to a particular pixel value with the nearest mean. Clustering is done based on some features of the image like intensity of the image, texture, location or combination of all these factors. K value can be selected according to the user or randomly. The result or output of the technique depends upon the selection of k value or the number of clusters which are made.

Fuzzy c-means clustering: It is also called as soft clustering. In this technique to one cluster many data points are assigned. To each data point a membership function is assigned using fuzzy logic. Therefore these membership functions determine the degree of the participation which determines the data point of the particular cluster. The function with the lower participation indicates the lesser degree of participation than the central cluster. This algorithm allows the clusters to grow in to the natural shape by using mean and standard deviation of the pixel values. This is simple but it is widely used for segmentation. By using this cluster location and neighbourhood smoothing is obtained.

Region based segmentation:

Sharma et al proposed that region based segmentation is based on the selection of the initial seed points which are pixel values and few parameters[12]. Kandil et al described that there is a desired threshold value for the selection of seed points[13].

It is a simple region and pixel based segmentation process. This process continues by finding the initial seed points. This segmentation can be approached by determining the neighbourhood pixels for whether it should be added to the region. Homogeniety is one of the region growing segmentation criterion. This depends on grey level, colour, texture, shape, and model. Initially we have to select a set of seed points. This selection is based on the homogeneity. The topics that should be taken into consideration are

a) Selection of seed points should be appropriate.

b) Get clear information about image

c) Minimum area threshold value

In this segmentation we should mark the strongest lightening parts of the image. Then we should determine the seed points within the range of the threshold and then we can mark the points which are holding the value

above the threshold range. Then we can see the difference between the two images. All these seed points should be connected. This process provides the ability to resist noise

The main advantage of this segmentation is it provides the clear edges in the images which leads to the good segmentation and also the concept is simple.

The disadvantages are – expensive, sensitive to noise.

Threshold based segmentation:

Trupti et al proposed that usage of otsu method can give better result in thresholding[14]. Minal et al determined a easy way to detect the leukemia cells by using the threshold value[15].

Thresholding is the process of converting the gray scale images into binary images. In this every pixel value can be replaced with another black pixel in an image. For example if intensity of an image is greater than the fixed threshold value when the dark portion completely become black. By this, we can separate the light and dark regions through the segmentation.

Global Thresholding: In global thresholding, it can set an intensity value (threshold), so that two phases can be formed by grouping of below threshold values as one phase and grouping of above threshold phase as another phase. This can reveal two histogram. Sometimes, it can be achieved by automatic choice of the threshold. The output can be packed in (0, 1) bit format. The values which are below the threshold value can be set to 0 and remaining will be 1. The steps in global algorithm are

a) Estimate the threshold value.

b) Segmentation by comparing the intensities

c) Calculation of average intensities.

Get new threshold value if T- T(new)> delta T go to step (b) and continue.

Otsu Threshold: It is one of the methods used to perform clustering based Image. The steps of the Otsu algorithm.

a) Separate into two phases based on pixel values.

b) Calculate the each cluster mean.

c) Difference between the mean values should be squared.

d) Multiply the pixels from one cluster to another cluster.

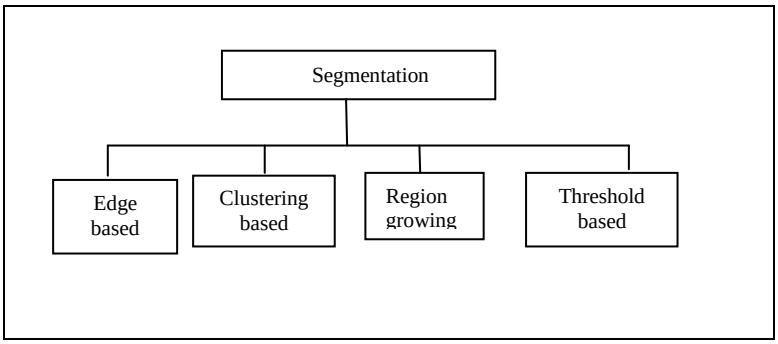

Fig 2.2 Image segmentation

3. Neural network segmentation

Mahapatra et al proposed that, this segmentation can be considered as pixel classification problem and neural architecture is applied to classify the every pixel value into cytoplasm and nucleus. Neural network segmentation can also designed for automated leukemia detection [16]. This technique applied successfully because of its real time success in all aspects, signal to noise independency and easy implementation. We can classify the neural networks based on the hidden layers and how it is connected to the next layer. These layers can performs a basic function. Rodrigues proposed that neural networks are used in the classification of pixels in the computer vision and also in various areas[17].

4. Feature Extraction

Dong ping Tian described about the feature extraction in leukemia and determined the importance of the feature extraction in image processing [18]. Atira et al described about how the hd dimension can be found which is the important technique in feature extraction [19].

In order to detect the presence of leukemia, feature extraction is an important step. After segmentation many steps are taken into consideration in order to detect whether leukemia is present or not. One of the techniques is by finding the hausdorff dimension. And also by using shape based features like area, perimeter, mean, standard deviation, solidity, elongation, compactness etc it can be detected. Since the area perimeter, mean, standard deviation, solidity, elongation, compactness of the normal blood cell and the affected blood cell varies, it can be detected easily.

Hausdorff dimension can be found in the following process:

a) Initially the RGB image is converted into grey scale image

b) After the conversion it's edges are detected using the edge detection method i.e it's nucleus is detected

c) Then the grid of R squares is super imposed over the edges, then the HD dimension is calculated as follows

HD = log(R)/log(R(S))

here R is the number of squares in the grid, and R(s) is the number squares (box count) which are occupied. Higher HD signifies higher degree of roughness.

Geometric features:

Area : No: of non-zero pixels present in the image region.

Perimeter : Distance between successive boundary pixels.

Circularity : It is calculated by using area and perimeter

Circularity = 4*pi*Area/perimeter

Eccentricity $= \frac{(a^2-b^2)^{1/2}}{a}$

Where 'a' is the major axis and 'b' is the minor axis in the nucleus image. These are the few important features in extraction.

5. Conclusion:

In this paper, the main aim is to detect leukemia by using different methods and also there is brief explanation about the types of leukemia. In this process of detection we discussed different types of enhancement and segmentation techniques. Segmentation involves various types of algorithms to process the image. Some of the methods give better accuracy in detecting leukemia when compared to that of hematologist. Segmentation is followed by feature extraction. These techniques can be preferred on the few aspects like accuracy, less noise and good performance.

Conflicts of Interests: Authors have none to declare.

References:

1. S.Jagadeesh, Dr.E.Nagabhooshanam, Dr.S.Venkatachalam,2013, Vol 1,pp 01-04.
2. N.Poornima, T.Karthikeyan ,2016, Vol 5, pp 587-590
3. Niranjan Chatap, Sini Shibu, 2014, Vol 16, pp 79-87

4. Amanjot Kaur Randhawa , Alka Bamotra ,2017, Vol 6, pp 21443 -21447

5. Dr. Pierre Soille, Morphological Image Analysis, Berlin, 2004.

6. Aziz Makandar, Bhagirathi Halalli, 2015, Vol 109, pp 12-15

7. Mashiat Fatma, Jaya Sharma, 2014, Vol 4, pp 66-71.

8. Muthukrishnan.R, M.Radha , 2011, Vol 3, pp 259-267

9. Sneha Pise , H. R.Turkar, A. V. Anjikar, A. Golghate, P. Khobragade, 2017,Vol 5, pp 4026 - 4032.

10. Nameirakpam, Dhanachandra, Khumanthem Manglem,Yambem Jina Chanu ,2015, Vol 54, pp764- 771.

11. Mariena A.A, DR. J.G.R.Sathiaseelan, 2017, Vol 6, pp 367-372

12. Neha Sharma, Dr Supreet Kaur, 2016, Vol 4, pp 15038-15045

13. A.H. Kandil, O.A. Hassan, 2016, Vol 133, pp 01-08

14. Mrs. Trupti A. Kulkarni-Joshi, Prof. Dilip S. Bhosale, 2014, Vol 3, pp 7253-7258.

15. Ms. Minal D. Joshi, Prof. Atul H. Karode , Prof. S.R.Suralkar, 2013,Vol 2,pp 147-151.

16. Subrajeet Mohapatra, Dipti Patra, Sunil Kumar, Sanghamitra Satpathy, 2012, Vol 2, pp 100-110.

17. Pedro Rodrigues, Manuel Ferreira, João Monteiro, Segmentation and Classification of Leukocytes Using Neural Networks: A Generalization Direction, Berlin, 2007.

18. Dong ping Tian, 2013, Vol 8, pp 385-396

19. Athira Krishnan, Sreekumar K, 2014, Vol. 5, pp 7877-7879.

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