International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 03 | Mar 2021 www.irjet.net p-ISSN: 2395-0072

A REVIEW OF LEUKEMIA DETECTION TECHNIQUES IN IMAGE PROCESSING

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Abstract -- There are many deadly diseases present in a large population of the people in the world and cancerous diseases are few of them. By proven analysis, it is known that early diagnosis is very important for acute leukaemia. A traditional way of diagnosis is not sufficient as it is done manually using a device known as Haemocytometer and has various drawbacks. So, developing a medical diagnosis system based on machine learning for it's prediction is required. By predicting the disease in an earlier stage reduces the cost of treatment and it also plays a crucial role in the treatment. The existing system uses count of blood cells as the parameter to detect acute leukaemia. This proposed prediction system's application uses microscopic image of blood cells as input of the patient's data and predicts the cells as normal or not. Our goal is to detect acute leukaemia based on given microscopic image of patient's blood cell. The proposed model makes the things easier and simpler to find some complicated predictions about acute leukaemia.

I. INTRODUCTION

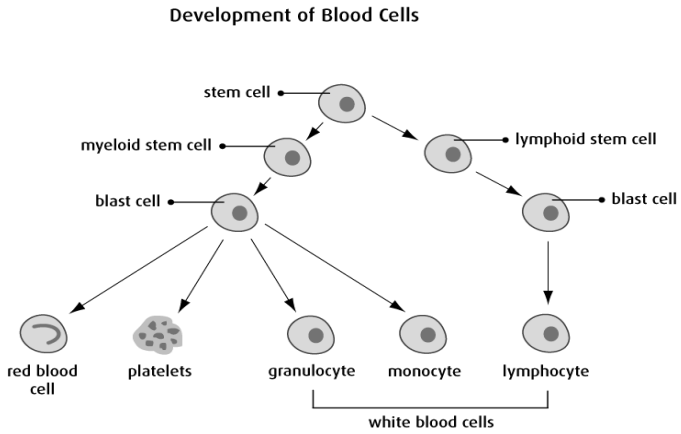
Leukemia is a special type of cancer that affects blood stem cells. Blood stem cells are basic unit of cells and are of different types. Blood stem cells are of two types, one is lymphoid stem cell and other one is myeloid stem cell. Further as the cell grows, lymphoid stem cell develops into lymphocytes and these lymphocytes are of three types, B cell, T cell and natural killer(NK) cell. Lymphocytes helps body in fighting bacteria and to get rid of dead or abnormal cells. As same as lymphoid growth, as the cell grows, it develops into red blood cells(RBC's), granulocytes, monocytes and platelets. These four types of cells has same unique and important functions like RBC's is the one that will transfer blood from one body part to another. Granulocytes and monocytes are type of a WBC's and does the same function as that of WBC. Platelets helps in healing by clotting the blood.

Blood contains stem cells and as time goes, these stem cells grows into blood cells but sometimes stem cells also grows into immature blood cells also called as blast cells. These blast cells are responsible for leukemia disease. When stem cells produces blast cells more than normal blood cells and crowds them so that normal blood cells can't do their job properly then this situation is called as leukemia and these blast cells are called leukemia cells.

There are two types of leukemia and are named after stem cells they are formed. One is lymphoblastic leukemia and another one is myelogenous leukemia.

They are also classified on the basis of there speed of growth. Acute leukemia and chronic leukemia are the two types of leukemia. Acute leukemia grows faster(months) and chronic leukemia grows slower(years).

As discussed, leukemia can be classified on the basis of their stem cells they grows or speed of their growth. So there can be 4 types of leukemia, lymphoblastic leukemia, myelogenous leukemia, acute leukemia and chronic leukemia. There are many techniques to detect leukemia, traditional method is to manually count the white blood cells by analysing blood cell images because as we know that leukemia affects white blood cells. But manually counting of cells have some flaws, first that it is time consuming and degree of correctness depends on the skills of individuals. Another method is to automate the whole process of counting of white blood cells by developing a model that can automatically count the white blood cells. This method is more efficient because it is not that time consuming and degree of correctness is also on the higher side.

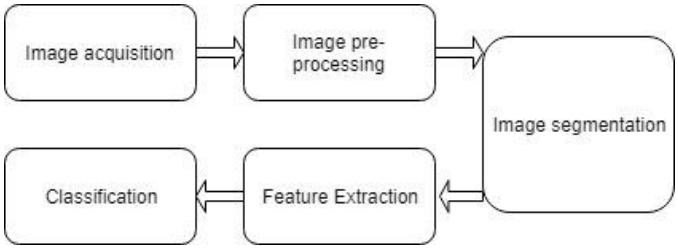


Components of Automatic Detection System

Automatic detection of leukemia is a three step process. First segmentation, then feature extraction and at last classification. At segmentation stage, focus is on to separate white blood cells from the blood sample image. At feature extraction stage, numerical values are calculated for the blood image. At classification stage, a classifier is used to get the result that patient is affected by leukemia or not.

1) *Segmentation*: In segmentation, target object is identified using slightly difference in brightness and other features.
2) *Feature Extraction:* This step is the most crucial part for classification. Several features are extracted in terms of numerical values from the target object and these features are used in classification.
3) *Classification:* Classification is the process of providing output in terms of classes like affected or not affected. Unique features are used to train the particular classifier.

Apart from above important steps there are some basic steps also. The whole detection process will go like this :-



II. LITERATURESURVEY

In this literature survey, methods and techniques used in leukemia detection through image processing is discussed.

A. Acquisition of images, image pre-processing

Image acquisition of images is the first step in the detection of acute leukemia. At this stage, images of blood smear images samples will be collected from different sources and can also be captured using camera and collected in the form of digital data. The Quality of blood sample image is determined using microscope, when a cell is seen through the microscope, light exposure will determines it's quality. After blood sample images are acquired then comes the image pre-processing step. There are various steps in image pre-processing. Image color from RGB is converted to CMYK [0].

B. Image segmentation

After image pre-processing, comes the image segmentation step. At this stage images will be separated on the basis of same or similar characteristics [20].As it is known that Blood cells contains several cells, White blood cells, Red blood cells, Platelets, etc But detection of leukemia only requires white blood cells thus all the cells are rejected or precisely segmented from white blood cells Thus the Sole purpose of segmentation is to segment the white blood cells from other cells and get it's nucleus to be analysed further.

In [1] L * a * b color space and used Fuzzy C-Means clustering method with the help of color based segmentation and thus created four clustered white blood cells. L * a * b * color space has two-dimensional space as compared to the three-dimensional RGB color.

In [2] utilizedotsu threshold method to get the effective segmentation.

In [3] comparison is made among three segmentation methods, K-means, Fuzzy C-means, and moving K-means.

In [4] K-means method with k=4is used with grayscale color space. In [6] additionally they utilized K-means division yet division is finished utilizing the estimation of H and S in HSV color space. In [5] used L * a * b * color space same as that used in [1] and additionally used K-Means Clustering method and as a result obtaining nucleus of white blood cells which the is followed by Otsu thresholding and thus obtained a binary image which will then remove the region which is not required and as a result obtain a clear and well defined white blood cell nucleus images which will be used for classification .

In [7] HIS color segmentation is used to enhance the contrast of the image and to improve the result through segmentation. Based on [8], it also used HIS color segmentation but used thresholding in color space and also region growing and median filtering method is used to get the better segmentation. In [9] also used HIS color segmentation on white blood cells.

In[10] two methods are used for segmentation. One is active contour and the other one is watershed transformation and it was also noticed that watershed method is more reliable and accurate when comes to nucleus segmentation and also computational cost is also low. Research [12] used ZACK algorithm on red blood cells for segmentation.

C. Feature Extraction

This step is the most crucial part for classification. Several features are extracted in terms of numerical values from the target object and these features are used in classification. Extracted features will be used to train the classifier to provide the result as affected or not affected.

In Research [1] selective features are extracted from lymphoblast's, that can be used to train the classifier. Shape, Size, color, texture, fractal dimension, area, perimeter, solidity form factor are some of the features that need to be extracted.

Research [2] used a method called Fisher's Discrimination ratio (FDR) to get the most efficient features for classification.

Research [10] used LAB color space to extract the features. It also used basophile intensity texture features which are useful on Lab color space.

D. Classification

Classification is the process of providing output in terms of classes like affected or not affected. Unique features are used to train the particular classifier. It is also the last step in detection of leukemia. In all the previous steps white blood were separated and then features were extracted. In this last step it will be determined whether if these white blood cells are normal or blast cells which will determine if patient is normal or affected.

In Classification[7], two classes are to be made and to be assigned to a unknown vector. Two classes will be leukemia affected or not affected. There are many classification techniques available some are : SVM, K Nearest neighbour, Naïve Bayesian, Decision tree and many more. These classifiers will be trained using the extracted features and two classes will be generated- affected or not. During classification, input image will be given and classifier will give the desired output along with desired class and will classify the image into two classes : affected or not affected.

SVM(Support Vector Machine) is one of the most important classifier for classification, in this method whole data will be divided into two : testing and training. In the training data, classifier is trained using the extracted data and SVM vector will also be trained and parameters are updated to assign them to their deserved vector. In SVM, each blast cell will be labelled as affected or not affected. All the features extracted from the feature extraction phase will be used in training and obtaining the result.

WBC plays a major role in the detection of leukemia. As it is known that WBC are very much important to human body and these resist the cancer cell also and leukemia mostly affects WBC only. If body has low count of WBC then it will affect the immune system and body will be at a high risk of infection. If body has high count of WBC then it will damage the tissue. If counting of WBC can be done successfully then leukemia detection can be done. For counting of WBC, Nucleus counting is done from the blood image. Formula is : Z = X*3000

Where Z - WBC count in cubic millimetre X - Count of WBC in an image.

Research [2] used K-nearest neighbour with Euclidean distance. In this also they trained the dataset to make two classifiers. They used morphological features of blast cell and normal lymphoblast cell.In [5] utilized successive neural system classifier with two phases, where the main stage is to recognize typical cells with unusual cells, while the second stage is to separate among ALL and AML.Next research which same with [6], inquire about [11] performed improvement utilizing HSV and FCM to distinguish dangerous and non-harmful cells. In light of research [7], they analysed two strategies for arrangement of white platelets, the Multilayer Perceptron (MLP) as in [8], however here they utilized two calculations for preparing, called Lavenberg-Marquardt calculation (LM) and Bayesian Regulation (BR). [9] additionally analysed three strategies for grouping white platelets, in here MLP

acquires the most noteworthy level of exactness contrasted and SVM and HRCNN.

Table I. IMAGE PREPROCESSING

S.NO.	REFERENCE	TECHNIQUES
1	Mohapatr a et al. 2010[1]	Selective Filtering
2	Harun et al. 2015[3]	median filter
3	Vincent et al. [5]	Otsu Threshold Morphological. filtering
4	Amin et al. 2015 [6]	HSV Color Space and histogram eqaulization
5	Nasir et al. 2013 [7]	contrast enhancement technique
6	Francis et al. 2011 [8]	Contrast Stretching
7	Mu-Chun Su al. 2014 [9]	HSI Color Space
8	Amin et al. 2015 [11]	RGB to HSV Colorspace and Histogram equalization on V band
9	Putzu et al. 2014 [12]	RGB to CMYK color model and Histogram Equalization or contrast stretching.
10	Y. Li et al. 2016 [13]	one contrast-stretched gray image and one H component image from transformed HSV color space Performed global contrast stretching
11	A.H Kandil and O.A. Hassan, 2016 [14]	Histogram of Red and Blue Component
12	C. Vidhya et al., 2015 [16]	CIELAB color space is resized and converted to RGB
13	M. Madhukar et al., 2012 [17]	CIELAB color space is resized and converted to RGB
14	N. Patel and A. Mishra, 2015 [18]	Median filtering, image cleaning,

TABLE II. IMAGE CLASSIFICATION

S.NO.	STUDY BY	TECHNIQUES	ACCURACY
1	Mohapatr a et al. 2010[1]	SVM	95%
2	Goutam et al..2015 [4]	SVM Two Class Classifier	98%
3	Amin et al. 2015 [6]	SVM	97%
4	Francis et al. 2011 [8]	Multilayer Perceptron Network usingLavenberg – Marquardt	Training Results Accuracy: 98.667% Validation Result Accuracy: 97 % Testing Result Accuracy: 94.5%
5	Alferez et al. 2013 [10]	Cells are classified into three groups: hairy, normal and chronic using Fuzzy C-Means	--
6	Putzu et al. 2014 [12]	SVM tested with common kernel: Linear (L), Quadratic (Q), Polynomial (P) and Gaussian RBF (R) and was tuned using optimization techniques to find the maximum accuracy value	--
7	S.C. Neoh et al., 2015 [15]	MLP SVM Dempster-Shafer	96.72%
8	M. Madhukar et al., 2012 [17]	SVM and three types of validation is done: K-Cross Validation,, Leave-one-out Cross Validation, Hold-out Validation	93.5%
9	A. Mishra	SVM	93.57%

	and N. Patel 2015 [18]		
10	Madhloom al. 2013[2]	KNN using Euclidean Distance	92.5%
11	Vincent et al. [5]	Sequential Neural Network	SVM: accuracy rate : 93.5% Accuracy: 97.7%
12	Nasir al. 2013 [7]	Multilayer Perceptron Neural Network with Lavenberg – Marquardt Algorithm and Bayesian Regulation Algorithm for training and Simplified Fuzzy ARTMAP Neural Network	MLP-LM network : 95.55% at 80 training epochs and seven hidden nodes. MLP-BR : 95.70% at 100 training epochs and six hidden nodes. SFAM : 92.43% at three training epochs and 0.65 vigilance parameter
13	Mu-Chun Su al. 2014 [9]	Three classifiers :SVM, Multiplayer perception and HRCNN	Accuracy of MLP : 99.11% Accuracy of SVM : 97.55% Accuracy HRCNN: 88.9%
14	C. Vidhya al., 2015 [16]	SVM	--

III. CONCLUSION

This paper showcases various techniques and studies that are been done in this field for leukemia detection. After carefully analysing all the studies conducted it has been clearly found that manual detection of leukemia is not at all feasible in today's world and automatic detection of leukemia should be carried out because it saves time and also will help in early detection of leukemia and which in turn can save the lives. It is also found that we can use many classification techniques after carefully analysing the situation and type of data collected.

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