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Region –Convolutional Neural Network For The Inspection Of Lymphoblastic Cells

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Abstract

Leukemia is identified as cancer that develops in different types of blood cells. . Most often, these type of cancer is found to be developed in white blood cells. Acute lymphoblastic cells are also known as acute lymphocytic leukemia. Acute means fast growing and develops quickly and if not attended early, may be fatal within a few months. Lymphocytes are white blood cells. ALL originate in bone marrow. Lymphoblasts are cancerous Lymphocytes. Around 25,000 children in India are found to be with this deadly disease. Here a system is introduced to identify the cancer cells at a early stage which involves RCNN(Region-CNN). The images are segmented and the variations in the geometry of these cells can be analysed using statistical parameters like mean and standard deviation. The system is designed to be cost effective and accurate. Features are extracted and the disease is identified from the microscopic images of blood samples.

Keywords : *ALL, RCNN, morphological features, Segmentation of images*

I. INTRODUCTION

The blood samples are collected and tested for the presence of any type of cancer cells in the human body. From the blood test, the doctor can diagnose the proper functioning of the internal organs of the body. The following are some of the blood tests to diagnose cancer:

- **Complete blood count (CBC):** This type of count gives the number of different types of blood cells. A cancer may be present if the count of blood cells varies or an abnormal count occurs. Also to confirm the presence of blood cancer, bone marrow biopsy may be needed.
- **Blood protein testing:** Electrophoresis is an another test conducted to detect various types of proteins and to diagnose the immune system of the body.
- **Tumor marker tests:** Tumor markers tests are done to check for the chemicals made by tumor cells present in the blood.

Considering the results of various tests, careful interpretation is made for the presence of cancer cells.
Sometimes abnormal test results may come from non-cancerous conditions too. On the other hand, normal results of the blood test may have cancer.

The blood test done by pathologists is expensive and also time consuming at the cost of the life of the patient. This is not affordable for all the patients. Blood test is done by chemical treatments on blood samples. Also the instruments used for the blood tests are expensive. Thus there arises an automatic system that generates the test reports in less time and must be inexpensive.

Here a system is designed to generate the report in less time. At present the reports are generated in one to seven days.

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II. Analysis of Leukemia

Leukemia can be defined as a defect in white blood cells affected and the disease progresses quickly. Lymphocytes or lymphoblastic leukemia are found in white blood cells and in bone marrow. Major classification of leukemia depends on the rate of growth of the cells, acute which is fast growing and chronic which is slow growing.

Types of leukemia include:

1. Acute Lymphocytic leukemia (ALL):

rapidly progressing and the cells cannot mature properly. These Cells will be transmitted to the rest of the body parts like liver, brain and tissues because the cells continue to grow and divide. The growth and spread of the cells causes many symptoms.

2. *Acute myeloid leukemia (AML):* these are fast growing cells in the blood and bone marrow. They are also called Acute myeloblastic leukemis, mylegenous leukemia and granulocytic etc.

3. *Chronic lymphocytic leukemia (CLL):* this type is slow growing and this originates in the bone marrow and slowly develops into blood. It may also reach other parts of the body like liver and spleen. This stops the growth of normal blood cells and thereby reducing the immunity of the human body, making prone to infections.

4.*Chronic myeloid leukemia (CML):* This type of cells also develops in the marrow and slowly reaches the blood. Eventually grows to the rest of the body parts. Such type is also known as Chronic myelogenous leukemia.

5. *Hairy cell leukemia (HCL):* This is a rare type that grows very slowly. HCL is said to develop when bone marrow tries to generate more number of lymphocytes. Increase in the number of such B cells inhibits the growth of normal RBC, WBC and blood platelets.

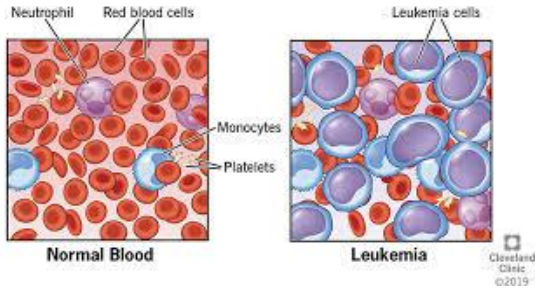

Fig.1. Normal blood cell and Leukemia cell

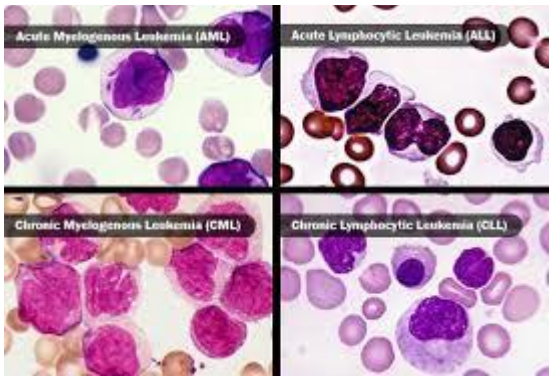

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Fig. 2 Types of Leukemia

III. Proposed System

The proposed system includes machine learning concepts embedded with neural network algorithms to classify the cancer cells. The following steps are organized to detect the system.

1. Preprocessing
2. Segmentation
3. Feature Extraction
4. Cancer Type Classification.

The system can detect the types of leukemia and its sub types too. Such a design helps in early detection of the disease and it may help to do appropriate treatment for that particular leukemia in early stage and thereby saving lives.

III. Preprocessing

Every system needs pre-processing step to obtain the image suitable for further processing. The raw or the input image will contain unwanted noise and thus it has to be removed in this pre-processing stage. Also the size of the input image must also be reduced to speed up the process. Here the image is reduced to the size of 512 X 384. Then it performs filtering as selective median filtering and the noise is removed by unsharp masking. This noise may be present during the acquisition of the image. The image is then converted to grey image for further processing.

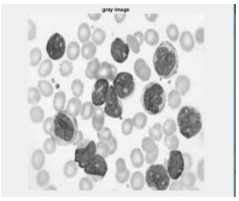

Fig 3: Grey image Conversion

IV. Segmentation

Image segmentation is the process of partitioning the image into many segments. There are several segmentation algorithms that can be used based on applications. Here, segmentation is done using the similarity property. Lloyd's clustering technique is implemented that clusters or merges the regions with similar property. K- Mean clustering algorithm is implemented and this segmentation process is repeated. First, the centroid of the segment is found and then it is re-segmented close to the centroid. Thus the image characteristics of interest can be obtained using this method.

V. Feature Extraction

Extracting the features of interest to obtain the desired output is an important process in the design. Obtaining the relevant information from the input image simplifies the work as compared to working with huge set of data. Large amount of memory and computation power can be reduced when worked with reduced set of features. The following geometrical features are considered for the work.

Geometrical Features

- 'Area feature'- Number of pixels present in an area is calculated.
- Center of mass in both x coordinate and y coordinate is calculated which gives the centroid feature(x, y)

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- 'Eccentricity' feature describes the foci of the ellipse with respect to its major axis length. It can be found to vary between 0 and 1.
- 'Equiv Diameter' is a scalar parameter that specifies the diameter of the circle of same region.
- 'Extent' — this parameter calculates the pixels in the region to the pixels in the bounding box.
- 'Major Axis Length' —describes the pixel length of the major axis of the ellipse.
- 'Minor Axis Length' — describes the pixel length of the minor axis of the ellipse.
- 'Orientation' — the angle of the major axis with respect to the x axis is defined as the orientation. This varies between -90 to +90 degrees.
- 'Perimeter' — the distance of the boundary of the region is calculated as the perimeter of the region.

Textural features

- ‘Angular momentum’ – this is the rotational momentum of the region.
- ‘Energy’ of the region is calculated to help for energy minimization problem.
- ‘Entropy’- the amount of uncertain information content from the source of the information.
- ‘Homogeneity’ – this is the measure of the adaptability with the background intensity that a human visual system (HVS) can respond. This is logarithmic response.
- ‘Correlation’- Correlation specifies the relation between pixels in the region.

Convolution and correlation are two operations that are usually done on the image to extract useful information.

VI. CONVOLUTIONAL NEURAL NETWORK (CNN)

One vital algorithm of Deep learning is convolutional neural network. The network receives inputs as images, text data, sound or video. This then performs any classification for the input image. CNN is implemented to locate patterns in images and performs image recognition and classifies them. CNN has various advantages like it eliminates the process of human extracting the features for the learning is done by the model itself. Also, the model can be trained again for any other new classification problem utilising the already existing neural network. Here, the classifier helps in classifying the types of leukemia like ALL,AML,CLL and CML. K nearest neighbour classifier takes into account all the available cases and performs classification based on the similarity property. RCNN is applied over regions

VII. Simulation Results

About 410 microscopic blood image sample database were collected. The images are then inspected to classify them to the 4 types of leulemia.

Fig 4(a) shows the resemblance of sample blood images of a normal human. Fig 4(b) shows the Acute Myeloid Leukemia affected cells (AML), Fig 5 a) shows the Acute Lymphocytic Leukemia (ALL) affected cells and Fig 5b) shows CLL affected cells and Fig 6 shows the cells that were affected by Chronic Myeloid Leukemia(CML).

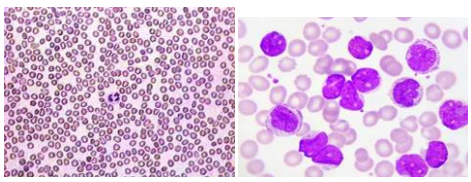

Fig 4 Normal and AML image

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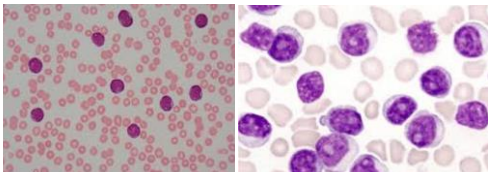

Fig 5 ALL and CLL image

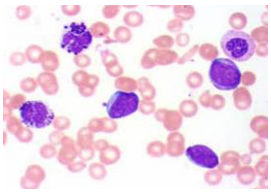

Fig 6 CML image

The following image depicts the original image and the images generated using the RCNN algorithm.

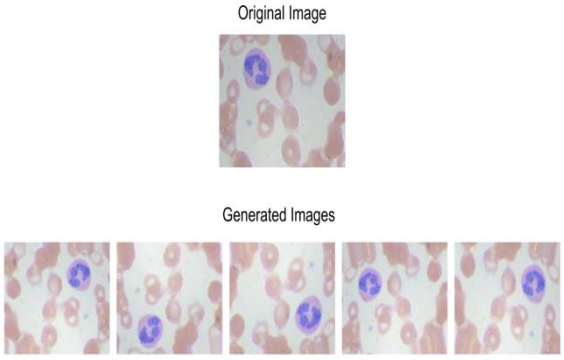

Fig 7 Original image and images generated using rCNN

VIII. Conclusion & Future Work

The system thus performs segmentation, feature extraction and classification. This proposed model has good accuracy of selecting the correct circle from the three candidate circles. The work may be further extended to other blood cancers that utilize more time to diagnose. Such detection systems involve complex algorithms and are under research.

This can be extended to detect other blood smear cancers which are deadly and take time to diagnose. The areas of detection these cancers are still in research which involves complex algorithms

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