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DETECTION OF ALL AND CLL BLOOD CELLS IN WBC'S USING BLOOD SMEAR IMAGES

R. Vishnu Vardhan[1], P. Poornima[2], M. Shreetha[3], Shwathi R.M[4], D. Soundarya[5]

[1]Assistant professor, [2,3,4,5]UG Scholar

Department of Electronics and Communication Engineering

P.A. College of Engineering and Technology, Pollachi, TamilNadu, India

Abstract

White blood cells (WBC) are generated in the bone marrow and account for about 1% of all blood cells. These white blood cells proliferate unregulated, which leads to the development of blood cancer. The proposed work proposes a reliable method for classifying Acute Lymphoblastic Leukemia (ALL) and Chronic Lymphoblastic Leukemia using the ALL-IDB and Kaggle datasets (CLL). Acute lymphoblastic leukemia is a cancer that develops when the bone marrow produces an excessive number of lymphocytes (ALL). ALL is one of the most common types of cancer in kids. Contrarily, Chronic Lymphocytic Leukemia (CLL) attacks the spongy tissue inside the bones where blood cells are made. CLL is a type of blood and bone marrow malignancy. Older people are more frequently affected by CLL.Traditionally, the procedure was completed manually over a long period of time by a qualified expert. By utilizing deep learning techniques, specifically convolutional neural networks, the suggested approach completely eliminates the possibility of errors in the human process. The model first pre-processes the photos and extracts the best features after being trained on images of cells. The model was able to precisely collect the samples 90 times out of 100 and reproduce all measurements. In order to accurately identify the type of cancer in the bone marrow, the model can be employed. After classifying the normal and pathological cells using CNN, this task may be implemented utilizing the Python programming environment.

Keywords:Thresholding methods, image processing, image segmentation, image enhancement, and Convolution Neural Network (CNN).

I. Introduction

A blood cancer called leukemia is caused by the rapid proliferation of aberrant white platelet cells in the bone marrow. The uncontrolled growth of white platelets damages the body's immune system. The immune system provides sickness resistance. There are more white blood cells because of the malignancy leukemia's irregular cell structure. Researchers and oncologists have struggled for years to make an early diagnosis of leukemia due to the disease's initial non-obvious symptoms, such as fever, fatigue, and bruising. Moreover, leukemia doesn't form tumors like other cancers do, which makes it very challenging to detect.Manual methods for evaluating blood smears are time-consuming, costly, and prone to error since they rely on costly resources such as the knowledge of qualified medical experts who have specialized in picture interpretation. Patients with leukemia undergo a plethora of blood tests for blood cell counts and analysis after being diagnosed.

White blood cell cancer known as acute lymphocytic leukemia typically affects the bone marrow (ALL). The term "acute" describes the disease's speedy development; if it is not treated when it is first diagnosed, it could swiftly prove fatal. The blood count in this case is normal, unlike leukemia, yet the infected person is found. As acute leukemia will spread more quickly, treatment should begin as soon as the disease is identified.

Chronic lymphoblastic leukemia (CLL) can cause both an excess of and a deficiency of cells. Some of the blood cells can temporarily operate normally, and it involves more completely grown blood cells that mature more gradually. Cancer is caused by a cell growth group that is out of control. The most common type of cancer, blood cancer, will impede the bone marrow's ability to produce healthy blood cells and will stunt their growth. The majority of illnesses' high death rates could be decreased with early identification.

Convolutional Neural Networks (CNNs) combine several multi-layer perceptron's to provide effective results with minimal pre-processing. Because each convolutional layer of the network learns a new feature that is present in the images and causes a high activation, CNNs naturally function as feature extractors. The suggested study describes a strong and reliable automated classification method using convolution neural networks for the kinds of ALL and CLL white blood cancer.Although artificial intelligence has been increasingly used to medicine in recent years, using machine learning techniques can encourage more effective, accurate, and cost-efficient diagnostic and blood tests. The disease's progression must be stopped, complications must be kept to a minimum, and survival rates must rise. Accelerating diagnosis and treatment may not only help thousands of leukemia patients feel less pain, but it may also benefit the healthcare system by allowing doctors to treat more patients with higher-quality care.

Our goal is to clearly identify ALL and CLL cells in a blood smear so that an immediate inference may be made. For instance, real-time inference may allow doctors to examine a large image of a group of cells while receiving a rapid response for each new area of the image. To help researchers improve leukemia identification, we investigate a variety of neural networks, including traditional convolutional neural networks (CNN) models.

II. Pre-processing

The term "image pre-processing" refers to operations on images at the most fundamental level of abstraction. These operations decrease rather than increase the information content of the image if entropy is a measure of information. Pre-processing aims to enhance the picture data by reducing undesired distortions or enhancing specific visual features crucial for later processing and analysis tasks. As images are being preprocessed, redundancy in photos is employed. Adjacent pixels from the same real object share the same brightness value or one that is very similar to it.The image can be recreated as the average value of neighboring pixels if a deformed pixel can be identified in it. Several different kinds of image pre-processing techniques can be grouped according to the size of the pixel neighborhood that is used to determine the brightness of a new pixel.

The following are the preprocessing methods:

1. Read the image

In this stage, we write a function that loads image-containing folders into arrays and then saves the path to our image dataset in a variable.

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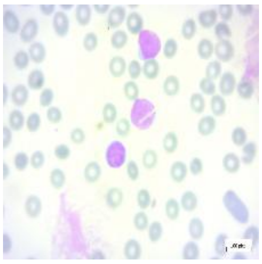

Figure 1: Original Image

2. Resizing the image

When the total number of pixels needs to be increased or decreased, image resizing is required, whereas remapping can occur when compensating for lens distortion or rotating a picture. When you zoom in on an image, you can see more detail because there are more pixels there. When using a digital zoom, interpolating the image alone lowers quality. Although the image with digital zoom has the same amount of pixels as one with optical zoom, the level of detail is plainly considerably less.

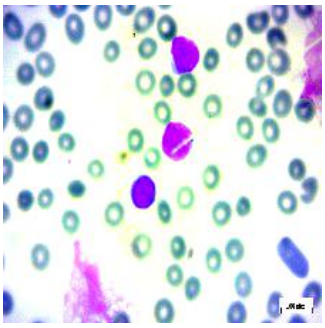

Figure 2: Resizing Image

3. Segmentation

The Image segmentation is the process of splitting a picture into numerous layers that are each represented by a clever, pixel-by-pixel mask. A image's integration level determines how it is mixed, blocked, and separated. The first stage in image processing is to separate a photo into a collection of Image Objects with related features. Image segmentation, which divides an image into several portions or areas sometimes depending on the characteristics of the picture's pixels, is a commonly used technique in digital image processing and analysis.

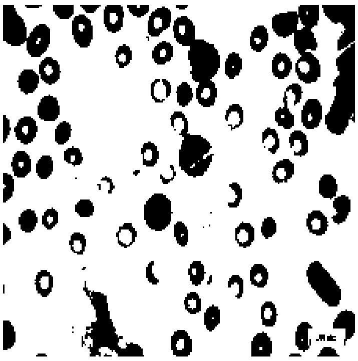

Figure 3: Segmented Image

III.Convolution Neural Network

The Image segmentation is the process of splitting a picture into numerous layers that are each represented by a clever, pixel-by-pixel mask. An image's integration level determines how it is mixed, blocked, and separated. The first stage in image processing is to separate a photo into a collection of Image Objects with related features. Image segmentation, which divides an image into several portions or areas sometimes depending on the characteristics of the image's pixels, is a commonly used technique in digital image processing and analysis.

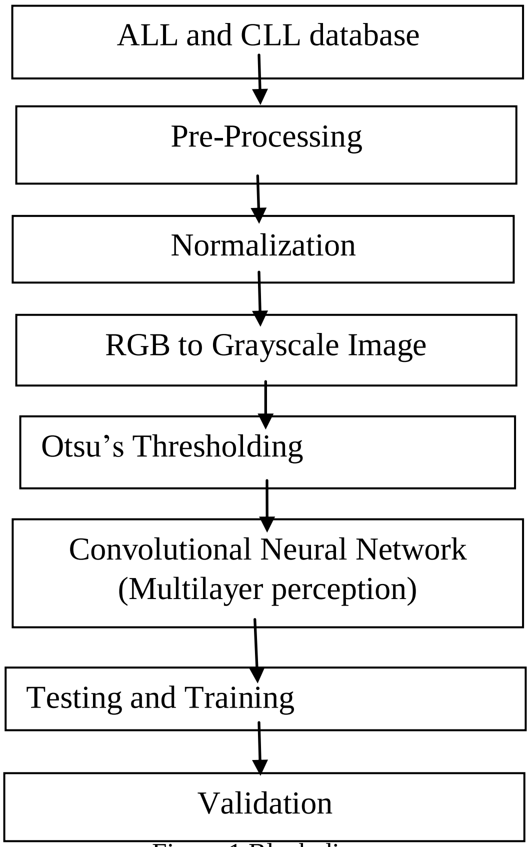

Figure.1 Block diagram

Our goal was to reduce runtime without considerably sacrificing accuracy on high-resolution, therefore we constructed a unique CNN rather than utilising a pre-trained model. To compensate for the short dataset, we improved the data by randomly flipping, rotating, and zooming in the images. After initial image resizing and rotation, the bulk of cancer cells were kept in the image. In order to assess whether a big collection of cells contained any ALL and CLL cells, we avoided over-zooming the data. All of the photos that were labelled as malignant retained cancer cells and could still be categorised as positive because the images were thoroughly classified, therefore accuracy values did not significantly change if a few cells were removed from the image.Our CNN model consisted of three convolution-pooling layers, one dropout layer, a flatten layer, three dense layers, and one dropout layer in between. In order to prevent overfitting as we grew the neural network, we included dropout layers between dense layers as we created the model. The model was trained over a period of 40 epochs. We stopped adding layers after the validation and training losses stabilised simultaneously.

Figure 2 illustrates a general CNN model that has four parts: (a) convolution layer, (b) pooling layer, (c) activation function, and (d) fully connected layer. The functionality of each component is shown in the following diagram.

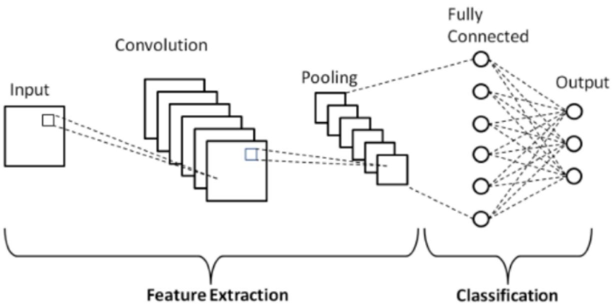

Figure.2 Basic CNN model

1. InputSubcaste

In this subcaste of a CNN model, images are used as inputs. The size of the inputs is also handed then.

2. Convolutional Layer

In a complication subcaste, multitudinous pollutants unite to perform thecomplication action. It's possible to see each and every image as a 3x3 matrix of pixel values. Slide the sludge matrix over the image and cipher the fleck product to get the convolved point matrix. This approach retrieves N number of attributes from the input image.

3. Pool Layer

In order to reduce computational costs and speed up literacy, it’s occasionally necessary to pool or subsample data in order to reduce the dimensionality of an image and its point dimension. It's also used to suppress over-fitting issues.Max Pooling and Average Pooling are two of the most generally used pooling strategies at CNN.

- **Max Pooling:**The value from the image region to which the pooling kernel is applied is handed at the loftiest position by this option. Its job is to reject any noisy activations in order to lower the dimensionality while contemporaneously dampening the noise.
- **Average Pooling:**This system presents the normal of the data from the area of the image where the pooling kernel was applied.

4. Completely Connected Layer

In conventional models, the completely linked network is similar to the completely connected subcaste. The completely connected subcaste computes the fleck product of the weight vector and the input vector to gain the final affair from the first phase's affair, which includes intermittent complication and pooling.

5. CNNAlgorithm

CNN is a well- liked and effective pattern discovery and image processing approach. It has a number of benefits, including as rigidity, a simple structure, and reduced training conditions.

IV. Training and Validation Graph

The images are trained for Versatility, Visualization, and Community support for a specific reason.

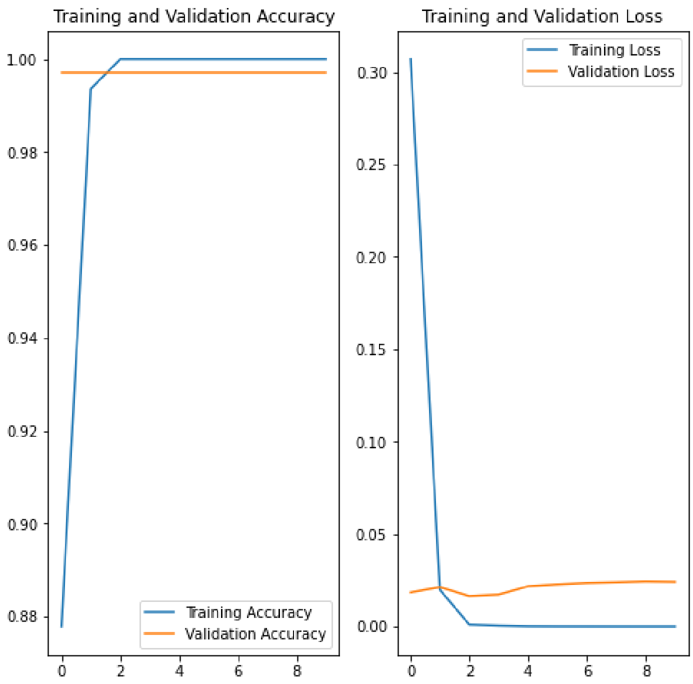

Figure 6: Accuracy Graph

1. Training

The CNN is exposed to a sizable collection of labelled images during the training phase, where it picks up on patterns and characteristics in the images. The purpose of training is to modify the network's weights in order to improve the network's ability to correctly identify images based on their attributes. During training, the CNN learns to recognize crucial visual elements including edges, textures, forms, and colors and use those elements to generate predictions.

2. Testing

During the testing step, the trained CNN's performance is tested on a collection of new, previously unseen images. To judge how well the CNN generalizes to new images, the testing set is employed. During testing, the CNN makes predictions for each image in the testing set, and the accuracy of those predictions is tested by comparing them to the true labels of the images.

3. Difference

The primary distinction between the training and testing phases is that during training, the CNN picks up on patterns and characteristics in the images, whereas during testing, the CNN's performance is examined on fresh photos to determine how well it has learnt to generalize to fresh data.

V. Result

The categorization model was developed using TensorFlow, an open-source framework that runs from top to bottom. An algorithm for binary classification was created using at least 1000 images. The trained model was then used to estimate the type of cancer depicted in the photographs. The outputs of the suggested model are first described in the next section. Comparisons and analyses of the suggested approach with deep learning models are also described. to gather the data in Python using tensor flow and Keras.

```
Epoch 1/10
89/89 [==============================] - 63s 697ms/step - loss: 0.5172 - accuracy: 0.7733 - val_loss: 0.0490 - val_accuracy: 0.9943
Epoch 2/10
89/89 [==============================] - 62s 691ms/step - loss: 0.0295 - accuracy: 0.9887 - val_loss: 0.0185 - val_accuracy: 0.9943
Epoch 3/10
89/89 [==============================] - 62s 691ms/step - loss: 0.0544 - accuracy: 0.9816 - val_loss: 0.0207 - val_accuracy: 0.9915
Epoch 4/10
89/89 [==============================] - 60s 674ms/step - loss: 0.0104 - accuracy: 0.9958 - val_loss: 0.0196 - val_accuracy: 0.9972
Epoch 5/10
89/89 [==============================] - 62s 691ms/step - loss: 0.0093 - accuracy: 0.9972 - val_loss: 0.0204 - val_accuracy: 0.9972
Epoch 6/10
89/89 [==============================] - 66s 741ms/step - loss: 2.6212e-04 - accuracy: 1.0000 - val_loss: 0.0236 - val_accuracy: 0.9943
Epoch 7/10
89/89 [==============================] - 62s 700ms/step - loss: 1.3186e-04 - accuracy: 1.0000 - val_loss: 0.0259 - val_accuracy: 0.9943
Epoch 8/10
89/89 [==============================] - 62s 699ms/step - loss: 8.5439e-05 - accuracy: 1.0000 - val_loss: 0.0277 - val_accuracy: 0.9943
Epoch 9/10
89/89 [==============================] - 63s 702ms/step - loss: 6.2733e-05 - accuracy: 1.0000 - val_loss: 0.0291 - val_accuracy: 0.9943
Epoch 10/10
89/89 [==============================] - 63s 701ms/step - loss: 4.8668e-05 - accuracy: 1.0000 - val_loss: 0.0302 - val_accuracy: 0.9943
```

Figure 5: Output Image

VI.Conclusion

In conclusion, the accuracy and effectiveness of diagnosis can be greatly enhanced by the employment of deep learning techniques in the identification of acute and chronic leukemia. These methods are very helpful when analyzing medical images like bone marrow biopsies and blood smears. Convolutional neural networks and artificial neural networks are examples of deep learning techniques that can be used to directly extract information from images, enabling more precise and effective diagnosis.It is feasible to develop strong image processing pipelines for the identification of acute and chronic leukemia by combining the functions in various ways. To accurately identify acute and chronic leukemia, the performance of the most popular convolutional and deep learning neural network approaches was tested. A 99.72% detection accuracy rate was produced by CNN.

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