iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VIII **Month of publication:** August 2021

DOI: https://doi.org/10.22214/ijraset.2021.37670

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VIII Aug 2021- Available at www.ijraset.com

An Automated Detection of Leukemia

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Abstract: Currently, the identification of blood disorders is through visual inspection of microscopic images of the blood cells. The identification of blood disorders can lead to the classification of certain diseases related to blood. This paper describes a preliminary study of developing the detection of leukemia types using microscopic blood sample images. Analyzing through images is very important because diseases can be detected and diagnosed at an earlier stage. From there further actions like controlling, monitoring, and prevention of diseases can be done.
Keywords: Image processing; leukemia detection; Lymphocytes; Myelocytes; Random Forest; Graphical User Interface.

I. INTRODUCTION

There are different types of white blood cells in our body. Leukemia is nothing but cancer of blood cells in which the number of white cells keeps increasing, and these immature cells destroy other cells. In the manual method of Leukemia detection, experts examine the microscopic images of blood, this is a very lengthy and time taking process that requires expert skills. Therefore the accuracy is not fixed. The ratio of white blood cells in our body is 1000:1. It means that one white blood cell is present between 1000 red blood cells. So if the number of white blood cells increases remarkably in large numbers then the person will succumb to Leukemia. Leukemia is classified as either acute or chronic. In chronic Leukemia, the infected white blood cells perform the role of a normal white blood cell, which gradually increases the severity. In acute Leukemia, the infected white blood cells do not perform the role of a normal white blood cell, which gradually increases the count of infected white blood cells thereby increasing the severity.

II. OPERATION

The automated leukemia detection system is built for experts and students to learn about how the leukemia cells are in a blood cancer sample. This system is built using python and opencv with image processing techniques. A total of 350 images were collected in order to train our machine learning model where it will classify when a test sample given is cancerous or not cancerous. The graphical user interface built will help the experts in order to visualize the cells better by segmenting the given image where the final image only consists of the cancer cells if they are present. The graphical user interface consists of operations such as selecting image to be segmented and classified, image processing tools such as enhancement of the image, grayscale conversion, smoothing the image, thresholding the image after gray scale conversion and finally classifying the image. When the user presses the classify button, a new window pops up where the segmentation process results can be seen and a message telling the user that the model has detected cancer or not. The fundamental steps taken in the implementation of this model were image acquisition, image preprocessing, image segmentation, feature extraction and classification.

A. Image Acquisition

The images were obtained from kaggle, UCI repository and cancer image archive. A total of 370 good quality images were obtained.

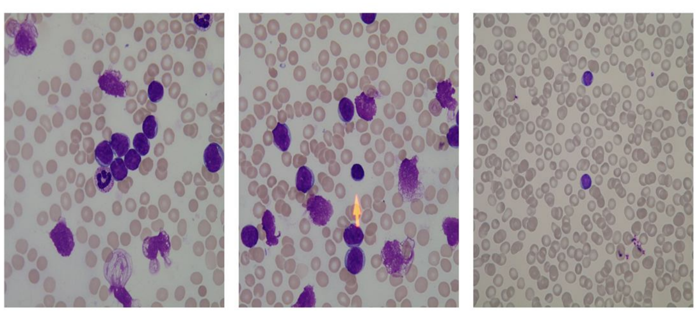

Fig 1. Sample images

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B. Image Pre-processing

The collected images needed some processing such as resizing as the images were large which was 1200X1200 pixels. The images were resized to 500X500 pixels. After resizing the images were enhanced using a method of non-photorealistic image rendering where the results were promising for further process. Then the images were converted into grayscale for methods such as thresholding and other feature extraction processes. Then the images were smoothened in order to remove any outliers.

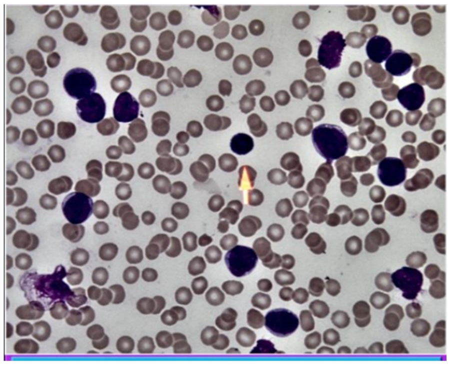

Fig 2a. Image Enhancement

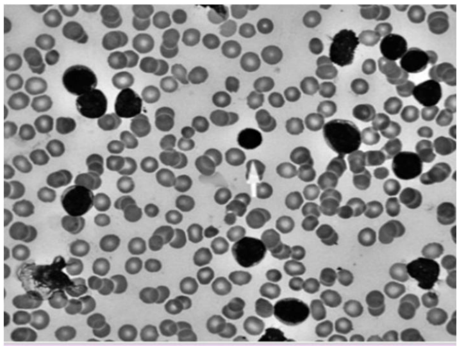

Fig 2b. GrayScale Image

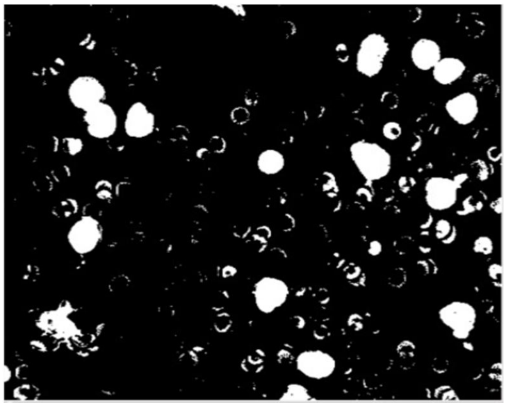

Fig2c . Initial Thresholding

C. Image Segmentation

Image segmentation is a process where only the region of interest is extracted from the preprocessed images. In the microscopic images, the region of interest (ROI) are the cells in a purple stain which are acute lymphoblastic cells. We implemented our own algorithm using a bunch of filters like blurring filters, sharpening filters, and morphological operations to clean the image. Blurring was extensively used to remove outliers after the final segmentation step is done. Two stages of thresholding were done in order to segment the image. The segmentation results are white spots on the image which are the ALL cells from which the features are extracted.

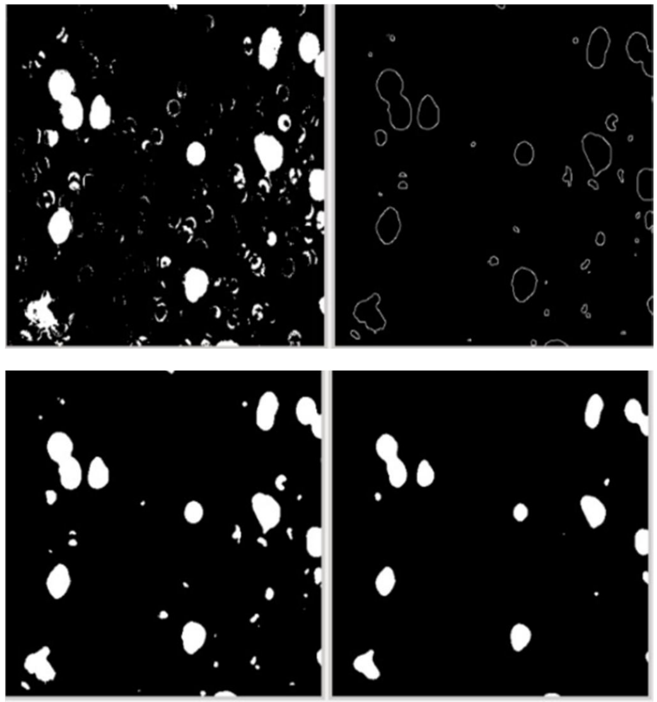

Fig 3 .Segmentation Results

D. Feature Extraction

Feature extraction is an important step in classifying an image. A total of 12 features were extracted where these features are statistical interpretations of the images. These features are then scaled using a standard scaling procedure to feed them to the machine learning model. The features extracted were the standard deviation and mean of all the images at each segmentation stage. Finally the number of blast cells were calculated and that was one of the major features in the classification process.

E. Classification

In machine learning, classification refers to a predictive modeling problem where a class label is predicted for a given example of input data. Our model is a binary classification model where the image given can be classified as cancerous or not cancerous. Random Forest classifiers were used to classify the images.

F. Validation

Initially, the data was split as 80% training and 20% testing for which we got 87% accuracy. Then we trained 100% of our data to give an external image that the model hasn't seen. A total of 15 images were given and a 95% accuracy was achieved.

G. Graphical User interface

The final step of the operation was to build a frontend so that a user can use our work as an application. Using libraries such as tkinter, we built a GUI in order to make it user friendly.

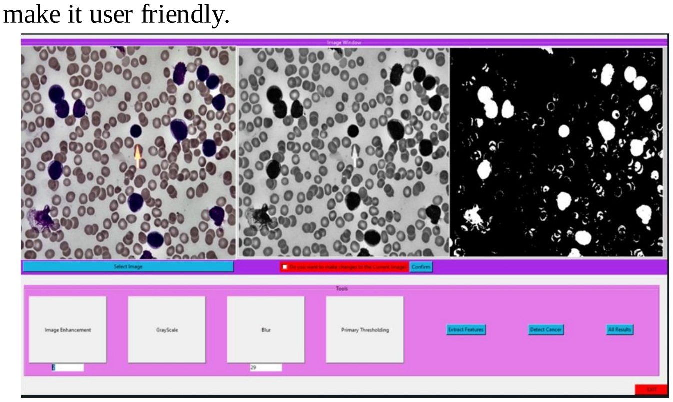

Fig 4 . GUI

III. FLOWCHART OF THE BACKEND CODE.

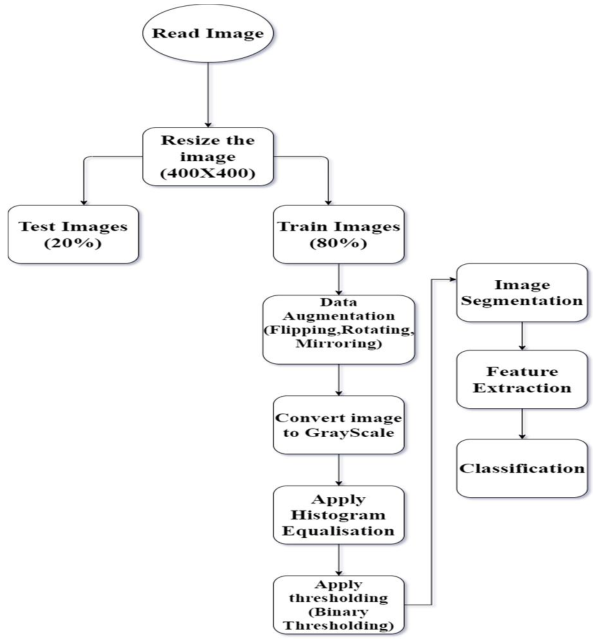

Fig 5 . Flowchart

IV. RESULT

With an average accuracy 92%, selectivity of 90% and sensitivity of 88% our model is perfectly working while classifying the test images. The GUI is user friendly and it finally performs all the preprocessing, segmentation and feature extraction and classifies the image.

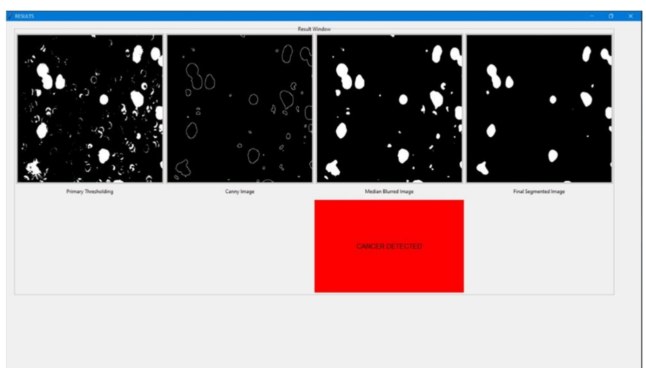

Fig 6a: Cancer detected

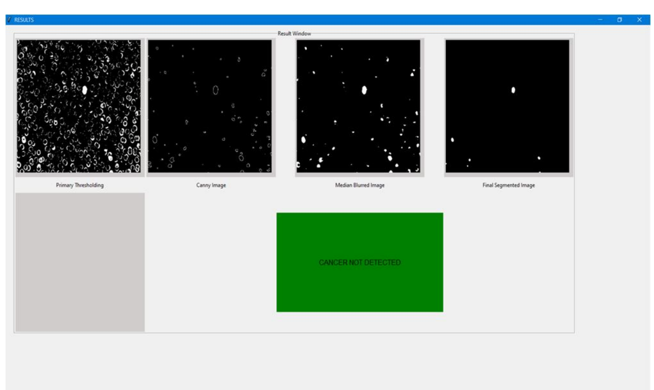

Fig 6b: Cancer not detected

V. CONCLUSION

Leukemia is a dangerous cancer that affects the white blood cells and bone marrow and weakens the immune system of the human body. One of the most commonly used diagnosis is based on microscopic blood cells (blood smears) analysis. In this study, we present a new approach for leukemia diagnosis from microscopic blood images by using random forest classifiers, which are capable of identifying cancerous or non-cancerous cells. Our model proved its competency to deal with the limited number of image samples. As a result, 91% accuracy, 90% specificity, and 88% sensitivity for the binary classification of acute lymphoblastic Leukemia were achieved. Besides, we did apply cross-validation in all experiments and got healthy results.

VI. APPLICATION

A. User-friendly application.
B. Computationally efficient software.
C. Quick Results obtained to diagnose acute lymphoblastic leukemia.
D. High quality enhanced results.

VII. ADVANTAGES

Overcomes drawbacks of traditional diagnosis of leukemia which include CBC, bone marrow aspiration whose results take a lot of time to obtain the results.

Our method can be one of the diagnosis methods where the doctor can consider diagnosing leukemia.

In this method we are separating the blast cells from the normal cells.

VIII. FUTURE SCOPE

In the future, we plan to expand our experiments by using a hybrid deep learning approach using convolutional neural networks accompanied by recurrent neural networks to enhance performance. Further, we plan to enlarge our dataset by adding new samples as well as using new data augmentation techniques. We are also planning to implement hardware using a microscope along with a raspberry pi camera module.

IX. ACKNOWLEDGEMENT

We would like to express our deep and sincere gratitude to our Professor and the person who guided us in this mini project, Dr. Beena Ullala Mata, Department of Medical Electronics Engineering, BMS College of Engineering, Bengaluru, for giving us the opportunity to do research and providing invaluable guidance throughout this research. Her dynamism, vision, sincerity, and motivation have deeply inspired us. She has taught us the methodology to carry out the research and to present the research works as clearly as possible. It was a great privilege and honor to work and study under her guidance. We are extremely grateful for what she has offered us.

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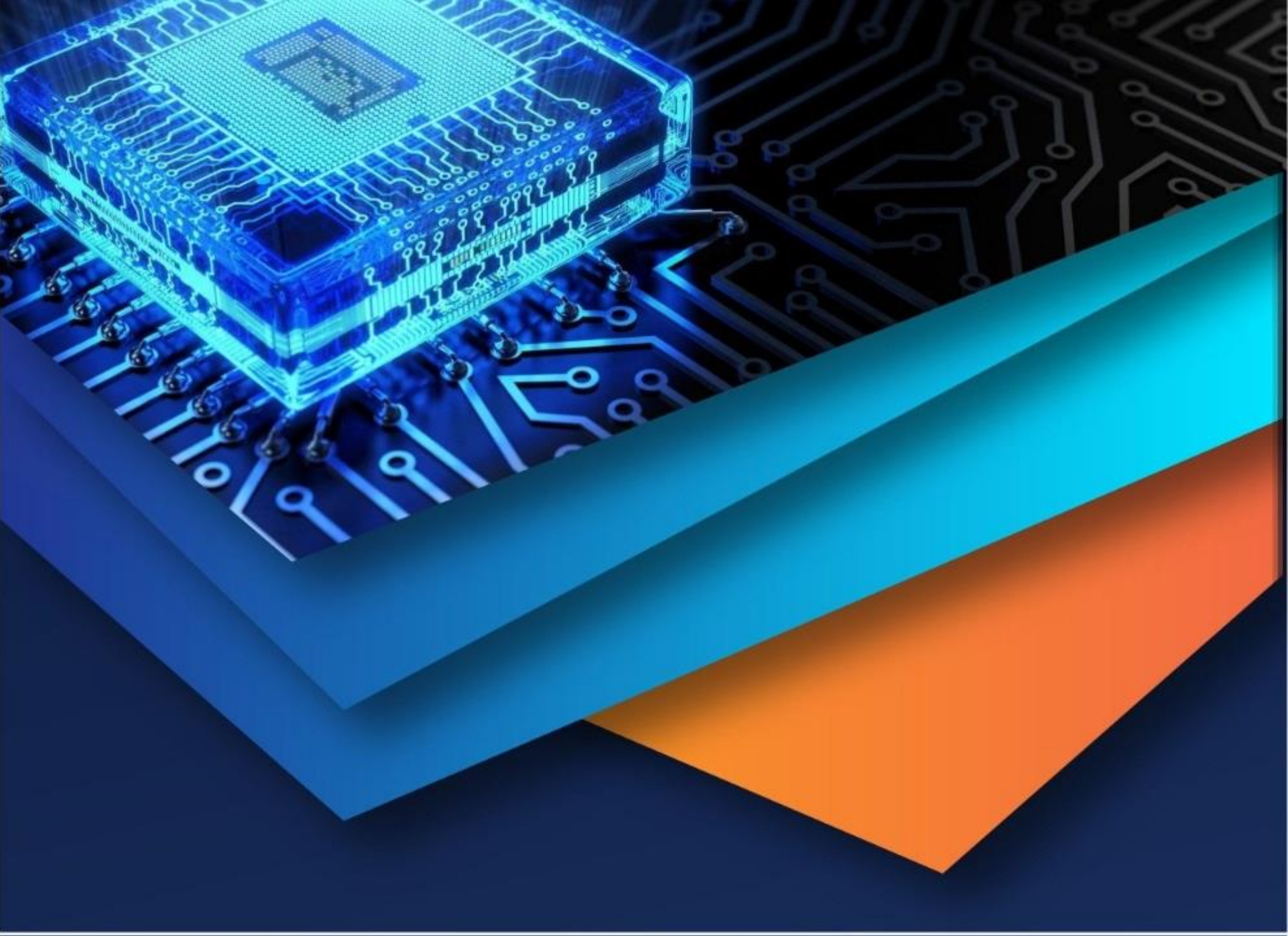

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