Automatic Detection of Bone Marrow Cancer From Microscopic Images Using CNN

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Abstract- *Human blood consists of three types of major cells: Red blood cell (RBC), White blood cell (WBC) and platelets. Each of them has their own functions in our body. RBC helps in supplying oxygen, WBC fights against infection and platelet helps in clotting of blood. WBCs, also called leukocytes or leucocytes, are the cells of the immune system that are involved in protecting the body against both infectious disease and foreign invaders. All WBCs are produced and derived from multipotent cells in the bone marrow known as hematopoietic stem cells. Leukocytes are found throughout the body, including the blood and lymphatic system. To perform the segmentation, this project uses the techniques such as Green Plane Extraction, Arithmetic operations, Linear Contrast Stretching, Histogram Equalization and Global Thresholding and GLCM is used for classification. This project describes the results of fast and accurate WBC segmentation of bone marrow.The existing method undergoes segmentation, classification and counting cells based on their size of white blood cells. Classifications of cell were done using Multi-Layer Perceptron (MLP). In this project color k-means algorithm is used to segment WBCs from blood smear images. Next, morphological operations are performed to segment the regions of interests for removing unwanted components. Then, a set of texture, geometrical, and statistical features are extracted from the segmented region. The drawback of this method carried on the sub-image is that accuracy is less compared to proposed method.Proposed method uses gray level intensities for segmentation which require less processing time and suitable for processing. The advantage of the proposed method is good accuracy than existing method, use of minimum filter improves the segmentation result.*

Keywords- Acute Lymphoblastic Leukemia, Convolutional Neural Network, Matrix Laboratory, White Blood Cell.

I. INTRODUCTION

Marrow is the sponge-like material inside your bones. Located deep within the marrow are stem cells, which can develop into RBCs, WBCs, and platelets. Bone marrow cancer happens when cells in the marrow begin to grow abnormally or at an accelerated rate.Together with RBCs and platelets, WBCs represent the corpuscles of the human blood. WBCs are a safeguard of the human immune system resisting and eradicating the invasion of germs and healing injury. A too high or too low amount of WBCs is a sign of a pathological condition, thus, it should not be ignored. An increase of WBCs usually corresponds to organs or tissues acute/chronic infection, inflammation or injury caused by a bacterial infection.Recently, approaches based on deep CNN have developed rapidly in the field of computer vision, because deep learning is more adept at extracting information in high-dimensional data. It has been applied to the area of image classification, object detection and image segmentation. Long et al. proposed a Fully Convolutional Network (FCN) which transforms the image-level classification to pixel-level through a CNN. FCN allows images of any size and reduces part of the pre-processing workload. As regards natural images instance segmentation, Mask R-CNN performs better than others. It classifies object bounding boxes using Faster R-CNN and then applies FCN inside each box to segment a single object therein.For the detection, a custom-designed CNN operating on focus stack of images is used, the cell counting problem is addressed as the segmentation problem. At present, one of the difficulties in leukocyte segmentation in Acute Lymphoblastic Leukemia (ALL) microscopic images is the removal of the interference of both RBCs and platelets, whereas the other consists of segmenting adhesive WBCs. Thus, in this work, a target detection method is described, based on color space transformation to extract WBCs. To accurately segment adhesive cells, a weight map based on class weight and distance transformation weight was introduced for the multi-class weighted cross-entropy loss function, which enables U-Net to learn cell border features.

II. SOFTWARE DESCRIPTION

MATLAB

MATLAB is a programming language developed by MathWorks. It started out as a matrix programming language where linear algebra programming was simple. It can be run both under interactive sessions and as a batch job. MATLAB (matrix laboratory) is a fourth-generation high-level programming language and interactive environment for numerical computation, visualization and programming. MATLAB is developed by MathWorks. It allows matrix manipulations; plotting of functions and data; implementation of algorithms; creation of user interfaces; interfacing with programs written in other languages, including C, C++,Java and FORTRAN; analyse data; develop algorithms; and create models and applications. It has numerous built-in commands and math functions that help you in mathematical calculations, generating plots and performing numerical methods.It is a high-level language for numerical computation, visualization and application development. It also provides an interactive environment for iterative exploration, design and problem solving. It provides vast library of mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, numerical integration and solving ordinary differential equations. It provides built-in graphics for visualizing data and tools for creating custom plots. This programming interface gives development tools for improving code quality, maintainability and maximizing performance. It provides tools for building applications with custom graphical interfaces. It provides functions for integrating MATLAB based algorithms with external applications and languages such as C, Java, .NET and Microsoft Excel.

PROGRAMMING AND ALGORITHM DEVELOPMENT

MATLAB provides a high-level language and development tools that let you quickly develop and analyze algorithms and applications as shown in figure 1.

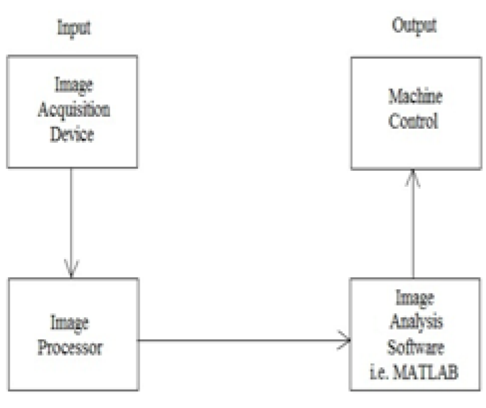

Figure 1. Block diagram of image processing in MATLAB

III. PROPOSED METHODOLOGY

The proposed system unit which consists of various techniques are explained below.The first stage of any vision system is the image acquisition stage. After the image has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks required. However, if the image has not been acquired satisfactorily then the intended tasks may not be achievable, even with the aid of some form of image enhancement.The reverse is also possible in color conversion to build a full color image from their separate grayscale channels. By mangling channels, using offsets, rotating and other manipulations, artistic effects can be achieved instead of accurately reproducing the original image. In signal processing, the Wiener filter is a filter used to produce an estimate of a desired or target random process by Linear Time-Invariant (LTI) filtering of an observed noisy process, assuming known stationary signal and noise spectra, and additive noise. The Wiener filter minimizes the mean square error between the estimated random process and the desired process.Histogram equalization method usually increases the global contrast of many images, especially when the usable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values.Adaptive histogram equalizationis a computer image processing technique used to improve contrast in images. It differs from ordinary histogram equalization in the respect that the adaptive method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image.In computer vision, image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. It is typically used to locate objects and boundaries (lines, curves, etc.) in images.The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image.

IV. RESULTS

Once the code has been executed, the program will run to display the images of those techniques as discussed in Chapter III and the message panel indicates whether the bone marrow cancer is present or not.

TECHNIQUES

The basic two-dimensional image is a monochrome (grayscale) image which has been digitized by image acquisitionas input image. The input image is converted into gray image as shown in figure 2.Then the filtering process is done by using two filters:Wiener filter can be used to filter out the noise from the corrupted signal, Gabor filter is a linear filter used for texture analysis.Contrast enhancement is done by two methods:Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values,Adaptive histogram equalization is a computer image processing technique used to improve contrast in images.In segmentation process, irrelevant artifacts are removed from images, so as to obtain more accurate recognition of shapes and the tumor is detected.

Figure 2. Output with images of those techniques

MESSAGE PANEL

In the figure 3, the input image is a non-cancerous tumor so it is displayed as benign.If the tumor is non-cancerous the message BENIGN will display. If the tumor is cancerous, the message MALIGNANT will display. If there is no tumor, the message NORMAL will display.

Figure 3. Output with message panel

ACCURACY

In the figure 4, the accuracy is 99% by using convolutional neural network technique.Compared to the accuracy of other algorithms like SVM, K-Best, decision trees etc., the convolutional neural network gives the better accuracy.

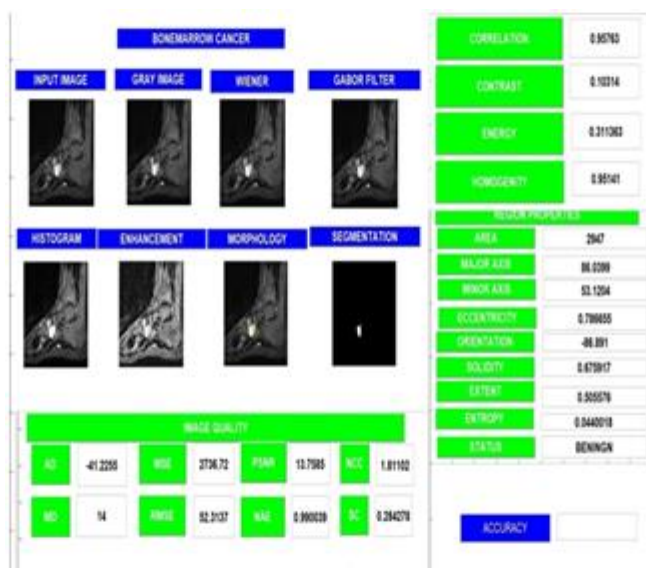

Figure 4. Output with accuracy

V. DISCUSSIONS

Peripheral blood smear images dataset consisting of 32 X-Ray images is used for comparison. The proposed model achieved an accuracy of 99.0% in classifying the peripheral blood smear images into an infected and healthy state and it also classifies the data into benign and malignant.

VI. CONCLUSION

In this chapter the proposed model annihilates the likelihood of blunders in the manual procedure by utilizing a profound learning strategy in particular CNN. The model is first pre-forms the pictures and concentrates the best highlights out of them followed via preparing the model with the changed CNN structure. In the end, it predicts the type of cancer in the given image. The model accuracy evaluated to 99%. The proposed model performed better than the baseline methods like Support Vector Machine (SVM), Decision Trees, Random Forests, K-best, Naive Bayes. Therefore, the model can be utilized viably as an apparatus for deciding the sort of malignant growth in the bone marrow.

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