QUALITATIVE EVALUATION OF ENHANCEMENT METHODS FOR ANALYSIS OF ACUTE LEUKEMIA IMAGES

Ravindraiah R.

CBIT, Proddatur, India
Email: ravindra.ranga@gmail.com

ABSTRACT

With the evolution of automated computing systems Bio-Medical image analysis is made simple. Leukemia is a malignant disease (Cancer) seen in people of any age groups either in children or adults aged over 50 years. The microscopic images usually inadequate to identify the type of the cell in most of the cases, the traditional morphology test done by a hematologist to look under the microscope is a time consuming and tedious job. Also the equipment required is very costly and may not be exist in all hospitals and clinics. Further the noises and blurness effect often leads to false diagnosis of leukemia. An automatic image enhancement and segmentation system can make the inspection procedure of leukocytes much easier and faster and the amount of data that can be analyzed by such a clinician handle more data than they normally can handle. In this paper four contrast enhancement techniques are implemented for analysis of blood cancer. A comparative approach is done on Local contrast stretching, Global contrast stretching, Dark contrast stretching, Bright contrast stretching methods. All these methods involve threshold mapping which often useful to attain segmented results.

Index Terms: Electron micrograph image enhancement, Acute leukemia, local contrast, global contrast, dark, bright contrast stretching.

I INTRODUCTION

Leukemia is the common malignancy in childhood and is second only to accidents as the major cause of most death in childhood in the age group 1-15 years [1]. The pathology is characterized by the uncontrolled accumulation of immature white blood cells. Leukemia is classified into four categories: lymphocytic or myelogenous, each of which can be acute or chronic. The term lymphocytic or myelogenous denotes the cell type involved. Each type of leukemia origins in a cell in the bone marrow, it leads immature cell and functionless in the blood.

Acute leukemia is a progressive disease which appears suddenly and need to be treated urgently. It is a disease of leukocytes and their precursors. The pathology is characterized as the accumulation of immature, abnormal cells in the bone marrow and peripheral blood. The aspirated marrow is found to be infiltrated by abnormal cells[2]. There are some signs or symptoms of leukemia that are similar to other common illnesses. Initial symptoms of acute leukemia are quite common, namely weight loss and/or loss of appetite, excessive bruising or bleeding from wound [3]. Leukemia's patient will also feel tired, short of breathe during physical activity and pale skin. Early diagnosis of the disease is fundamental for the recovery of patient especially in the case of children [3].

The objective of image enhancement is to improve the interpretability of the information present in the images for human viewers. An enhancement algorithm is one that yields a better quality image for the purpose of some particular application which can be done by either suppressing the noise or increasing the image contrast[4]. Enhancement methods are application specific and are often developed empirically. Several research expert groups have been focused on computerized system development that can screen and analyze different types of medical images to extract useful information for the medical professionals [4].

II METHODOLOGY

A. Image Enhancement

Enhancement is the process of manipulating an image so that the result is important suitable than the original for specific applications. The word *specific* is important here because it establishes at the outset that enhancement techniques are problem oriented [5].

One of the simplest piecewise linear functions is a contrast-stretching transformation. Low-contrast images can result from poor illumination, lack of dynamic range in the image sensor, or even the wrong setting of a lens aperture during image acquisition. Contrast stretching is a process that expands the range of intensity levels in an image so that it spans the full intensity range of the recording medium or display device [5].

To date, contrast stretching process plays an important role in enhancing the quality and contrast of medical images [6]. In this work 4 techniques for contrast enhancement based on local contrast, global contrast, bright and dark contrast are implemented.

B. The proposed techniques

B.1 Local and Global Contrast Stretching

Local contrast stretching (LCS) is an image enhancement method aims at locally adjusting each picture element value to improve the visualization of structures in both darkest and lightest portions of the image at the same time. In this a sliding window (called the KERNEL) is moved across the image and the center element is adjusted using the formula

$$Ip(x, y) = 255*[Io(x, y) - min]/(max - min) \qquad (1)$$

Where,

$Ip(x, y)$ is the output pixel(x, y) color level after the contrast stretching process.

$Io(x, y)$ is the input color level for data the pixel(x, y).

max - is the maximum value for color level in the input image.

min - is the minimum value for color level in the input image.

In the equation (1), (x, y) are the coordinates of the center picture element in the KERNEL and min and max are the minimum and maximum values of the image data in the selected KERNEL.

Local contrast stretching will consider each range of color palate in the image (R, G and B). The range of each color will be used for contrast stretching process to represent each range of color. This will give each color palate a set of min and max values [7].

Meanwhile, global contrast stretching will consider all color palate range at once to determine the maximum and minimum for all RGB color image. The combination of RGB color will give only one value for maximum and minimum for RGB color. This maximum and minimum value will be used for contrast stretching process [7].

B.2 Dark Contrast Stretching and Bright Contrast stretching

In these two auto scaling method a linear mapping function is usually used to increase the contrast level and brightness level of the image. These techniques are based on the original brightness and contrast level of the images to do the adjustment.

The mapping function is as follows [8]:

$$P_k = \frac{(\max - \min)}{(f_{\max} - f_{\min})}\left(q_k - f_{\min}\right) + \min \qquad (2)$$

Dark stretching is a reverse process of bright stretching process. The color level produces is based on equation 3, [8]:

$$\text{out}(x, y) = \begin{cases} \dfrac{\text{in}(x, y) - TH}{255 - TH} * \text{New } TH & \text{for in}(x, y) < TH \\ \left[\dfrac{(\text{in}(x, y) - TH)}{255 - TH} * (255 - \text{New}TH)\right] + \min & \text{for in}(x, y) > TH \end{cases} \qquad (3)$$

where,

in(x,y) : value of pixel color level located at *(x,y)* input image

TH : threshold value.

NewTH : dark stretching factor

Figure 1 shows the dark stretching process with the value of 100 is used as an example of threshold value and 250 as a dark stretching factor.

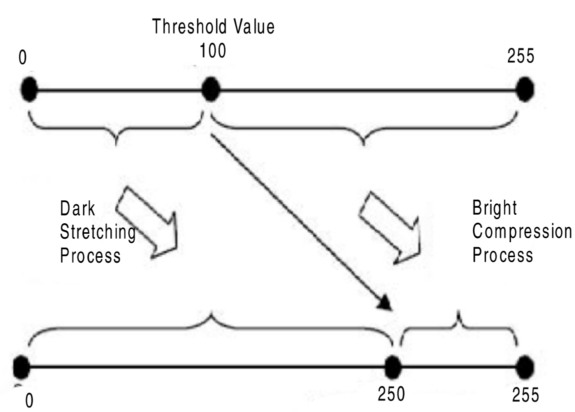


Fig. 1. Dark stretching method

Bright stretching is a process that also used auto scaling method which is a common linear mapping function to enhance the brightness and contrast level of an image. This method is based on Equation 2. The bright stretching process is implemented based on Equation 3 [9].

$$out(x, y) = \begin{Bmatrix} \dfrac{in(x, y) - TH}{255 - TH} * \text{New } TH & \text{for } in(x, y) < TH \\ \left[\dfrac{(in(x, y) - TH)}{255 - TH} * (255 - \text{New}TH) \right] + \min & \text{for } in(x, y) > TH \end{Bmatrix} \quad (4)$$

where,

TH : threshold value

NewTH : Bright stretching factor

NewTH is a new range of bright stretching pixel for the threshold value of red, green and blue. *in(x,y)* is a value of color level at pixel *(x,y)* from the input image. Figure 2 illustrates the stretching and compression processes for bright stretching technique.

In this threshold value of 150 and Dark stretching factor of value 100 is taken i.e., the bright value specified range from 0 to *TH in the input image* is compressed to 0 to Dark threshold factor while the remaining intensities are made to adjust to the remnant output intensities.

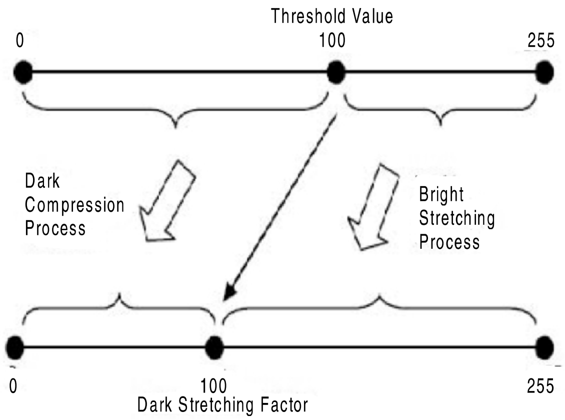
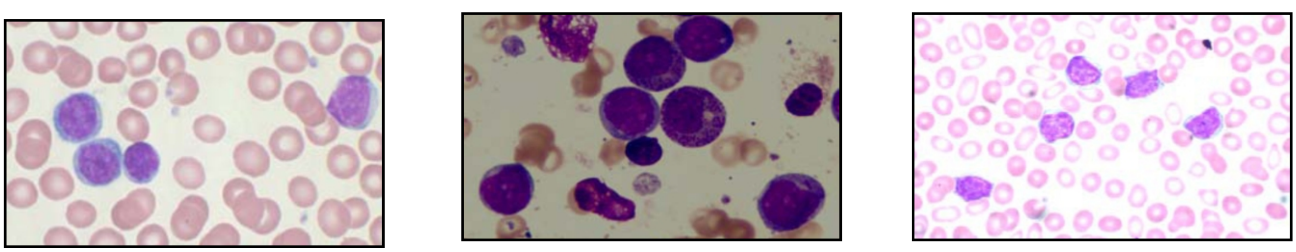


Fig. 2. Bright stretching method

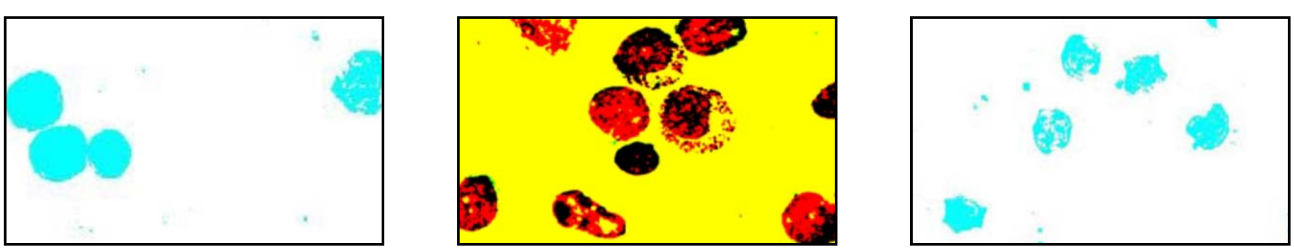
III. RESULTS

The proposed contrast enhancement techniques were applied to three Leukemia images labeled as normal, dark and bright images. Those images were categorized based on the human visual interpretation. Figure 3 shows original the three images. The results for each normal, dark and bright image for each technique are shown in Figure 4, Figure 5, Figure 6, Figure 7.



(a) Normal Image (b) Dark Image (c) Bright Image

Fig. 3. Original images



(a) Normal Image (b) Dark Image (c) Bright Image

Fig. 4. Images after local contrast stretching

Figure 4 shows the result from the local contrast stretching technique. The resultant, images become clearer and the features of leukemia cells can easily been seen and improved from the original for each category. Nucleus and cytoplasm of immature white blood cells become clearer.

Hence, they can easily been discussed by hematologists.

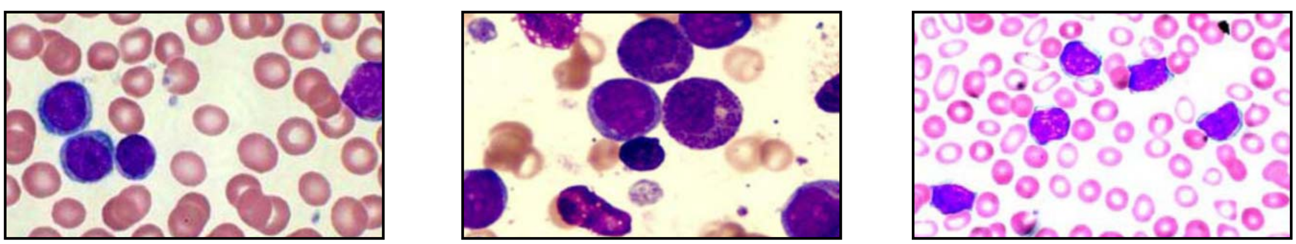
In this technique the stretching operation is done only over a normalized range 0.1 to 0.35. Thus it leads to selection and enhancement of the immature cells which further results in segmentation of the cells too.

Figure 5 shows the resulting after global contrast stretching technique. Generally, in this approach the resultant images produced are not much different from the original images. Globally, for all type of images it only become brighter than the original images. Characteristic of nucleus and cytoplasm of the immature white blood cells after global stretching was not as good as the ones produced by local contrast stretching.

Figure 6 shows the results after bright stretching method. In this one can observe that the image become brighter where more bright pixels are stretched towards the dark region. This way the color of the cytoplasm is enhanced. The shape of cytoplasm can be seen clearly. Besides that, the contrast was increased between the edge of cytoplasm and the background. Different controlled parameters called thresholds and bright stretching factors have been used for the three different types of images. Also the background preset in the normal and bright image is washed away and hence more useful for a hematologist to analyze how chronic the disease is.

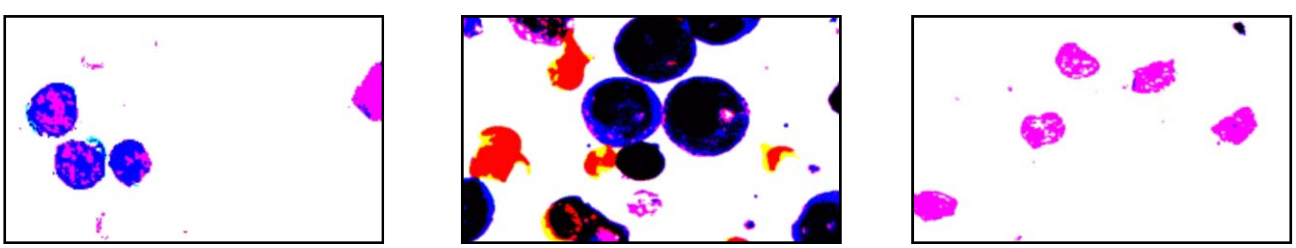
The threshold value for normal image (Figure 6 (a)) is 250 and the bright stretching is 150, for threshold value for dark image (Figure 6 (b)) is 250 and the bright stretching factor is 200. While, for threshold value for bright image (Figure 6(c)) is 200 and the bright stretching factors is 150.

In contrast to bright stretching process, dark stretching results as shown in figure 7 below where dark areas of the image are stretched and the bright areas are compressed. In the leukemia images dark area refers to nucleus, therefore the nucleus is clearer because of the stretching step in dark stretching method. The controlled parameters called threshold value and dark stretching factor have being used. The parameters are different for each figure according to



(a) For Normal Image (b) For Dark Image (c) For Bright Image

Fig. 5. Images after Global contrast stretching



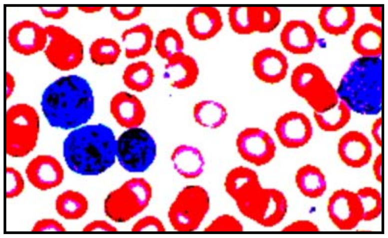
(a) For Normal Image (b) For Dark Image (c) For Bright Image

Threshold value = 250
Bright stretching factor = 150

Threshold value = 250
Bright stretching factor = 100

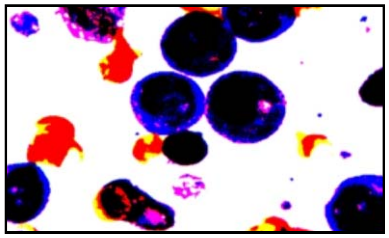
Threshold value = 200
Bright stretching factor = 150

Fig. 6. Images after bright contrast stretching



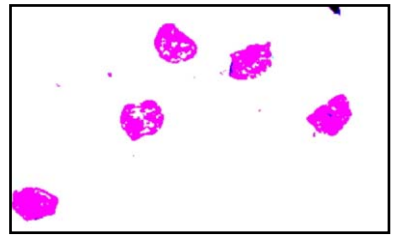
(a) For Normal Image

Threshold value = 185
Dark stretching factor = 255



(b) For Dark Image

Threshold value = 100
Dark stretching factor = 150



(c) For Bright Image

Threshold value = 100
Dark stretching factor = 150

Fig. 7. Images after dark contrast stretching

the contrast and brightness level of the original leukemia images.

The threshold value for normal image (Figure 7(a)) is 185 and the dark stretching factor is 255, the threshold value for dark image (Figure 7(b)) and for bright image is 100 and the dark stretching factors is 150. Here also manual adjustment of threshold values will leads segmented results while enhancing the region of interest.

IV CONCLUSION

The presented contrast enhancement techniques are effective in enhancing the contrast of leukemia images. Each method hopefully gives extra information for nucleus and cytoplasm of acute leukemia images. Thus from the end results, acute leukemia blood images that have been applied with this technique appears to be clearer and hopefully would ease further analysis by hematologist.

ACKNOWLEDGEMENT

This paper is dedicated to all my teachers of G. Pulla Reddy engineering college, Kurnool, Andhra Pradesh, India.

REFERENCES

[1] Lascari, A.D.: General aspects. *In* Leukemia in childhood, fifth Edition, Springfield, Illinois, Charles C Thomas, 1973; pp 3-29.

[2] Osowski Stanislaw, Markiewicz Tomasz, Marianska Bozena, Moszczynski Leszek, Feature generation for the cell image recognition of mylogenous leukemia. EUSIPCO 2004 : (XII. European Signal Processing Conference) (September 6-10, 2004, Vienna, Austria).

[3] Fabio Scotti, Automatic Morphological Analysis for Acute Leukemia Identification in peripheral blood microscope images. CIMSA 2005-IEEE international Conference on Computational Intelligence for Measurement Systems and Appliccation.

[4] Digital Image Processing by S. Jayaraman, S. Esakkirajan and T. Veerakumar. An imprint of McGraw Hill publication, 3rd edition.

[5] Digital Image Processing Using MATLAB by Rafael C. Gonzalez, Richard E. Woods and Steven L. Eddins. An imprint of pearson publication, 3rd edition.

[6] Mat Isa, N.A. Mashor, M.Y. & Othman, N.H. (2003). Contrast Enhancement Image Processing on Segmented Pap Smear Cytology Images. Prof. of Int. Conf. on Robotic, Vision, Information and Signal Processing. 118 – 125

[7] N.R. Mokhtar, Nor Hazlyna Harun, M.Y. Mashor, H. Roseline, R. Adollah, H. Adilah, Nazahah Mustafa, N.F. Mohd Nasir, 'Contrast Enhancement of Acute Leukemia Images Using Local and Global Contrast Stretching Algorithms', ICPE-2008.

[8] R.W.Jr. Weeks, (1996). Fundamental of Electronic Image Processing. Bellingham: SPIE Press.

[9] Nor Hazlyna Harun, N.R. Mokhtar, M.Y. Mashor, H. Adilah, R. Adollah, Nazahah Mustafa, N.F. Mohd Nasir, H. Roseline, 'Color image enhancement techniques based on partial contrast and contrast stretching for acute leukaemia images', ICPE-2008.