ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 1, July 2012

Comparison of Several Contrast Stretching Techniques on Acute Leukemia Images

Jaspreet Kaur, Amita Choudhary

Abstract*—Leukemia is a malignant disease (Cancer) seen in people of any age groups either in children or adults aged over 50 years. It is characterized by the uncontrolled accumulation of immature white blood cells. Further the noises and blurriness effect often leads to false diagnosis of leukemia. An automatic image enhancement 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, several contrast enhancement techniques such as local contrast stretching, global contrast stretching, partial contrast stretching, bright and dark contrast stretching techniques are applied on the leukaemia images. The comparison for all the proposed image enhancement techniques was carried out to find the best technique to enhance the acute leukemia images.

***Keywords*—Acute Leukemia, Image Enhancement, Local Contrast, Global Contrast, Partial Contrast, Bright and Dark Contrast.**

I. INTRODUCTION

Leukemia is a cancer of blood cells characterized by the abnormal increase in the number of white blood cells in the tissues [1]. It is a progressive malignant disease of the blood-forming organs, marked by distorted proliferation and development of leukocytes and their precursors in the blood and bone marrow. 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 [2]. 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. Thus image pre-processing such as image enhancement techniques are needed to improve this situation. 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. [3]

Leukemia is divided into four categories: myelogenous or lymphocytic, each of which can be acute or chronic.[4] Acute myelogenous leukemia (AML) is a cancer of the myeloid line of blood cells, characterized by the rapid growth of abnormal white blood cells that accumulate in the bone marrow and interfere with the production of normal blood cells. Chronic myelogenous leukemia (CML), also known as chronic granulocytic leukemia (CGL), is a cancer of the white blood cells. It is a form of leukemia characterized by the increased and unregulated growth of predominantly myeloid cells in the bone marrow and the accumulation of these cells in the blood. [5] Acute lymphoblastic leukemia (ALL) is a form of leukemia, or cancer of the white blood cells characterized by excess lymphoblasts. Malignant, immature white blood cells continuously multiply and are overproduced in the bone marrow. Chronic lymphocytic leukemia (CLL) causes a slow increase in white blood cells called B lymphocytes, or B cells. Cancer cells spread through the blood and bone marrow, and can also affect the lymph nodes or other organs such as the liver and spleen.[6]

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.

II. METHODOLOGY

A. Image Enhancement

Image enhancement processes consist of a collection of techniques that seek to improve the visual appearance of an image or to convert the image to a form better suited for analysis by a human or machine [8]. The process of manipulating an image so that result is more suitable then the original for a specific application Enhancement technique is applied in order to increase the contrast of an image. Meanwhile, the term image enhancement is mean as the improvement of an image appearance by increasing dominance of some features or by decreasing ambiguity between different regions of the image [9]. The aim of image enhancement is to improve the visibility of low-contrast features while suppressing noise.

Contrast stretching is one of the image enhancement technique that attempts to improve the contrast in an image by stretching the range of the intensity values it contains to span a desired range of values. The full range of pixel values that the image type concerned allows Contrast Stretching changes the distribution and range of digital numbers assigned to each pixel in an image. This is normally done to accent the details that are difficult for human viewer to observe. Contrast stretching is the image enhancement technique that is commonly used for medical images. Contrast stretching process plays an important role in enhancing the quality and contrast of medical images. [10]

The primary goal of acute leukemia blood cell image enhancement is improve the false diagnosis caused by white blood cells in Leukaemia. The proposed algorithm for acute leukaemia image enhancement is given below

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 1, July 2012

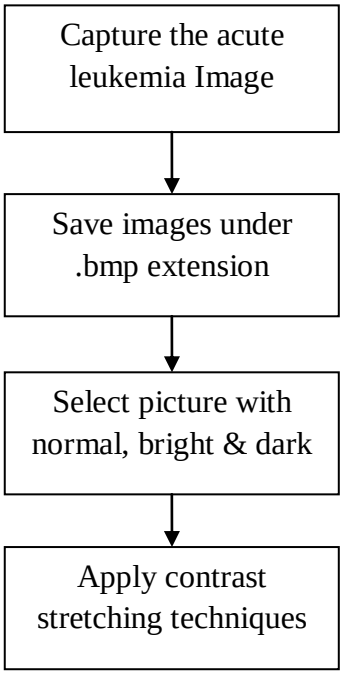

Fig. 1: Proposed System for Acute Leukaemia Enhancement

These are 4 steps involved in applying image enhancement process is explained below:

a) The first step is image capturing of acute leukemia blood slide under 40 x magnifications.

b) Then, save the images under .bmp extension.

c) The third step is to select picture with 3 different types which is normal image, bright image and dark image. Three images are selected for each different type.

d) The last step is applying the 5 proposed techniques to the selected images.

B. The Proposed Techniques

i. Local Contrast Stretching

Local contrast stretching (LCS) equalizes the contrast throughout the image and makes it easier to see the details in the regions that are originally very light or dark. It is an enhancement method for locally adjusting each picture value to improve the visualization of structures in the both darkest and lightest portions of the image at the same time. Local contrast enhancement attempts to increase the appearance of large-scale light-dark transitions, similar to how sharpening with an "unsharp mask" increases the appearance of small-scale edges. LCS is performed by sliding windows (called the KERNEL) across the image and adjusting the centre element using the formula:

$$I_p(x, y) = 255.[\, I_0\,(x\,, y) - min\,] \,/\, (max\text{-}min) \quad (1)$$

Where,

Ip(x, y) is the colour level for the output pixel *(x, y)* after the contrast stretching process.

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

Max - is the maximum value for colour level in the input image.

Min - is the minimum value for colour level in the input image.

ii. Global Contrast Stretching

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 [4].

iii. Partial Contrast Stretching

Partial contrast is a linear mapping function that is used to increase the contrast level and brightness level of the image. The technique is based on the original brightness and contrast level of the images to be adjusted. First the system will find the range of where the majority input pixels converge for each colour space. Since the input image is in RGB colour space, so it is necessary to find the pixels range between the red, blue and green intensities. Then, the average of these three colour space will be calculated to obtain the upper and lower colour values by using the following formula [11]:

maxTH = (maxRed + maxBlue + maxGreen)/3

minTH = (minRed + minBlue + minGreen)/3 (2)

maxRed, maxBlue and maxGreen are the maximum colour level while *minRed, minBlue* and *minGreen* are the minimum colour level for each colour palette respectively. *maxTH* and *minTH* are the average number of maximum and minimum RGB colour space. *maxTH* and *minTH* will be used as the desired colour ranges for all the three colour palettes.

Next is to start with the mapping process. The mapping function is as follows [12] :

$$P_K = \frac{(max - min\,)}{(f_{max} - f_{min})}\,(\,q_K - f_{min}\,) + min \qquad (3)$$

Where,

P_K : Colour level of the output pixel

q_K : Colour level of the input pixel

f_{max} : Maximum colour level values in the input image

f_{min} : Minimum colour level values in the input image

min : Desired minimum colour levels in the output image

max : Desired maximum colour levels in the output image

For partial contrast, the function in (4) is used for the pixels transformation which is based on the concept of linear mapping function shown in (3).

$$Out(x,y) = \begin{cases} \dfrac{in\,(x\,,y\,)}{minTH} * NminTH \\ [\,\dfrac{(\,NmaxTH\, - NminTH)}{maxTH\, - minTH} * (\,in\,(x,y) - f_{min}\,)] \\ \dfrac{in\,(x,y)}{maxTH} * NmaxTH \end{cases} \qquad (4)$$

Where,

in(x,y) : color level for the input pixel

out(x,y) : color level for the output pixel

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 1, July 2012

minTH : lower threshold value
maxTH : upper threshold value
NminTH : new lower stretching value
NmaxTH : new upper stretching value

iv. Bright Contrast stretching

Bright stretching is a process that also used as a auto scaling method which is a common linear mapping function to enhance the brightness and contrast level of an image. In general, bright stretching method is based on linear mapping function used to enhance the brightness and contrast level of the images [12]. The process tends to compress the range of image value which is less than the threshold value. On the other side, it expands the range of image values which are greater than the threshold value. The bright stretching process is implemented based on Equation 5 [11],

$$Out(x,y)= \begin{cases} \frac{in(x,y)}{TH} * NewTH \\ \left[\frac{(in(x,y)-TH)}{255-TH} * (255-NewTH)\right] + min \end{cases} \quad (5)$$

Where,
TH: threshold value
NewTH: bright stretching factor

v. Dark Contrast Stretching

Dark stretching is a reverse process of bright stretching process. Where TH and SFd are the threshold value and the dark stretching factor respectively. Process tends to stretch the range of image value which is less than the threshold value. On the other side, it compresses the range of image values which are greater than the threshold value.

$$Out(x,y)= \begin{cases} \frac{in(x,y)-TH}{255-TH} * NewTH \\ \left[\frac{(in(x,y)-TH)}{255-TH} * (255-NewTH)\right] + min \end{cases} \quad (6)$$

Where,
in(x,y) : value of pixel color level located at *(x,y)* input image
TH : threshold value.
NewTH : dark stretching factor

III. RESULTS AND DISCUSSION

The presented contrast enhancement techniques are effective in enhancing the contrast of leukemia images. In order to compare the image enhancement techniques, the comparison of image before and after enhancement will be done. The proposed contrast enhancement techniques will then be applied to leukemia images labelled as normal, dark and bright Images. These images are then categorized based on the human visual interpretation. Figure 2 shows original image. Meanwhile, the results for each normal, dark and bright image for each technique are shown in Figure 3, Figure 4, Figure 5, Figure 6, Figure 7.

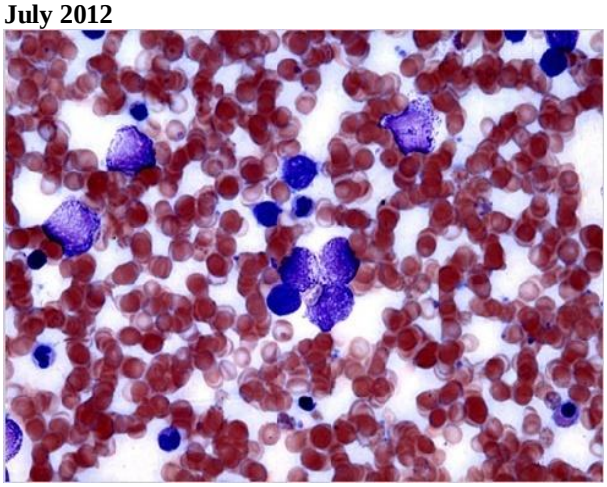

Fig. 2: Original Image

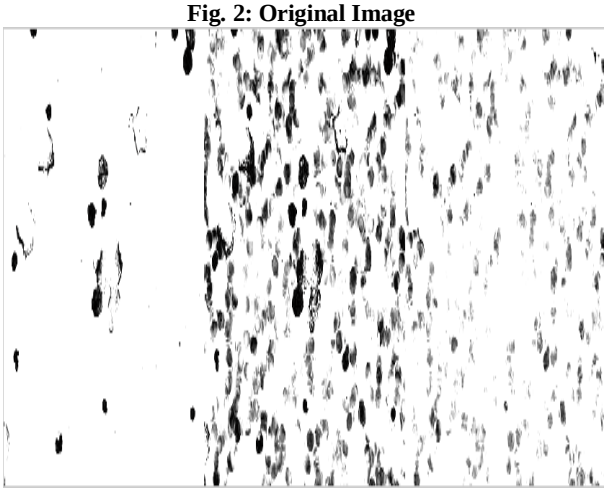

Fig. 3: Images after Local Contrast Stretching

Figure 3 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.

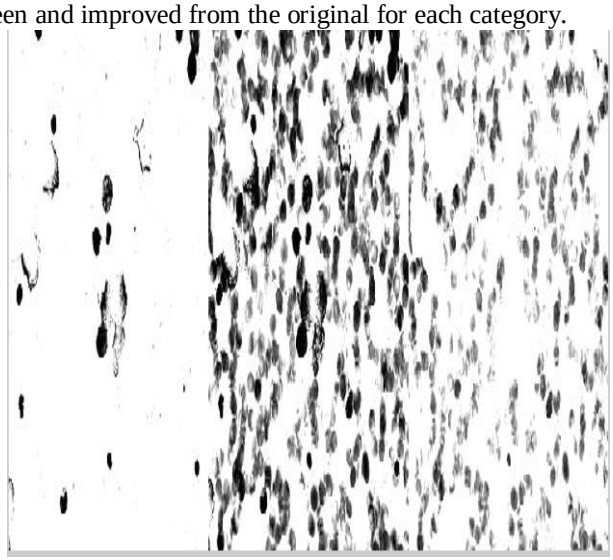

Fig. 4: Images after Global Contrast Stretching

Figure 4 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.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 1, July 2012

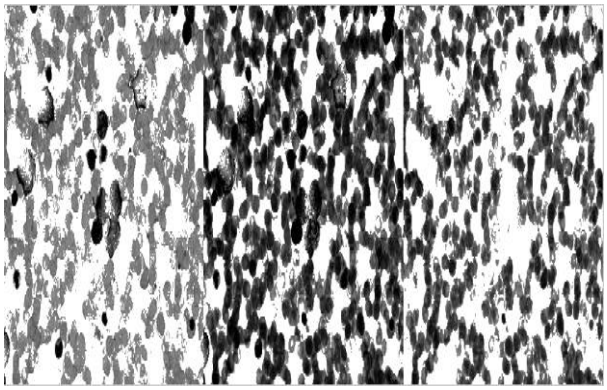

Fig. 5: Images after Partial Contrast Stretching

Figure 5 shows the result from the partial contrast stretching which has better contrast than the original images. These choices of parameters can improve the quality of the original images.

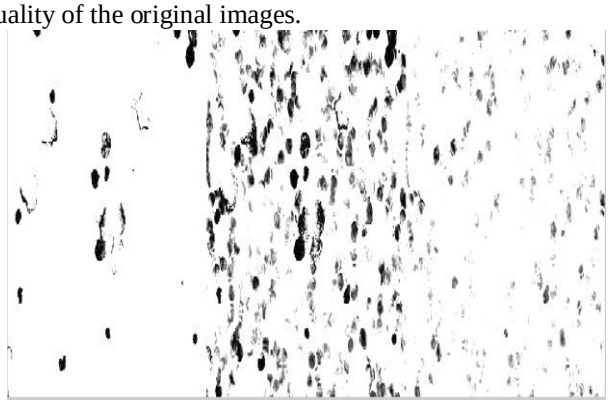

Fig. 6: Images after Bright Contrast Stretching

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 colour 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.

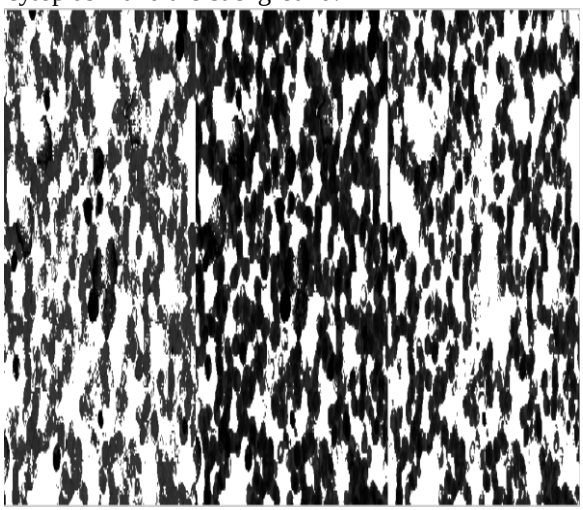

Fig. 7: Images after Dark Contrast Stretching

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 leukaemia images dark area refers to nucleus, therefore the nucleus is clearer because of the stretching step in dark stretching method.

IV. CONCLUSION

The presented contrast enhancement techniques are effective in enhancing the contrast of leukemia images. From those 5 techniques, partial contrast gives the best result and hopefully could give 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.

REFERENCES

[1] Aimi Salihah,.A.N., M.Y.Mashor, Nor Hazlyna, H.Rosline "Colour Image Enhancement Techniques for Acute Leukaemia Blood Cell Morphological Features" IEEE Transactions on Image Processing , 2010 , 15(9) :2588 - 2595.

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

[3] R.Ravindraiah, Dr. M.N.Giri Prasad, "QUALITATIVE EVALUATION OF ENHANCEMENT METHODS FOR ANALYSIS OF ACUTE LEUKEMIA IMAGES", International Journal of Engineering Science and Technology (IJEST) ISSN: 0975-5462, Vol 3, 8 August 2011 Page 6447-6452.

[4] N.R. Mokhtar, Nor Hazlyna Harun "Image Enhancement Techniques Using Local, Global, Bright, Dark and Partial Contrast Stretching For Acute Leukemia", Proceedings of the World Congress on Engineering 2009 Vol I WCE 2009, July 1 - 3, 2009, London, U.K..

[5] en.wikipedia.org/wiki/Acute_myeloid_leukemia&en.wikipedia.org/wiki/Chronic_myelogenous_leukemia.

[6] en.wikipedia.org/wiki/Acute_lymphoblastic_leukemia.

[7] Rohini Patil and Prof. Mandar Sohani "Acute Leukemia blast counting using RGB, HIS color".

[8] William K.Pratt(2007), Digital Image Processing , Los Altos, California.

[9] Bhabatosh Chanda and Dwijest Dutta Majumder, 2002, Digital Image Processing and Analysis.

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

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

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