Comparison of Acute Leukemia Image Segmentation using HSI and RGB Color Space


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ABSTRACT

The Image segmentation plays an important role in computer vision and image processing areas. In this paper, the use of color segmentation for segmenting acute leukemia images is proposed. The segmentation technique segments each leukemia image into two regions: blast and background. In our approach, the segmentation is based on HSI and RGB color space. The performance comparison between the segmentation algorithms based on HSI and RGB color space is carried out to choose a better color image segmentation for blast detection. The results show that the proposed segmentation technique based on HSI has successfully segmented the acute leukemia images while preserving significant features and removing background noise.

1. INTRODUCTION

The term leukemia refers to a group of cancers of the blood cells. In leukemia, white blood cells become abnormal, divide and grow in an uncontrolled way. There are two main types of leukemia: acute leukemia and chronic leukemia. The word acute means the disease develop and progress rapidly [1]. The recognition of acute leukemia cell images based on color image is one of the most challenging tasks in image processing.

Segmentation of an image refers to the separation of regions with similar characteristics. The most basic characteristics for segmentation are image luminance amplitude for a monochrome image, color components for a color image, edges and also texture of the image [2]. The applications of image segmentation are widely used in medical imaging, remote sensing and robotic vision. In medical imaging, segmentation are useful for studying the anatomical structure, diagnosis, treatment planning or to locate tumors and other pathologies [3]. Image segmentation is the most important step in image processing as it will directly affect the post-processing.

Computer analysis of images usually starts with segmentation, which reduce pixel data to region-based information about the objects and structures present in the image [4]. There are several general-purpose algorithms and techniques that have been developed for image segmentation. With the combination between mathematical theories and computer vision, image segmentation has achieved great progress. However, some algorithms for segmentation have their own drawbacks [5]. As for the blood cell images, due to the cells complex nature and overlapping between these cells, it still remains a challenging task to segment and count them [6]. These are two difficult issues in image segmentation where common segmentation algorithms cannot solve this problem. Moreover, many algorithms for segmentation have been developed for grayscale images. The segmentation of color images which requiring more information about the scene has make it received less attention to develop the algorithms [7].

Image segmentation techniques can be classified into four main categories: thresholding techniques, boundary-based, region based segmentation and hybrid techniques that combine boundary and region criteria [4]. Region based or edge-based schemes are the most popular of segmentation methods applied for peripheral blood or bone marrow smears [3]. Proper combination of boundary and region information may produce better segmentation results than those obtained by either method on its own [4].

Skarbek and Koschan [7] discussed about a survey of algorithms for color image segmentation. They concluded that color images allow for more reliable image segmentation than grayscale images. Kumar [8] stated that color images are very rich source of information, because it provides a better description of a scene as compared to gray scale images.

The goal of segmentation is to simplify and/or to change the representation of an image into something that is more meaningful and easier to analyze [9]. Two of the basic models for color images are the HSI (Hue, Intensity, Saturation) color space and the RGB (Red, Green, Blue) color space. The current study uses these
two color space to segment the acute leukemia slide images.

2. METHODOLOGY

2.1. Image Segmentation Based on RGB Color Space

The ultimate goal of acute leukemia blood cell segmentation is to extract morphological component such as blast from its complicated blood cells background by using RGB color space. There are 5 steps involved in the processing method based on RGB color space.

Step 1: Capture acute leukemia slide image at 40x magnification and save into bitmap (*.bmp) extension with 800x600 resolution.

Step 2: Applying the Local Contrast Stretching (LCS) to increase the contrast of the image captured.

Step 3: Select the threshold value by using histogram.

Step 4: Implement the median filter to the resulted images.

Step 5: Display the resulted image in RGB color space.

For RGB color space, local contrast stretching (LCS) is an enhancement method performed on acute leukemia images for locally adjusting each RGB pixel value to improve the visualization of structures in both darkest and lightest parts of the acute leukemia images at the same time. The algorithm is shown in equation 1.

\[
I_{output}(x,y) = 255 \frac{I_{input}(x,y) - \text{min}}{\text{max} - \text{min}}
\]

where,

- \(I_{output}(x,y)\) is the color level for the output pixel
- \(I_{input}(x,y)\) is the color level for the input pixel
- max is the maximum value for color level in the input image
- min is the minimum value for color level in the input image

2.2 Image Segmentation using HSI Color Space

The transformation from the source RGB color space to HSI color space is performed based on the following equations [10]:

\[
\theta = \cos^{-1} \left( \frac{1}{2} \frac{(R-G)+(R-B)}{(R-G)^2+(R-B)(G-B)} \right)
\]

\[
\text{Saturation} = 1 - \frac{3}{R+G+B} \min(R,G,B)
\]

\[
\text{Intensity} = \frac{1}{3}(R+G+B)
\]

In this current study, only S component is used. The methodology in this method includes 4 major steps. The summary of the method are shown as follow:

Step 1: Capture acute leukemia slide image at 40x magnification and save into bitmap (*.bmp) extension with 800x600 resolution.

Step 2: Select the threshold value by using S component from HSI color space. The threshold value is obtained from histogram.

Step 3: Implement the median filter \(N \times N(N = 7)\) to the resulted images.

Step 4: Restore the original HSI color to the resulted images.

Step 5: Convert to RGB to display.

3. RESULT AND DISCUSSIONS

In this study, image segmentation method by using RGB and HSI color space are proposed. Figure 2 shows the captured acute leukemia image with resolution of 800x600.

Figure 2. Original Acute Leukemia Image

Figure 3(a) shows the results of the S component using HSI color spaces. Figure 3(b) represents the saturation image intensity histogram. Based on Figure 3(b), the histogram has two peaks. Therefore, to suppress the background from the image will be not too difficult. The threshold value was selected and used to segment the background from the image.
Based on Figure 4(b), the LCS histogram that represents Figure 4(a) has three peaks. However, there are four objects in the image which needs our consideration: the background, red blood cell and blast (cytoplasm and nucleus). In this case, it is quite difficult to select the threshold value which is suitable for the image.

Based on Figure 5(a) and 5(b), the blast (abnormal white blood cells) in both images can be easily seen and identified. For Figure 5(b), after applying RGB based local contrast stretching, this will result on the elimination of all cytoplasm blast (abnormal white blood cell). However, this result does not appear on Figure 5(a). Based on Figure 5(a), by applying $S$ component from HSI color space seems to overcome the problem.
Results of using pixel subtraction technique between original image in Figure 2 and segmented image in Figures 5(a) and 5(b) are respectively shown in the Figures 6(a) and 6(b). The successfully segmented blasts appeared as a white color. Therefore, Figure 6(a) indicates that the shape of the blasts resulted from HSI color space yields almost similar shape to Figure 2 whereas the shape from Figure 6(b) is quite dissimilar. Meanwhile, Table 1 below shows that the selected pixel value for original blast (refer to the selected blast) from Figure 2, blast (refer to the selected blast) after applying $S$ component base on HSI color space from Figure 5(a) and blast (refer to the selected blast) after applying RGB color space base on local contrast method from Figure 5(b). The resultant image shown in Figure 5(a) indicates that this method was successfully produced similar pixel values with original blast (refer to the selected blast) from Figure 2.

Table 1. The selected pixel value for segmented image

<table>
<thead>
<tr>
<th>BLAST 1</th>
<th>Pixel (x, y)</th>
<th>Cytoplasm (226,228)</th>
<th>Nucleus (210,269)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RGB value</td>
<td>Original image</td>
<td>140,88,135</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resulted Image</td>
<td>140,88,135</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for HSI color space</td>
<td>118,53,116</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resulted Image</td>
<td>255,255,255</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for RGB color space</td>
<td>94,56,88</td>
</tr>
<tr>
<td>BLAST 2</td>
<td>Pixel (x,y)</td>
<td>Cytoplasm (271,100)</td>
<td>Nucleus (306,112)</td>
</tr>
<tr>
<td></td>
<td>RGB value</td>
<td>Original image</td>
<td>100,83,27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resulted Image</td>
<td>100,83,27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for HSI color space</td>
<td>112,89,62</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resulted Image</td>
<td>255,255,255</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for RGB color space</td>
<td>44,30,49</td>
</tr>
<tr>
<td>BLAST 3</td>
<td>Pixel (x,y)</td>
<td>Cytoplasm (582,129)</td>
<td>Nucleus (646,133)</td>
</tr>
<tr>
<td></td>
<td>RGB value</td>
<td>Original image</td>
<td>128,85,121</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resulted Image</td>
<td>128,85,121</td>
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<tr>
<td></td>
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<td>for HSI color space</td>
<td>108,45,95</td>
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<tr>
<td></td>
<td></td>
<td>Resulted Image</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for RGB color space</td>
<td>84,51,67</td>
</tr>
</tbody>
</table>

4. CONCLUSIONS

This paper presents a comparison between image segmentation method by using HSI and RGB color spaces for detection of blast (abnormal white blood cell) in blood slide images. The method based on RGB color space has not performed well. For image segmentation using RGB color space, the pixel values for the selected blasts are dissimilar to the original blasts. Besides that, the shape of the blast after the segmentation process is not quite similar to the original blasts. While the method based on HSI color space using $S$ component can provide almost similar pixel values and shape to original blasts. The results also show that the histogram is also useful to select the threshold value using HSI color space. For future work, the result of this paper can be used as the basis for extracting the features from the blood slide images.

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6. REFERENCES


