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Contour Detection of Leukocyte Cell Nucleus Using Morphological Image

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Abstract. Leukocytes are blood cells that do not contain color pigments. Leukocyte function to the tool body's defenses. Abnormal forms of leukocytes can be a sign of serious diseases such example is leukemia. Most laboratories still use cell morphology examination to assist the diagnosis of illness associated with white blood cells such example is leukemia because of limited resources, both infrastructure, and human resources as happens in developing nations, such as Indonesia. This examination is less expensive and quicker process. However, morphological review requires the expertise of a specialist clinical pathology were limited. This process is sometimes less valid cause in some cases trying to differentiate morphology blast cells into the type of myoblasts, lymphoblast, monoblast, or erythroblast thus potentially misdiagnosis. The goal of this research is to develop a detection device types of blood cells automatically as lower-priced, easy to use and accurate so that the tool can be distributed across all units in existing health services throughout Indonesia and in particular for remote areas. However, because the variables used in the identification of abnormal leukocytes are very complex, in this paper, we emphasize on the contour detection of leukocyte cell nucleus using the morphological image. The results show that this method is promising for further development.

1. Introduction

Leukocytes are white blood cells that work with the immune system to defend against infectious disease. Damage to the kidneys, ureters, urethra or bladder can cause leukocytes to appear. They can also be triggered when foreign materials are found in the body. There are five types of leukocytes. If a high level of a particular type of leukocyte is found in elevated levels, this can be a sign of disease. The types of leucocytes are (i) Monocytes: They have a longer lifespan than many white blood cells and help to break down bacteria. (ii) Lymphocytes: They make antibodies to defend against viruses, bacteria, and other potentially harmful invaders. (iii) Neutrophils: They kill and digest bacteria and fungi. They are the most numerous type of white blood cell and the first line of defense when infection strikes. (iv) Simple tools the blood. They secrete chemicals such as histamine, a marker of allergic disease, which help control the body's immune response. (v) to [1]. In order to determine an abnormality of leukocytes, there are some kinds of blood test, such as complete blood count, morphological of peripheral blood, morphological of bone marrow, Cytogenetic, double nucleic acid (DNA), and detection of cluster of differentiation (CD) using flow cytometry [2] [3] [4].

Most laboratories still use cell morphology examination to assist the diagnosis of diseases associated with white blood cells such example is leukemia because of limited resources, both infrastructure, and



human resources as the Indonesia. This examination is less expensive and quicker process. However, morphological examination requires the expertise of a specialist clinical pathology were limited. This examination is sometimes less valid because in some cases difficult to differentiate morphology blast cells into the type of myoblasts, lymphoblast, monoblast, or erythroblast thus potentially misdiagnosis. According to the condition as mentioned above, it is necessary to develop a detection device types of blood cells automatically as lower-priced, easy to use and accurate so that the tool can be distributed across all units in existing health services throughout Indonesia and in particular for remote areas.

According to the research about leucocytes using image processing, there is some research that discussed this topic. Ko [5] applied seam carving to cell images, an SSM is initially generated using a visual attention model, and the structural properties of white blood cells are then used to create an energy map for seam carving. As a result, the energy map maximizes the energies of the white blood cells, while minimizing the energies of the red blood cells and background. Thus, the use of an SSM allows the proposed method to reduce the image size efficiently while preserving the important white blood cells. Madhloom [6] presented a new method that integrates color features with the morphological reconstruction to localize and isolate lymphoblast cells from a microscope image that contains many cells. The localization and segmentation are conducted using a proposed method that consists of an integration of several digital image processing techniques. 180 microscopic blood images were tested, and the proposed framework managed to obtain 100% accuracy for the localization of the lymphoblast cells and separate it from the image scene. Li [7] implemented a series of digital image processing methods, such as gray stretch, median filter, threshold segmentation, edge extraction and detection, the variations of red blood cells and the goal of identifying the shapes of variable red blood cells. Eric [8] presented an application that integrates visualization and quantitative analysis of 5-D ($x, y, z, t, channel$) and large montage confocal fluorescence microscopy images. The image sequences show stem cells together with blood vessels, enabling quantification of the dynamic behaviors of stem cells about their vascular niche, with applications in developmental and cancer biology. Evans [9] developed an automated method to measure and compare the dynamic movement of cell membranes. Using the red blood cell as a common example the method locates the edge of the cell, with sub-pixel precision at multiple points on the periphery. Koltsov [10] considered the problem of the segmentation of microscopy images of blood cells. Krashenninniko [11] proposed some algorithms for processing images of blood serum facies for automated medical diagnosis, i.e., determination of the boundaries of facies, identification of their morphological type, and detection of certain markers indicating pathology. The mathematical modeling of such images is considered. Kinahan [12] presented retrieval of Peripheral Blood Mononuclear Cells by density-gradient medium based centrifugation for subsequent analysis of the leukocytes on an integrated microfluidic "Lab-on-a-Disc" cartridge. Isolation of white blood cells constitutes a critical sample preparation step for many bioassays. Centrifuge-pneumatic siphon valves are particularly suited for blood processing as they function without the need of surface treatment and are 'low-pass,' i.e., holding at high centrifugation speeds and opening upon reduction of the spin rate. Wojewodzka [13] used biodosimetric methods to measure the effects of radiation are critical for estimating the health risks to irradiated individuals or populations. The direct measurement of radiation-induced γ -H2AX foci in peripheral blood lymphocytes is one approach that provides a useful end point for triage. Panchbhai [14] developed an automated for the identification of malaria parasites. The given scheme based on used of RGB color space, G layer processing, and segmentation of Red Blood Cells (RBC) as well as cell parasites by auto-thresholding with the offset value and use of morphological processing. According to all research mentioned in this paragraph and also based on our previous research [15] [16] [17] [18] [19] [20] [21], we conclude that the image processing technique is widely used in applications of microscopic images of blood cells. However, the application of previous research was not emphasized on the identification of abnormal leucocytes. The goal of this research is developing simple tools for identifying abnormal leukocytes to support the diagnosis of leukemia quickly and easily in the rural areas are widely available in developing countries such as in Indonesia. However, because the variables used in the identification of abnormal leukocytes are very involved, in this paper, we emphasize on the contour detection of leukocyte cell nucleus using the morphological image.

2. Methods

2.1. Designing Contour Detection System of Leukocyte Cell Nucleus

In this experiment, we used the digital image of leukocytes coming from Margono Soekardjo Hospital, Banyumas, Central Java, Indonesia. The images have *.jpg format with size 640x480 pixels. Images data have different characteristics. It is to be used to test the extent to which this system can work. To facilitate the use of algorithms that we developed, we developed a Graphical User Interface (GUI) based on the programming language Matlab as shown in Figure 1. In the image, acquisition phase begins with selecting the "Select Image" in the original image panel. Figure 2 shows the display GUI application when opening the blood image file.



Figure 1. Initial display of our GUI

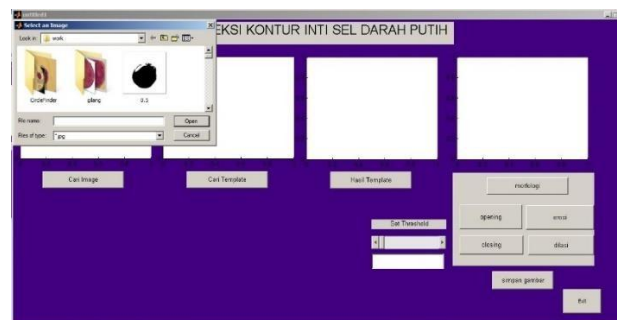


Figure 2. GUI display for Image Acquisition

2.2. Template Matching

Template matching is a technique in digital image processing to find small parts of the picture that matches the template image. Template matching is one idea that is used to explain how our brains recognize return forms or patterns. Templates in the context of pattern recognition refer to the internal constructs which if matched with sensing stimuli lead to the recognition of an object or pattern recognition occurs if there is a match between sensory stimuli with internal mental shape [22]. In this research approach towards partition division of white blood cell image by using a template. In the classification stage, the template is matched with the image of the white blood cells. Template matching with the image of the white blood cells produces a percentage match between templates with white blood cell nucleus.

2.3. Morphological Operations

Morphological operations are image processing techniques that are based on the shape of a segment or region in the image. Because it is focused on the shape of the object, then surgery is usually applied to the binary image. Usually, the segment was based on the object of concern. Segmentation is done by distinguishing between the object and the background, such as by utilizing a floating operation that changed the image of the color and gray-scale binary image. The binary value of the image represents the result of two circumstances: the object and not the object (background). Although it is more widely used in the binary image, morphological operations are often used in the image of gray scale and color. The results of morphological operations can be used for decision-making by further analysis. These operations include dilation, erosion, closing and the opening [22].


Erosion is a way to minimize the object. In this operation, the size of the object is reduced by eroding the surrounding objects. The first way is to change all the border points into the background and the

second-way point by setting all points around the point of the background becomes foreground point. Dilation is done to enlarge the size of the object segment by adding a layer around the object. There are two ways to do this operation that is by changing the background all the points neighboring the point boundary a point of the object or simply set each point that his neighbor is a point object into a point object. The second way is to change all points around the boundary points a point of the object, or simply set all the points neighbors a point object into a point object. Closing is a combination of dilation and erosion operations are performed sequentially. Closing is a combination of dilation and erosion operations are performed sequentially. This operation used to close or eliminate the small holes that exist in the object segments, combine objects are adjacent and soften the boundaries of large objects without changing the object significantly. Opening a combination of erosion and dilation operations are carried out sequentially. This procedure used to sever portions of the object which is only connected to one or two dots, or eliminate small objects and softens the boundaries of large objects without changing the object area significantly [22].

3. Results and Discussions

In research we've done, there are five image templates that will test the performance of its success is ultimately just use one template only. Table 1 and Figure 3 described this results.

Table 1. Template's name

Template's name	Template's image
Template1.jpg	
Template2.jpg	
Template3.jpg	
Template4.jpg	
Template5.jpg	



















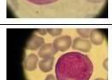





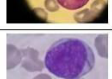





No	Citra Asli	Hasil template1	Hasil Template2	Hasil Template3	Hasil Template4	Hasil Template5
1.						
2.						
3.						
4.						
5.						

Figure 3. Template's result

Based on the above data, selected template five as a reference for template matching with the performance calculation as described in Table 2.

Table 2. Calculation of performance success template

Template	Performasi perhitungan
Template1. jpg	$\frac{2}{5} \times 100\% = 40\%$
Template2. jpg	$\frac{2}{5} \times 100\% = 40\%$
Template3. jpg	$\frac{2}{5} \times 100\% = 40\%$
Template4. jpg	$\frac{3}{5} \times 100\% = 60\%$
Template5. jpg	$\frac{5}{5} \times 100\% = 100\%$

Each image takes time that is different at the time of this template matching process. It was in because the size of the pixels of an image and also the intensity of the colors in the image, the larger the size of an image will be longer in the process of template matching. Table 3 shows the length of time the process template matching on the image of the white blood cells.

Morphology operation involves two components: the first component in the form of images that will be subjected to the morphology operation in this experiment is the image of blood cells, while the second component called a kernel or structuring element. We chose the disk-shaped structural element because its form is most appropriately used to detect the contours of the core blood. Because of its shape like a disc that conforms to the shape of blood cells. Table 4 shows the result of structure element comparison.

Each image has a different outcome after converted to binary. Thus requiring different morphological operations for each image. To get a perfect contour core, it is necessary to carefully search the Threshold value to get maximum results. Table 5 shows the results of this case.

Table 3. The time required for template calculation



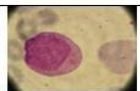
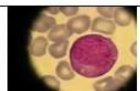
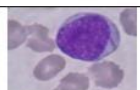
No	Nama Citra	Ukuran citra	Citra darah	Waktu template matching
1	Citra1	640x480 pixel		2 menit
2	Citra2	640x480 pixel		3 menit
3	Citra3	640x480 pixel		3 menit
4	Citra4	920x720 pixel		20 menit
5	Citra5	640x480 pixel		3 menit

Table 4. Comparison of structure element

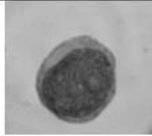

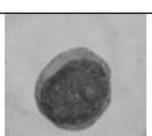
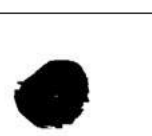
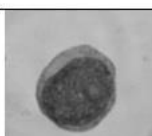
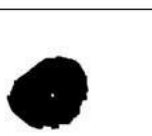
No	Citra grayscale	Citra biner	Jenis strel
1			disk
2			line
3			Rectangle

Table 5. Template's result


















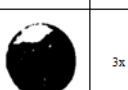

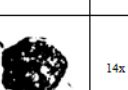

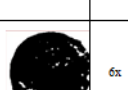
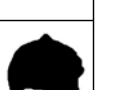
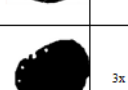
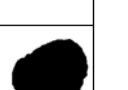
No	Nama File	Citra Asli	Citra Hasil Deteksi	Nilai Threshold	Citra Biner
1.	Citra1.jpg			0.37	
2.	Citra2.jpg			0.49	
3.	Citra3.jpg			0.4	
4.	Citra4.jpg			0.44	
5.	Citra5.jpg			0.41	

Table 6. Morphological operation

No	Nama File	Citra Biner	Operasi Morfologi				Citra Hasil
			Erosi	Dilasi	Opening	Closing	
1.	Citra1.jpg		3x	3x	1	1	
2.	Citra2.jpg		3x	3x	1	-	
3.	Citra3.jpg		14x	14x	1	1	
4.	Citra4.jpg		6x	22x	1	1	
5.	Citra5.jpg		3x	3x	1	-	

In image1.jpg, using a threshold value of 0:37. This value is not necessarily applicable to another image. With the value of the acquired binary image of white blood cell nucleus that needs to be perfected again because there is still noise around the image. Therefore, it is still necessary morphological operations, order to obtain better. image2.jpg, using a threshold value of 0:49. With these values, they obtained a binary image that there are patches or perceived as noise. Therefore still needs to be done morphological operations to obtain better results. Image3.jpg using a threshold value of 0.4. With these values, they obtained a binary image that there are patches or perceived as noise. Therefore still needs to be done morphological operations. Image 4. .jpg using a threshold value of 0:44. With these values, they obtained a binary image that there are patches or perceived as noise. Therefore still needs to be done morphological operations. Image5.jpg using a threshold value of 0:41. With these values, they obtained a binary image that there are patches or perceived as noise. Therefore still needs to be done morphological operations. The use of the threshold value and the amount of the morphological operations are in wear on the image can be different between the images of one another. It is in use by the needs for each image, if there are noise or rudimentary, then search threshold value and also morphological operations will continue to be done. To find the perfect contours.

4. Conclusions

According to the results as discussed above, we can conclude that: (i) Based on the test results of some samples of the image of the leucocytes are used, the system can identify the morphology of white blood cell nucleus. Tests were performed using the operation dilation, erosion, opening, and closing with the structure element 'disk.' (ii) The method of adaptive threshold, i.e., setting the threshold value depends on the value of each image pixel for each image has a threshold value is different. (iii) The use of less appropriate threshold value will affect the morphology. Therefore, it is necessary threshold value with the best performance, which is approaching the contours of leukocyte cell nucleus

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