❏   150

Computer Aided Diagnosis for Screening the Shape and Size of Leukocyte Cell Nucleus based on Morphological Image

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Article Info	ABSTRACT
	Hematology tests are examinations that aim to know the state of blood and its components, one of which is leukocytes. Hematologic examinations such as the number and morphology of blood generally still done manually, especially by a specialist pathologist. Despite the fact that today there is equipment that can identify morphological automatically, but for developing countries like Indonesia, it can only be done in the capital city. Low accuracy due to the differences identified either by doctors or laboratory staff, makes a great reason to use computer assistance, especially with the rapid technological developments at this time. In this paper, we will emphasize our experiment to screen leucocyte cell nucleus by identifying the contours of the cell nucleus, diameter, circumference and area of these cells based on digital image processing techniques, especially using the morphological image. The results obtained are promising for further development in the development of computer-aided diagnosis for identification of leukocytes based on a simple and inexpensive equipment.

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1. INTRODUCTION

Rapid technological development today brings many benefits in various fields including the health sector. A technology application in the health field is the use of computer-aided diagnosis in resolving the problem. On the other hand, in terms of health, usually, the problems faced mostly related to the human body, one of which is blood. Usually, for health problems associated with blood, will do a test called a hematology test. The aim of hematology test is to learn if a person has any diseases or conditions such as high cholesterol, diabetic etc. But in the process of examination and identification of blood is still done manually by the medical team of both doctors and laboratory staffs with the parameters used the amount of blood and blood cell morphology. Thus less accurate results obtained during the examination and identification of the blood cells. Although in fact it's been a lot of hematology test instrument for accurate and sophisticated, but for developing countries like Indonesia, it cannot be implemented in all places, limited to the capital city only. It was because the price of the equipment is very expensive On the other hand, the current use of automated computer-assisted system can provide more accurate results than taking images of blood, compared to the examination and identification were done manually. The system used is the image processing that executed by a computer and can identify the morphology and the number of blood cells. There some researchers that discussed using the computer-assisted system for identifying blood cells. Khan [1] proposed a software base solution related health industry which will assist the medical laboratory

technician (MLT) to detect and find a blood cell count and produce an accurate cell count report. Abbas [2] proposed an automated system of the counting process of Red Blood Cells in thin Blood smear images in more accurate, efficient and universal way. Li [3] proposed a series of digital image processing methods, such as gray stretch, median filter, threshold segmentation, edge extraction, and detection, to detect the variations of red blood cells for identifying the shapes of variable red blood cells. Panchbhai [4] proposed an automating process of blood smear screening for malaria parasite detection. Maitra [5] proposed an approach to automatic segmentation and counting of red blood cells in microscopic blood cell images using Hough Transform. Madhloom [6] new method that integrates color features with the morphological reconstruction to localize and isolate lymphoblast cells from a microscope image that contains many cells. Djawad [7] conducted an experiment to analyze the effect methanol extract of clove leaf on the profile of superoxide dismutase (SOD) in the rabbits liver under hypercholesterolemic condition. Ko [8] proposed a new image resizing method using seam carving and a Saliency Strength Map (SSM) to preserve important contents, such as white blood cells included in blood cell images. Ajala [9] proposed a method to perform a comparative analysis between edge-based segmentation and watershed segmentation on images of the red blood cell. Referring to the research above, it appears that the use of image processing techniques is very helpful in checking the condition of the blood in various circumstances.

On the one hand, one of the diseases caused by blood is leukemia. Leukemia or blood cancer is often called a malignancy of the blood that marked proliferation and excessive blood cell development in both blood and bone marrow. Leukemia is a non-communicable disease are quite a lot happening and causing death [10]. The incidence of leukemia worldwide is 4.7 / 100,000 with a mortality rate of 3.4 / 100,000 population. The incidence of leukemia in Australia 15.5 per 100,000 population with a mortality rate of 6.3 per 100,000 population. In Singapore, the leukemia incidence is 3.4 per 100,000 population with a mortality rate 3.4 also. Other data in the US showed that leukemia affects all ages which were obtained by 44 270 4220 adult patients and children. The incidence of leukemia in Indonesia is 2.4 - 4 per 100,000 children with an estimated 2000-3200 new cases of Acute Lymphoblastic Leukemia types (LLA) annually. Research conducted at Center Hospital in Indonesia get that leukemia is a type of cancer most common in children (30-40%), followed by brain tumors (10-15%) and cancer of the eye / retinoblastoma (10-12%) [11].

Leukemia diagnosis is made based on clinical signs and symptoms as well as investigation. Investigations lab used to help diagnosis is a complete blood count, a morphology of peripheral blood, bone marrow morphology, cytogenetics, double nucleoid acid (DNA), and or detection of a cluster of differentiation (CD) with flow cytometry [12]. Currently, cytogenetic examination, DNA, and the CD is an examination can help diagnose a specific type of leukemia. The cytogenetic examination can provide results in the form of chromosomal damage that occurs so that it can be known types of leukemia by a chromosomal abnormality that is obtained. DNA examination of the specific information of DNA abnormalities that occur, so that a specific diagnosis of leukemia can be enforced. Each of these cell types both series myoblasts, lymphoblast, monoblast, nor erythroblast, have different CDs so that inspection can provide information CD obtained cell types and thus can help the diagnosis of leukemia [13]. Most laboratories still use cell morphology examination to assist the diagnosis of leukemia because of limited resources, both infrastructure, and human resources. This examination is less costly than the three aforementioned examinations and faster 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. With conditions like these, it is necessary to develop a detection device types of blood cells automatically as an instrument for supporting low cost, easy-to-use and accurate leukemia diagnosis so that the instrument can be distributed across all units in existing health services throughout Indonesia and in particular to remote areas. One of them is implementing computer aided diagnosis based on image processing techniques. In this paper, we emphasize on identifying the shape and size of leucocyte cell nucleus. This will be the basis for the development of abnormal cell identification as an early marker of leukemia. The use of image processing techniques which have been done by the researchers [14-17]. Our previous research [18-25] also discussed the implementation of image processing techniques in order for supporting low-cost and easy-to-use equipment of health facilities.

This paper will be organized as follows, section 1 is introduction and literature reviews, section 2 is the method that used in our experiment, section 3 is results and discussion and section 4 is conclusions.

2. RESEARCH METHOD

In this paper, experiments are limited to the following matters. The programming language used for processing the digital image data is a programming language Matlab, in this research the processed image data is a microscopic image of leukocytes derived from Purwokerto Geriatric Hospital Indonesia, Simulation

method using Matlab R2013a, the research refers only to the contours and the longest diameter leukocyte cell nucleus with image morphology and also we only count one object in the image data. The goal of this research as follows : (a) identify the shape of the cell nucleus by the morphology of leukocytes, quickly and automatically, (b) identify the morphology of leukocytes nucleus cell with the microscopic image data using the morphological image method, (b) measure the diameter length of the leukocytes nucleus cell.

2.1. Image Acquisition

Figure 1 shows the image used in this research. We get the image in digital form. Previous blood cells are made preparations and analyzed in a microscope by a pathologist. We then take a digital photograph of the blood cells displayed on a microscope. For the future, we will use a digital microscope so that we no longer need to take the photo manually as a result of the microscope is instantly converted in the form of digital images and can be connected to a computer,
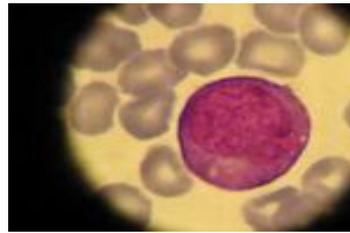

Figure 1. Blood cell

2.2. System Design

In this research, a system designed using GUI facility contained in Matlab R2013a. GUI is a user interface with an application program interface in the form of an object graph so that applications can be run more easily. Object graphs commonly used in GUI, some of the push button, static text, editText, axes, panel sliders, pop menu etc. Figure 2 shows our system design. System design is made as simple as possible. The language used in the system is Indonesian because the target users are the staff in the health services in remote areas.
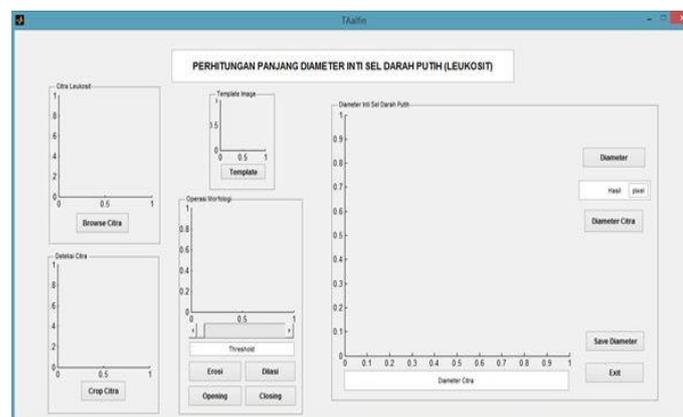

Figure 2. GUI display

The process of identifying contours and calculating diameter length of the cell nucleus leukocytes in Matlab R2013a consists of several stages. The first step is taking the input image to be analyzed by a push button and select the desired image. The next stage is the implementation of the template image is done automatically, cutting microscopic image of leucocyte cells based on the identification of the input image template, setting the threshold to set the conversion value of the binary image, morphological image processes to get the shape of leukocyte cell nucleus. The final stage of the system is calculating diameter length of leukocytes cell nucleus. The diameter length value is displayed on a pixel unit, and the diameter

value will be compared with manual calculations diameter length of leukocyte cell nucleus using Pythagorean formula.

2.3. Template Matching

Template matching is one idea that is used to explain how our brains recognize return forms or patterns. Template matching is a technique in digital image processing to find small parts of the image that match the template image [26]. Through template matching, we will set the template image most suited to recognize any image of leukocyte cells. Terms set for the template image template matching stage is when the image of the template can be detected and cut out digital image perfectly. Each image template will be tested to the individual leukocyte cell image and the template image will be selected which are the most widely detected and cut out a digital image. Later template election results will be used in the cropping process automatically, so we will get part of leukocyte cells that we desired.

2.4. Morphological Image

Morphological image operations that exist in this system, namely erosion, dilation, opening, and closing, wherein each pushbutton operation are different [23]. The user depending on the requirements of each image so that it can occur in one image will do some morphological image operations with each operation can be performed more than once. Unless for opening and closing operations that are idempotent who do not have a sustained impact. Referring to the morphological image method that has many operations, Morphology of the many operations that exist, we only use the Opening, Closing, Dilation, and Erosion. This is because in these systems need a way to erode the image and to thicken and soften the image. Morphological image operations involve two components: the first component in the form of images that will be subject to morphological operations, while the second component called a kernel or structuring element. Where the structure elements that are used in this system have been determined, the structure elements are disc-shaped or disk.

3. RESULTS AND ANALYSIS
3.1. Selection of Template Image

Template image piloted to each image, and the test results will be seen the performance of each template to be used as a template image in this experiment. Figure 3 shows the result of choosing template image.

From the test results of each candidate template image, as shown in Figure 3, we obtained the performance of the candidates as presented in Table 1
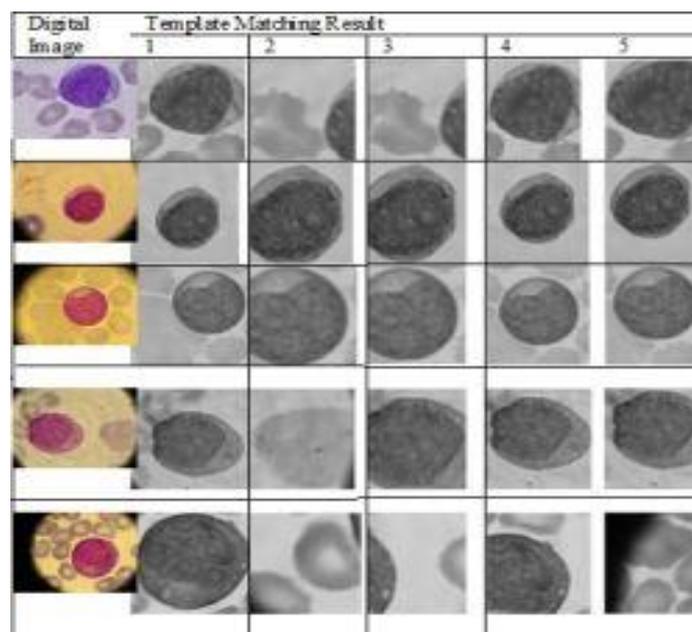

Figure 3. Result of choosing template image

Table 1. Accuracy value of Template image candidate

No	Template Image	Detection result	Cropping Results	Average
1	Img1	100%	100%	100%
2	Img2	40%	40%	40%
3	Img3	60%	40%	50%
4	Img4	100%	80%	90%
5	Img5	80%	80%	80%

Referring to Table 1, it can be selected a template image to detect perfectly when compared with the other template. The template image that has a perfect detection is the first template, so the template to be used in this experiment is the first image template. Template image test results shown in Figure 4.
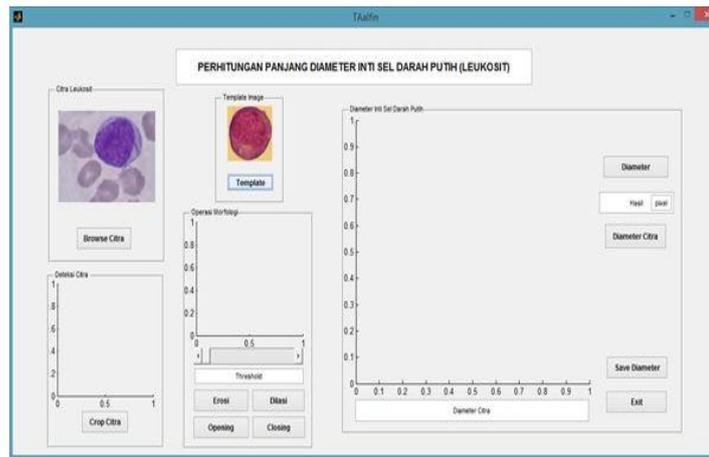

Figure 4. Template image

3.2. Thresholding

At thresholding stage, a digital image is converted into a binary form using a sliding arrangement thresholding to obtain the corresponding results. The results of the thresholding value for each digital image are shown in Figure 5.

Figure 5. Result of image thresholding

3.3. Morphological Image

At this stage, the thresholding image processed using dilation (thinning) erosion (thickening) closing (erosion-dilation) and opening (dilation-erosion). An example of morphological image operations results for one of the images shown in Figure 6.

No	Image	Morphological process	Morphological Result
1		Opening 1x	
2		Opening 1x	
3		Dilation 2x, Erosion 2x	
4		Erosion 1x, Dilation 3x, Erosion 1x	
5		O1x, D1x, C1x, D1x, C1x, D1x, C1x, D1x, O1x	

Figure 6. Examples of Morphological image operations

3.4. Calculating Image Diameter

After morphological processes, continue the process of calculating the diameter of the image. This calculation using Matlab and manually using the Pythagorean formula. The result of the calculation using Matlab diameter is shown in Figure 7 and Figure 8.
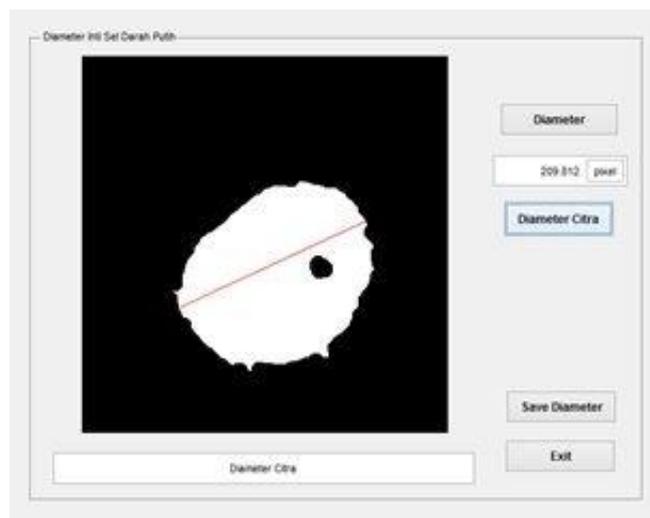

Figure 7. Calculating the diameter of leukocytes by Matlab

And for manual calculation, we use the paint to determine the points A and B as well as continued Pythagorean calculation.
Then the manual calculation is as follows.

$$AB = \sqrt{(x1 - x2)^2 + (y1 - y2)^2}$$

$$= \sqrt{(278 - 447)^2 + (332 - 192)^2}$$
$$= \sqrt{(-169)^2 + (140)^2}$$
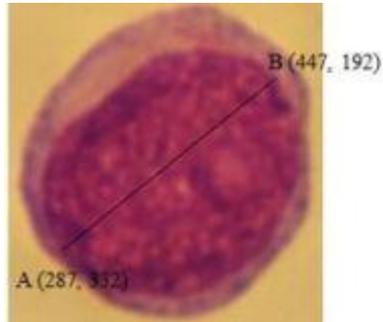$$= \sqrt{28561 + 19600}$$
$$= \sqrt{48161}$$
$$= 219.46$$

Figure 8. Leukocyte cell coordinates

Having obtained the manual calculation, the percentage of error can be searched to determine the validity of the program being used Equation.

$$\text{RN} = \frac{The\ value\ should\ be - The\ value\ obatined}{The\ value\ should\ be} \times 100\%$$

$$= \frac{219,46 - 209,812}{219,46} \times 100\ \%$$
$$= \frac{9,648}{219,46} \times 100\%$$
$$= 0.043 \times 100\%$$
$$= 4.3\ \%$$

It means that for the image as shown in Figure 7, it has an error about 4.3%. Table 2 shown the error percentage after we compared between Matlab and manual calculation for some image in our experiments.

Table 2. Error percentage

No	Image	Matlab	Manual	RN
1	Img1	209.812	219.46	4,3%
2	Img2	275.44	275.36	0.029
3	Img3	230.413	220.74	4.4%
4	Img4	230.361	229.61	0.32
5	Img5	265.126	294.18	9%

4. CONCLUSION

From the results of experiments on several samples of leukocyte cell image is used, the system can identify the morphology of cell nucleus leukocytes. Tests were performed using dilation, erosion, opening, and closing with the structure element 'disk'. Each image has a different color density which affects the threshold value, so we use the adaptive threshold method, i.e. setting the threshold value depends on the value of each image pixel. The system has been created it can measure the length of the diameter of the leucocytes cell nucleus, with the percentage of error is 10.

For further research, we will (a) Set the threshold value in the system automatically to simplify the calculation process leukocyte cell nucleus diameter, (b) Set the length of time in the process of template matching to accelerate the process of calculating the leucocytes cell nucleus, (c) The detection and calculation diameter of leukocyte cell nucleus more than one object in the image data. (d) Add the number of sample image data so that the results could have been better.

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