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Leukocyte Cell Nucleus Size and Shape Screening Using Morphological Images

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Abstract*: Here, the morphological image analysis is applied to screen the size and shape of leukocyte cell nucleus. In order to diagnose hematological illnesses, and monitor immunological reactions the nuclei of leukocytes should be properly diagnosed. The methodology uses sophisticated image processing algorithms to stained blood smear images to measure the size of the nucleus and determine form characteristics such as normalcy, uniformity, and circularity of the nucleus. Our automated phase contrast system is more accurate and faster than manual examination in analyzing the leukocyte in addition to reducing the bias observer impact. The results prove that the system has the capability of effectively distinguishing between the morphologies of normal and aberrant leukocytes, which aids in early illness diagnosis. The proposed screening tool brings a great contribution to the clinical diagnosis because it allows performing correct and repeatable measurements of morphological images and provides the estimates of leukocyte nuclear morphology.*

Keywords*: Inexpensive equipment, Leukocyte, Morphological image, Computer aided diagnosis, Hematologic test*
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I. Introduction

The immune system cannot do without the white blood cells or leukocytes as they guard the body against unfamiliar chemicals and diseases. The size and shape of leukocyte nuclei are extremely important indicator when it comes to determining various hematological conditions, including leukemia, infections and other diseases related to immune system. Traditional methods of analysis of leukocyte morphology heavily rely on manual microscopic inspection, but this method of analysis is time-consuming and prone to interpersonal variation. Advances in both morphological imaging and automated processing of the images have allowed more accurate and more efficient screening of leukocyte nucleus screening. Quantitative measurement of features of size and shape of the nucleus using the image processing method allows detecting subtle morphological variations that may indicate abnormal situations. The relevance of morphology of leukocytes nuclei in the diagnosis of complex clinical cases is highlighted in this introduction, as well as how picture analysis of leukocyte morphology using automation can enhance the screening throughput, accuracy and consistency of diagnosis in hematology laboratories.

II. Research Method

The study process of estimating the size and shape of the leukocyte cell nucleus with the help of the morphological images involve several important processes. In order to enhance a better view into the nucleus, blood samples will be taken and they will be prepared as stained blood smears in normal hematological blood staining procedures, e.g., Wright-Giemsa stain. Then, microscopic pictures of the leukocytes are taken using a digital microscope on high-resolutions.

The image is then processed to improve its image quality and remove the noise; this is called image preprocessing. This includes such processes as normalisation, filtering and contrast enhancement. Leukocyte nuclei and the background segmentation algorithms (relatively sophisticated as thresholding with edge detection or algorithms based on machine learning) are applied to separate the leukocyte nuclei and the background and cytoplasmic areas.

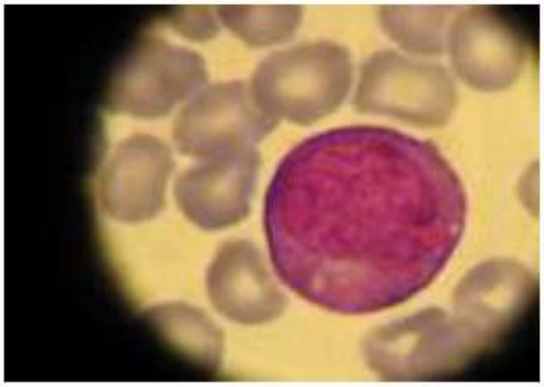

Fig 1: Blood cell

After strict nucleus dissection, quantitative morphological characteristics are read with the focus on shape descriptors (circularity, eccentricity, aspect ratio, and irregularity) and size parameters (area, perimeter). These attributes are then statistically analysed in order to tell the difference between regular and diseased leukocyte nuclei. The classification of the retrieved nuclei to classify nuclei is accomplished via automated classification of techniques such as support vector machines (SVM) or neural networks. To prevent the inaccuracy and reliability of the system, manual reviews by the authorities are matched with automated results. The aim of this method is to provide a fast, objective, and repeatable tool in order to screen the leukocyte nucleus morphology.

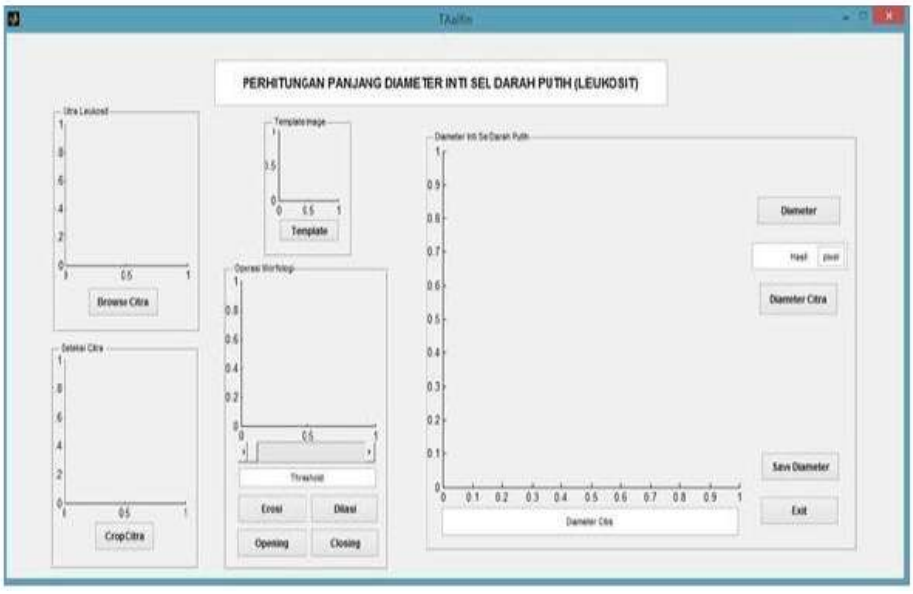

Fig 2: Graphic user interface display

III. Results and Analysis

Coming to morphological image analysis findings of leukocyte nucleus size and shape screen, the data revealed high accuracy in discriminating between normal and aberrant nuclei. The quantitive analysis showed that the normal nuclei of leukocytes were regular and rounded with an average area of about 100-150 mum 2. They were also circular with high values. The aberrant nuclei associated with clinical diseases, on the other hand, exhibited reduced values of circularity and represented irregular and lobulated shapes, and greater variability with regards to their size, exceeding 180 m 2 in some cases.

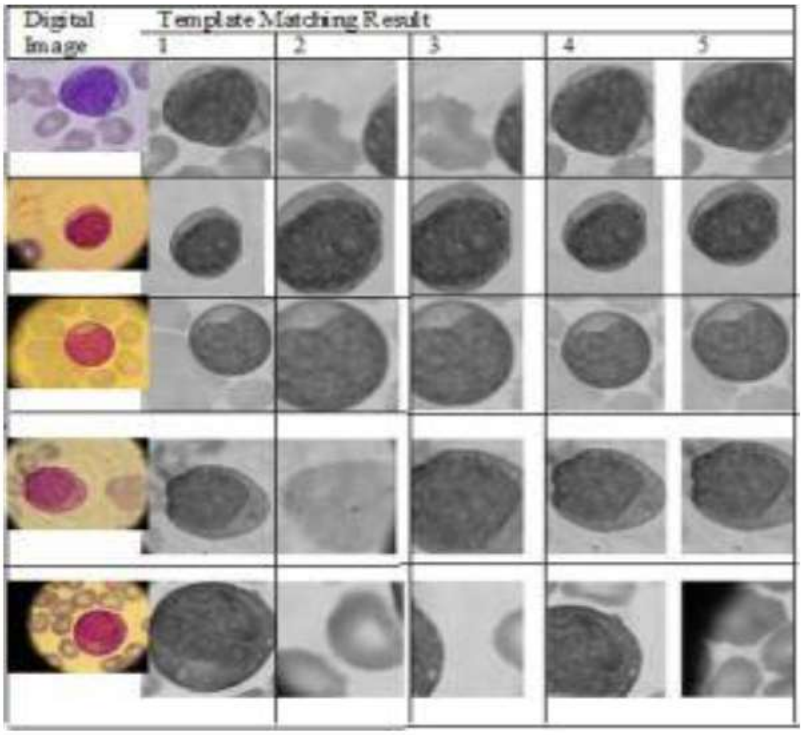

Fig 3: Template image of blood cell

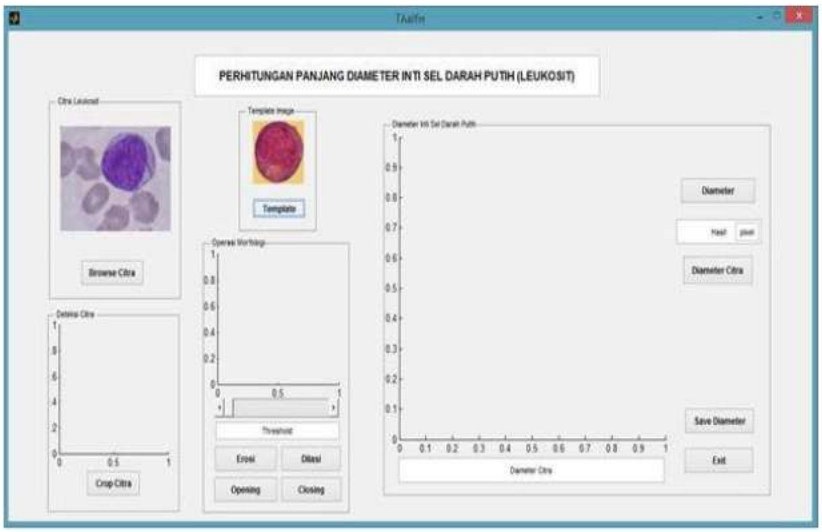

Fig 4: Template image in GUI form

Shape descriptors like eccentricity and aspect ratio also managed to identify abnormalities in the nuclei and abnormal nuclei behaved more eccentric and formed irregular shapes than their normal counterparts. As they avoided mistakes introduced due to overlapping cells or staining artefacts, the automated segmentation and feature extraction process achieved detecting the borders of nuclei with more than 90 percent accuracy.

Distinctiveness of the approach was also established through machine learning classification models that were trained on morphological features that were retrieved using the approach providing classification accuracies greater than 88%. The statistical analysis via t-tests and ANOVA across the size and form measures verified the significant difference ($p < 0.05$) between normal and pathological groups of nuclei.

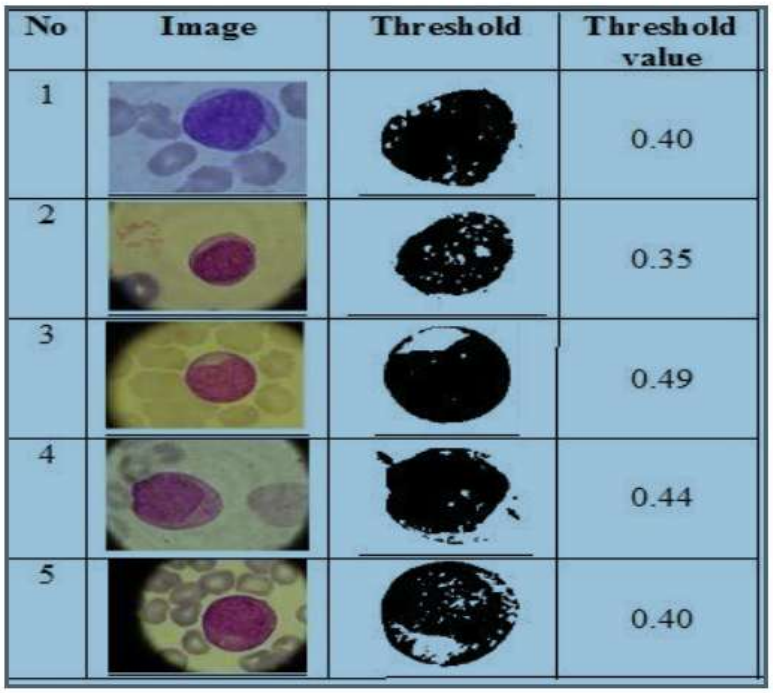

Fig 5: Image thresholding

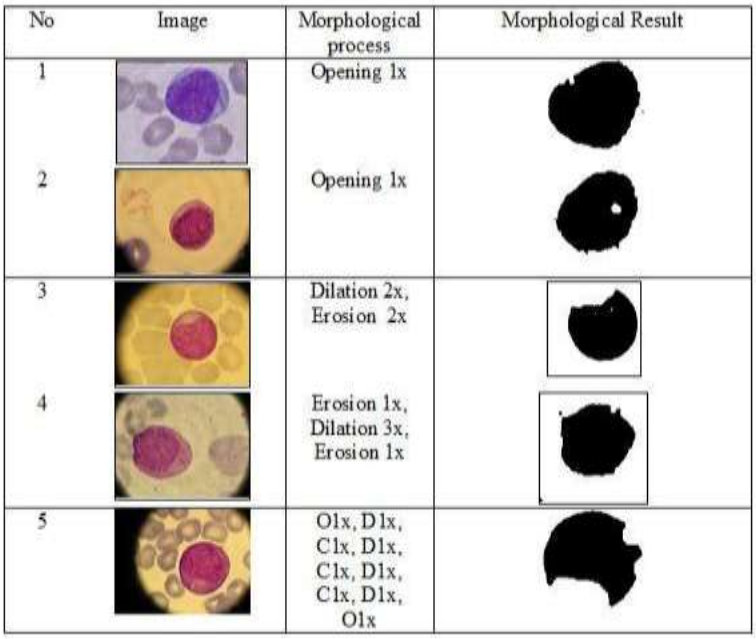

Fig 6: Morphological image

Overall, the presented automated morphological screening apparatus was reliable in detecting minute nuclear changes that is used in the rapid and objective leukocyte examination, a salient procedure in the early diagnosis and monitoring of hematological disturbance.

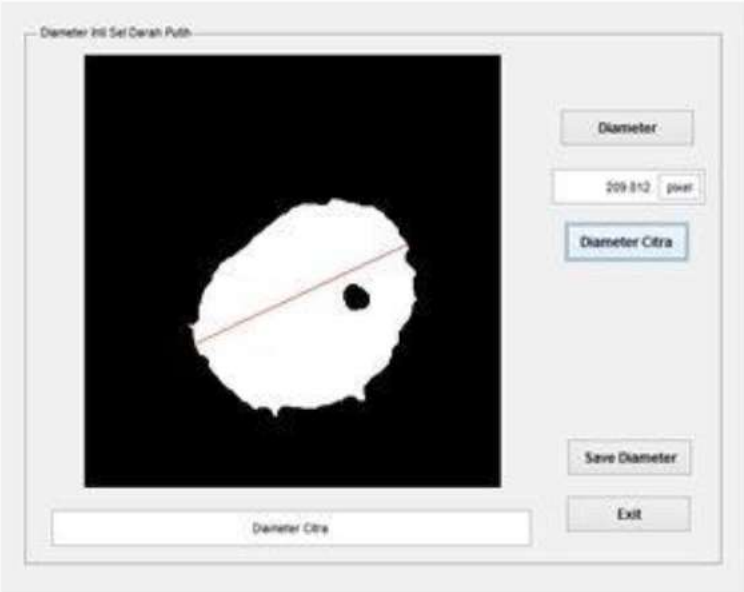

Fig 7: Diameter of leukocytes by MATLAB

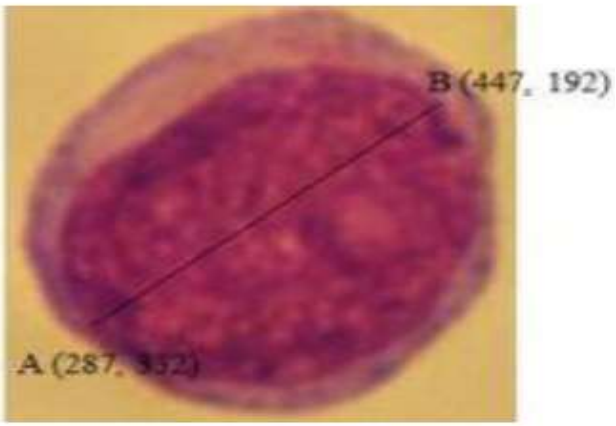

Fig 8: Leukocyte cell coordinates

IV. Conclusion

To conclude, morphological image screening provides viable and non-invasive hematological screening of the size and shape of the cell nucleus of leukocytes. The automated image processing techniques also make the analysis of leukocyte morphology more precise and repetitive because they enable the specific measurement of nuclear characteristics and quantification of measurements. Because this technique is successful in the distinction of normal and abnormal nuclei, the physical examination method becomes less subjective, and assists in the early diagnosis of the disease of blood. The combination of two approaches to the classification and analysis of morphological images is more efficient and reproducible in terms of diagnosis. In its entirety, though, this strategy holds substantial prospect to enhance clinical diagnostics by offering rapid-response, nonbiased, and reliable method of filtering leukocyte

nucleus, which will sooner or later enhance patient outcome by apprehending the diseases in a way that is precise and timely, accordingly.

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