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# Specifics of Using Image Processing Techniques for Blood Smear Analysis

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**Abstract**

*The process of medical diagnosis is an important stage in the study of human health. One of the directions of such diagnostics is the analysis of images of blood smears. In doing so, it is important to use different methods and analysis tools for image processing. It is also important to consider the specificity of blood smear imaging. The paper discusses various methods for analyzing blood smear images. The features of the application of the image processing technique for the analysis of a blood smear are highlighted. The results of processing blood smear images are presented.*

## Introduction

An important stage in the treatment of patients is the diagnosis of their state of health. The tasks of diagnosing the patient's body have different directions for their implementation. It depends on the stage of diagnosis, the severity of the disease. For this, various studies are carried out that allow you to determine a certain set of parameters. These parameters characterize the general health of the patient. At the same time, we can use various tools and methods to conduct diagnostics (Rabotiahov et al., 2018; Lyashenko, Babker & Kobylin, 2016).

Among the methods for diagnosing the state of human health, one should single out the method when the patient's blood parameters are analyzed. It can be a complete blood count or CBC. This can be a biochemical, immunological, hormonal blood test. We can look at the leukogram, assess the hemoglobin content, and determine the number of erythrocytes or leukocytes (Li et al., 2019; Andrade et al., 2019; Grill et al., 2020).

At the same time, it is possible to diagnose the state of human health based on the processing of the blood smear image (Lyashenko, Matarneh & Kobylin, 2016). Here we can also evaluate the different components of a blood smear. For this, various methods of image processing are used. The use of such methods is determined by the task of analyzing a blood smear, the method of obtaining an image of a blood smear. This imposes certain restrictions on the use of imaging



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techniques for examining a blood smear. These questions (especially the use of image processing techniques) are the subject of this study.

**Brief overview of related research papers**

The analysis of medical images is one of the areas of modern research. Among such scientific works, the analysis of the image of a blood smear occupies a special place.

The main task of blood smear image analysis is to identify individual components: plasma, erythrocytes, leukocytes, platelets. Researchers are also solving problems such as counting erythrocytes, leukocytes, and platelets.

For example, S. N. M. Safuan, M. R. M. Tomari and W. N. W. Zakaria discuss a procedure for counting white blood cells in blood smears (Safuan, Tomari & Zakaria, 2018). This analysis is carried out based on the color segmentation method. The first step is the identification of white blood cells; the second step is counting white blood cells in blood smears.

At the same time R. Tomari, W. N. W. Zakaria, M. M. A. Jamil, F. M. Nor and N. F. N. Fuad are investigating an automated system for counting red blood cells in blood smears (Tomari et al., 2014). For such counting of red cells, the authors use special techniques for processing and analyzing blood smear images. For this analysis, an artificial neural network classifier is used.

The system of counting red blood cells in a blood smear is considered by V. Acharya and P. Kumar (Acharya & Kumar, 2018). For this, the authors use morphological operations and the edge detection method. But the more difficult task is to identify and classify the components of a blood smear, identifying the constituent parts of each component of a blood smear.

In their research, D. C. Huang, K. D. Hung and Y. K. Chan offer their own method for recognizing leukocyte nuclei in blood smear images (Huang, Hung & Chan, 2012). For this, the authors perform segmentation of the initial image taking into account the morphological features of images of leukocyte nuclei. The preliminary stage of the analysis is the use of image enhancement techniques. The detection of nuclei and cytoplasm is also discussed in (Tran, Ismail, Hassan & Yoshitaka, 2016).

An original method for the identification of leukocyte nuclei is considered in the work of the authors R. B. Hegde, K. Prasad, H. Hebbar and B. M. K. Singh (Hegde, Prasad, Hebbar & Singh, 2019). For this, the authors have developed an appropriate neural network that adjusts depending on the type of input image of blood smears. For this, the brightness level of the input image and the brightness level around the nucleus of leukocytes are taken into account.

Various methods of segmentation and classification of leukocytes in blood smears are considered in the work of S. Sapna and A. Renuka (Sapna & Renuka, 2017). The authors provide a critical review of the various approaches that are used to analyze blood smear images. Thus, we see that different methods and approaches can be used to analyze images of blood smears. Moreover, the arsenal of such methods and approaches is large and varied. One of the reasons for such a variety of methods and approaches for studying images of blood smears is the specificity (features) of these images. Below we provide examples of some of these features of blood smear image analysis.

**Some features of the image processing technique of blood smears**

The preliminary step in analyzing blood smear images is to improve the quality of the original image. In this case, you can use such procedures as: changing the contrast of the original image, filtering procedure.



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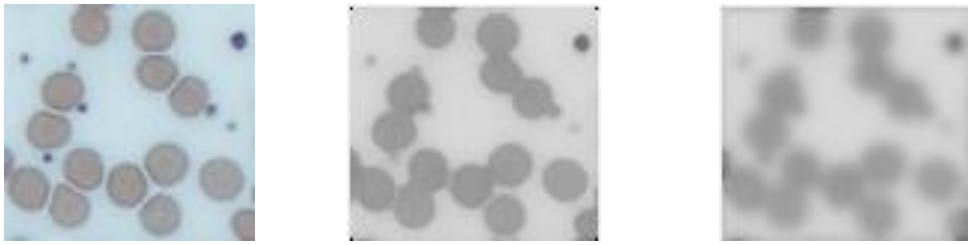
However, in each case, changes to the original image are possible, which may lead to errors. The filtering procedure can remove significant components from the blood smear image. For example, if these are platelets, then they can be removed (barely visible for further processing) after filtering the original image.

In Figure 1 shows an example of the original image where there are platelets (Figure 1a) and the images after the filtration procedure, where the platelets are poorly displayed (Figure 1b). Also procedure filtering may change the visualization of other components of the original image (Figure 1c).



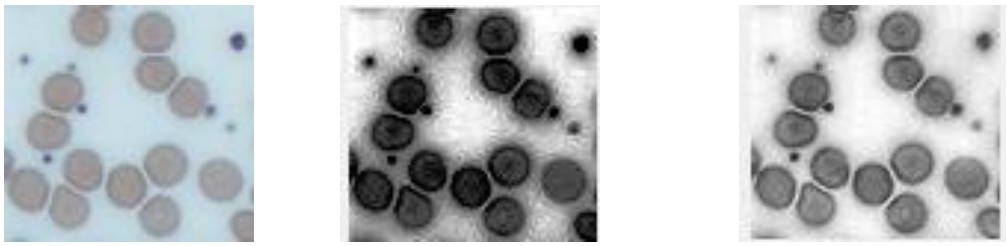
a) b) c)

*Figure 1. Examples of the initial image with platelets and images after the filtration procedure*

Therefore, it is important to select the necessary parameters of the filtration procedure for solving a specific problem of processing a blood smear image.

The same remark applies to the peculiarities of using the procedure for contrasting the original image.

In Figure 2 shows an example of the original image (Figure 2a) and the image after applying various procedures for changing the contrast (Figure 2b and Figure 2c).



a) b) c)

***Figure 2.*** *Examples of the original image with platelets and images after the contrasting procedure of the original image*

We see that different contrasting procedures give different results. Special attention should also be paid to the color segmentation method. To implement the color segmentation method, it is necessary to know the morphological parameters of each component of the blood smear image. But you definitely can't do it (Dey et al., 2015). This is due to the fact that it is possible to use various systems for staining a blood smear; some components overlap when coloring them. Some examples of color segmentation are shown in Figure 3.



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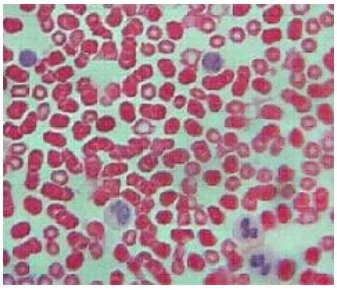
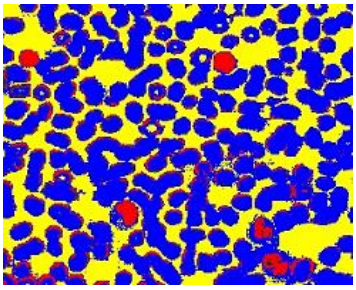
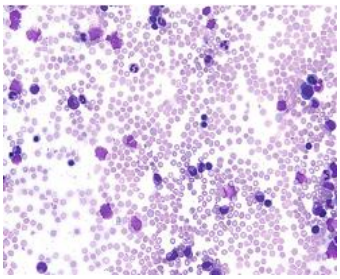


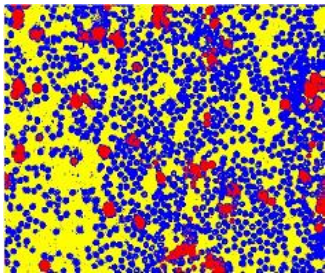
a) original image



b) image after color segmentation procedure



c) original image



d) image after color segmentation procedure

*Figure 3. Some examples of color segmentation for blood smear images*

We see that for different images of a blood smear, we have different images of different visualization quality, to which the color segmentation procedure is applied. Moreover, for blood smear images (Figure 3b), the selected components of the blood smear overlap or merge. This complicates further analysis. Therefore, image preprocessing procedures are required. But as we said earlier, these procedures can also give a false result.

Figure 4 shows the results of color segmentation for the image in Figure 3a.

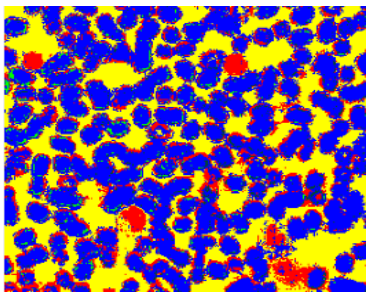
Here are the results of various procedures for changing the contrast of the original image (Lyashenko, Matarneh & Kobylin, 2016):

Figure 4a – Histogram equalization of brightness values,

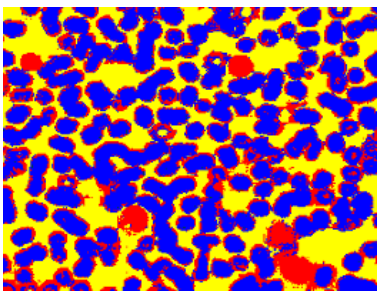
Figure 4b – Non-linear stretching of dynamic range of brightness values,

Figure 4c – Masks filtering,

Figure 4d – Fuzzy masking.



a)



b)



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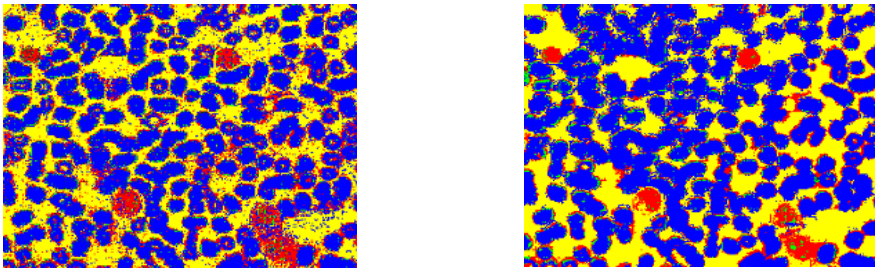
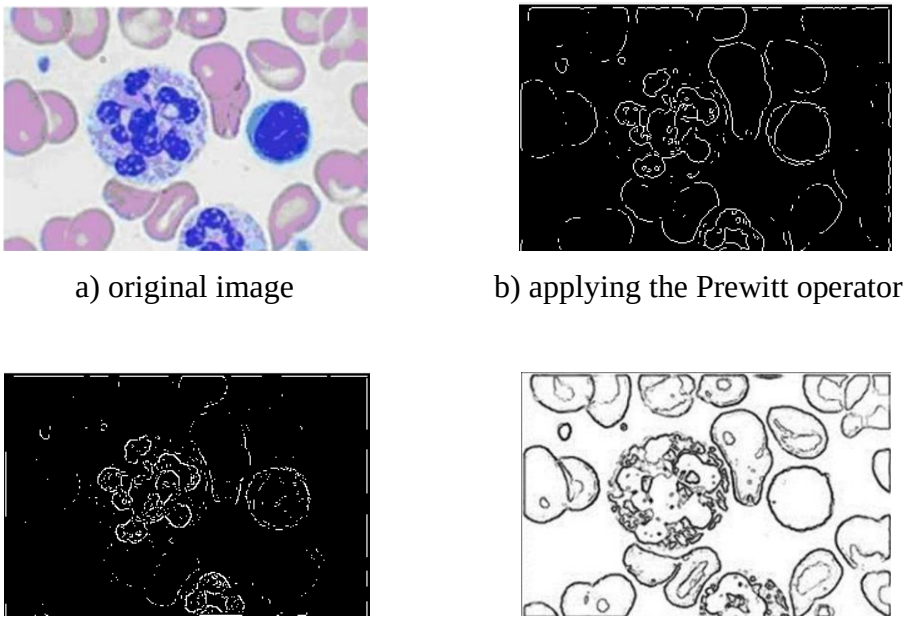


c) d)

*Figure 4. Results of color segmentation for the image in Figure 3a*

We also draw attention to the application of procedures for identifying components of a blood smear. To solve this problem, edge selection methods are used. But these methods also give different results.

Figure 5 (Figure 5a) shows the original image and the results of applying the edge extraction procedure to the blood smear image (Figure 5b – Figure 5d) (Babker & Lyashenko, 2020).



a) original image b) applying the Prewitt operator

c) applying the Roberts operator d) applying wavelet analysis

*Figure 5. Results of applying the edge extraction procedure to the blood smear image*

We see that different methods of edge extraction emphasize in different ways the structure of individual components of the blood smear image. This fact should also be taken into account when developing automated procedures for analyzing blood smear images.

## Conclusion

The paper deals with the use of image processing techniques for the analysis of blood smear images. In particular, special attention is paid to the preliminary processing of images: changing the image contrast and filtering functions. Color segmentation and identification of components of a blood smear using an edge extraction procedure are also discussed. Attention is paid to the specifics of using different procedures for processing blood smear images. Specific examples are given. Possibility of influence of such procedures on the general process of diagnostics of human health is indicated.



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