Research methodology of the artifact effect in the blood to the result of cell classification

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Abstract. A study of the influence of artifacts on the result of the division of blasts and lymphocytes in the problem of diagnosing the types of acute leukemia was conducted. A group of artifacts was formed to conduct the study. Preliminary studies allowed to estimate the degree of influence of artifacts on the results of the classification of red blood cells.

1. Introduction

Microscopic examination of blood smear allows to obtain diagnostic information about the state of health of the patient. The result of the blood test allows to determine a wide range of hematological abnormalities. For example, anemia, acute leukemia and other diseases can be identified based on the classification and counting of leukocytes[1]. Traditionally, blood smear analysis is performed by highly qualified specialist, who in the course of the study of blood specimen under the microscope counts the percentage of occurring cell types and evaluate their morphological characteristics [2-3]. This type of analysis is laborious and time-consuming, error-prone, depending on experience and qualifications of the doctor. In this regard, the development of automated image analysis using computer-based microscopy in the visible range of electromagnetic radiation is relevant[4-5]. Such systems allow to analyse normal blood cells, count features, to provide automatic and automated (online) classification of blood cells. However, the errors of existing systems in the case of the recognition of pathological blood cells are high, which requires further research [6-8]. Here little-explored area is assessment of the impact of artifacts on the recognition results. Important studies is the influence of defects on the accuracy of detection of pathological cell preparations.

The purpose of this work is to study the influence of artifacts in blood smear preparations on the results of automatic classification of the blood cell types.

2. Materials and methods

Were taken smears of the bone marrow of four patients with acute lymphoblastic leukemia (ALL) (images of blast cells) and smears of the peripheral blood of three donors (images of lymphocytes) to study the effect of artifacts. These preparations were prepared by the method of May-Grünwald-Romanovsky.

Taking pictures of lymphocytes and blasts were carried out from stained preparations by computer microscope system (Olympus BX43 automated microscope with camera Imperx IPX-4M1ST-GCFB).

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Images were saved in BMP format with a color-coded RGB24 (over 16 million colors per pixel). 634 images of blasts of ALL patients and 120 images of the lymphocyte donors were received.

A method of evaluation of the influence of artifacts on the results of a blood cell recognition was proposed to conduct the study. It comprises the steps of segmentation of leukocytes nuclei from the resulting images, calculation textural features on dedicated nuclei, cell classification on the textural characteristics, evaluation the impact of artifacts.

Cells with physical artefacts were selected from the resulting set. Classification of artifacts were conducted: such as dark spots on the cells, unfocused image, destroyed cells, scratches on the cells (wide or narrow), agglutinate cells.

3. Study methodology of the artifacts influence

Study of the influence of artifacts on the result of classification of blood cells was carried out in two stages. Group of blasts was formed in the first stage. We analyzed the cells within this group, and if they had a visual distortion or damage (scratches, blotches, poorly visible structure of the nucleus), they were placed in separate group labeled "artifacts" (example: dark cell, the nucleus of the cell is not in focus, scratch, etc.) (figure1). Two groups of cells lymphocytes and blasts without artifacts were created in result. Further these groups of lymphocytes and blasts were classified and minimum classification error was detected. Images of blasts nuclei with artifacts of a particular type (for example, dark spots on the cells) was added to the images of blasts nuclei in the second stage of the study. Cell classification results were analyzed according to the artifact. We studied the changes of cells distributions in space for the found pairs of features with a minimum level of error. General scheme of classification of influencing factors is presented in [9].

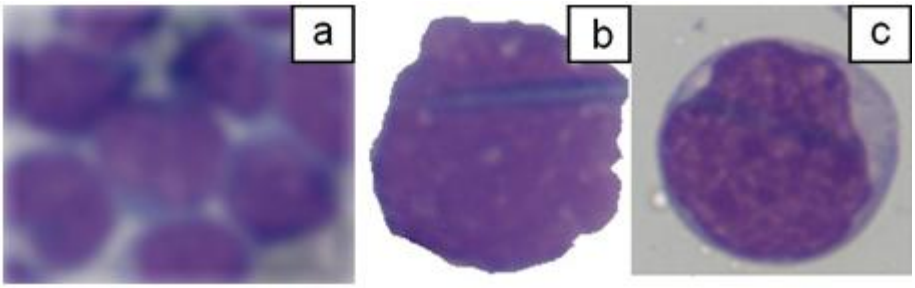


Figure 1. Example of images with a variety of artifacts a) the image is out of focus; b, c) presence of scratches on the image.

4. The results of the study

As a result of this study were constructed blasts and blood lymphocyte distribution in the two-dimensional feature space. One of them - P_{MAX} conforms to the "maximum probability", calculated by the matrix of spatial adjacency (MSA) for color-difference signal (V) in YUV color space. Second feature - P_{IM} represents a characteristic of the "moment of inertia", determined by the spatial adjacency matrix for a color difference signal (U) in the color space YUV. Taken together, these two characteristics determine the minimum error of classification of blood cells. Graphic distribution of cells in space of specified characteristics is shown in figure 2.

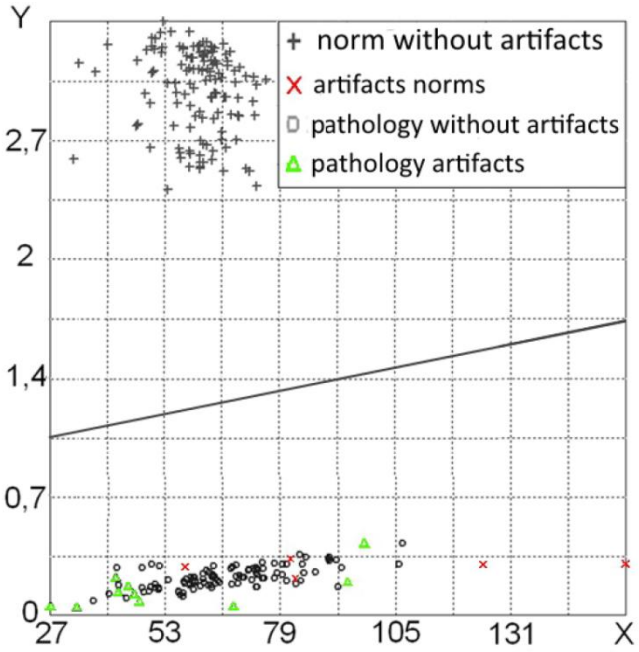


Figure 2. The distribution of lymphocytes and blasts without artifacts and with artifacts for features axis X = P_{IM} , axis Y = $\left|Log(P_{max})\right|$.

Further, an assessment of the changes of feature Pmax for lymphocytes and myeloblasts with and without the presence of artifacts on the basis of statistical characteristics $(\bar{x}, S, S_{\bar{x}})$ was made according to the study. Here $\bar{x}$ – arithmetic mean of the measured value, S – standard deviation, $S_{\bar{x}}$ – standard deviation of the arithmetic mean of the measured value.

Analysis of the data in table 1 shows that the artifacts affect the average values for the studied sample, the classification result is changed to 5%.

Table 1. Results of statistical measurements for cells with and without the presence of artifacts.

	P_{Max}			
Nucleus	$\bar{x}$	S	$S_{\bar{x}}$	$\left\|Log(\bar{x})\right\|$
Norm[a]	0.0013	0.0001	0.00001	2.89
Pathology[a]	0.51	0.07	0.01	0.29
Norm[b]	0.018	0.09	0.01	1.74
Pathology[b]	0.52	0.08	0.01	0.28

[a] with artifacts
[b] without artifacts

According to the results of these studies, it can be concluded that the presence of blood preparations artifacts increases the classification error by 5%, thereby reducing the quality of an automated analysis system. Artifacts on the blasts do not significantly affect the results of the classification of cells in contrast to artifacts on lymphocytes.

5. Conclusion

The degree of influence of artifacts on the result of classification of blood cells in the diagnosis of acute leukemia in devices of computer microscopy was assessed on base of experimental study.

The presence of artifacts on blood smear preparations increases blood cell classification error by 5%.

Our study shows the need to take account of artifacts on blood preparations in the design of computer microscopy systems for the diagnosis of acute leukemia.

The next steps is to assess the influence of artifacts on the result of classification of blood cells in acute myeloid leukemia.

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