Method of automating of the separation of blasts and lymphocytes in the diagnosis of acute myeloid leukemia

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Abstract. The work deals with the separation of the lymphocytes of healthy patients from blasts of patients with acute myeloblastic leukemia (different variants of the disease). In this study the evaluation of textural characteristics has been done for nuclei of blood cells for cells classification and for the determination of a variant of acute myeloblastic leukemia.

1. Introduction
One of the most complex tasks of medical diagnostics is the development of integrated systems for use in clinical medicine. Design, implementation and validation of complex medical systems require a close interdisciplinary cooperation between physicians and engineers [1]. Diagnosis of acute leukemia begins with a general clinical blood analysis. Bone marrow biopsy should be done in case detection of deviation from the norm in leucocyte count. In this case it is necessary to study the blood smears and bone marrow to confirm the presence of blast cells [2-4]. Acute leukemia is divided into two types according to Franco-American-British-classification: acute lymphoblastic and acute myeloblastic leukemia[5]. Leukemia variant definition is essential for effective treatment, in particular acute myeloid leukemia, common in children and adolescents. Traditional light microscopy has several disadvantages - labor intensive, tedious, subjective and error-prone[6-8]. The disadvantage of flow systems is the inability of the analysis of the morphology of blood cells, the inaccuracy of determining of the type of cells because of the variability. So microscopic method are still used, with simultaneous use of automatic devices[9]. So the creation of systems of automation of microscopic examination on the basis of digital image processing is important.

The aim of this work is to assess the feasibility of computer microscopy in the diagnosis of acute myeloid leukemia.

2. Materials and methods
Images of blood cells from smears of the peripheral blood of 3 donors and 6 patients with a diagnosis of acute myeloblastic leukemia were obtained to conduct the study.

Images of lymphocytes and blasts were performed on stained preparations using automatic Olympus BX43 microscope and camera Imperx IPX-4M1ST-GCFB. Images were saved in BMP format, color-coded RGB24 (more than 16 million colors).
126 images of peripheral blood lymphocytes of donors and 132 images of blasts of patients with acute myeloid leukemia were analyzed (including undifferentiated blasts M0).

3. Digital image processing
The study included the following stages of digital image processing: segmentation of white blood cells based on the method of histograms, texture characteristics calculation for the selected images of the nuclei of leukocytes, the separation of the nuclei images. The sequence of stages is shown in figure 1 [10-11].

![Figure 1. Stages of digital image processing in the diagnosis of acute leukemia.](image)

4. Experimental study
In the first stage, we studied the separation of normal leukocytes from bone marrow myeloblasts. Optimal textural characteristics for the classification of types of blood cells feature $P_{\text{LUM}}$ have been found as result of analysis of textural characteristics. It corresponds to the characteristic of "local uniformity". It was calculated according to the matrix of spatial adjacency for color-difference signal $V$ in the color space YUV.

![Figure 2. A histogram of the distribution of lymphocytes and myeloblasts according to the characteristics of $P_{\text{LUM}}$ (the number of cells with the corresponding value of the $P_{\text{LUM}}$ characteristics is on the ordinates axis).](image)
The obtained distribution allows to identify the zones, which are characteristic for myeloblasts of patients with acute myeloblastic leukemia and for lymphocytes of donors. Most of the blasts correspond to the range of values of the characteristics $P_{LUM}$ from 0.33 to 0.67 (figure 2). It should be noted, that there are cells among the blasts, that have $P_{LUM}$ characteristics differ from most of the blasts, but they correspond to lymphocytes range from 0.01 to 0.04.

It was found that the numerical values of $P_{LUM}$ for all studied lymphocytes are distributed in the range corresponding to typical values for $P_{LUM}$ values for lymphocytes.

It is necessary in further research to consider the influence of external conditions (lighting, painting), variability of patient's cells and the sample size on the result of the classification cells in the diagnosis of acute myeloid leukemia.

5. Conclusion

The preliminary study showed the applicability of texture analysis methods for the diagnosis of acute myeloid leukemia with the definition of blasts and lymphocytes and it can be used in high-tech hardware and software complexes for diagnostics of acute myeloid leukemia.

Planned step for further research is to determine the differences of blasts from other cells, the increase in volume of the experimental sample, estimate of the influence of external conditions (lighting, painting), variability of the cells and sample volume on the result of diagnosis of acute leukemia.

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