

# The method of selection of leukocytes in images of preparations of peripheral blood and bone marrow

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**Abstract.** Study of the segmentation method on the basis of histogram analysis for the selection of leukocytes in the images of blood and bone marrow in the diagnosis of acute leukemia was conducted in this paper. Method of filtering was offered to eliminate the artifacts, resulting from the selection of leukocytes.

## 1. Introduction

Current diagnosis of acute leukemia begins with general clinical blood test. The study of blood smears under a microscope calculates WBC (white blood cell count). A study of the bone marrow is carried out in case of deviations in WBC. The presence of 25-30% of blasts in the bone marrow are needed for confirmation of the diagnosis [1-3]. Work in the field of automation systems based on the use of digital image processing are carried out because of the subjectivity, the complexity and possible mistakes of microscopic examination, [4-9].

Segmentation is one of the main stages here – isolation of leukocytes on the images obtained from preparations of peripheral blood and bone marrow. There are widely used methods based on analysis of histograms, the threshold brightness limit, adaptive binarization, edge detection in solving of the tasks of segmentation. The analysis of literary sources shows that intensive research on improving the accuracy and performance of methods of segmentation, the separation of closely spaced cells and elimination of artifacts are conducted. Complexity isolation of leukocytes in blood preparation and bone marrow arise due to a variety of shooting conditions, multicellular. In works [10-12] the accuracy of the allocation of leukocytes 99% for peripheral blood and 77% for bone marrow cells were achieved, however, the this result was obtained on a small sample, also, when changing shooting conditions, the accuracy of the segmentation decreases.

The aim of this work is to study the applicability of the method of histograms in the allocation of leukocytes in the preparations of peripheral blood and bone marrow.

The study was conducted on the preparations of donor peripheral blood and bone marrow preparations prepared at different times (at intervals of six months to two years).

Registration of images was conducted by a system of computer microscopy (microscope Olympus BX43 with motorized stage, camera Imperx IPX-IPX-4M1ST-GCFB, image format BMP, size 1920x1280 pixels, color model RGB depth 24-bit encoding).

826 images of stained peripheral blood and 2800 images of smears of bone marrow were studied. The images were carried out under identical conditions (settings of camera and microscope according to Keller, external factors).

## 2. The method of selection of leucocytes



The following segmentation model were proposed to select leukocytes:  $M = \{I, G, D, P, F\}$ , where I – original image, G – histogram of the image, D – calculation procedure of the derivative on the histogram, P – window size finding minimum and maximum in the histogram, F – model filtering of interfering objects.

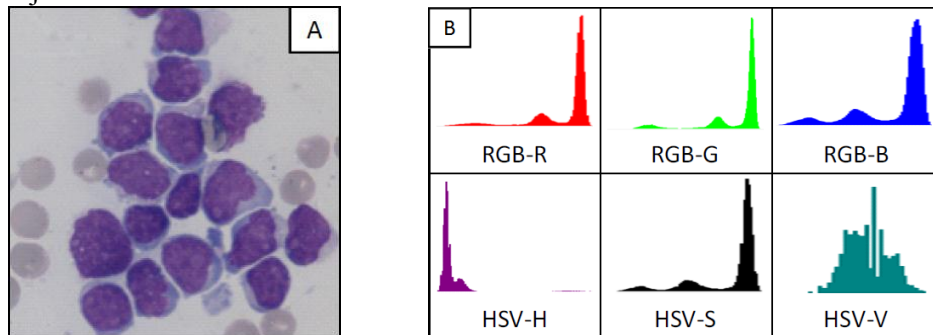


**Figure 1.** The sample image obtained with the bone marrow preparation A) and the luminance histogram distribution points to automatically determine of the binarization threshold B)

Segmentation of leukocytes was carried out according to the following procedure. For the recorded image a histogram of the distribution of the components of color models RGB and HSV was built (figure 1). Then the derivative was calculated, and the point of change of sign of the derivative was determined. Further the minimum between modes on the histogram was determined by applying window filter for the appropriate core and red blood cells. As a result the optimal threshold for the allocation of white blood cells in this image was defined.

Algorithm and software for experimental research were implemented on the basis of the proposed method of segmentation. To minimize the influence of interference, the search threshold was carried out in the area, equal to 10 pixels. The range of color component brightness values for the test chamber was 6 grades. During the experiment, green component «G» of RGB color model was the most effective in terms of determining the threshold to extract leukocytes from bone marrow preparations. The saturation of «S» and tone «H» HSV color model were less informative components. Stages of segmenting leukocytes on images obtained with the use of blood preparation and bone marrow are shown in figure 2.

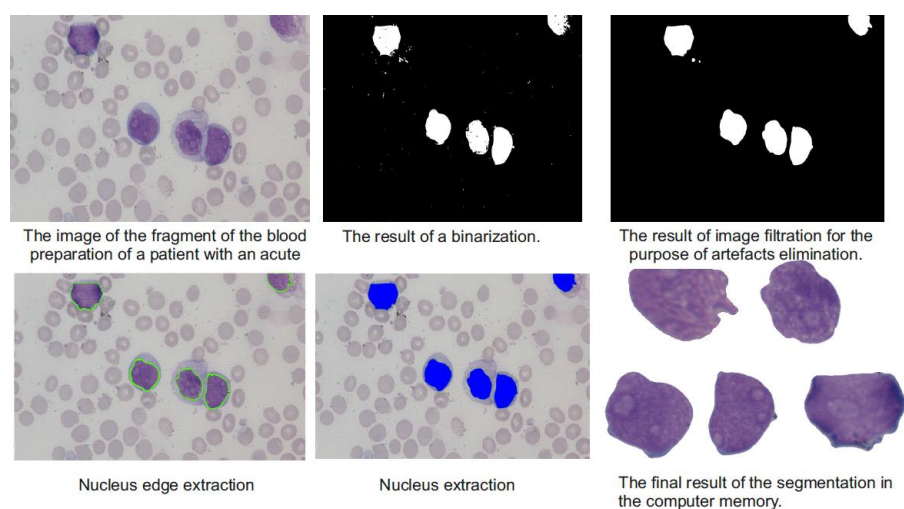


**Figure 2.** Leukocytes segmentation stages in images obtained with the blood preparation and bone marrow.

Selection by automatically calculated thresholds remains false objects. Median filtering was used to eliminate false objects (artifacts).

According to the results of the experiment, it was found that the automatic segmentation of the proposed algorithm is sensitive to defects in the preparations (for example, dirt particles in the preparation, scratches).

### 3. Conclusion

In this paper we proposed a method for automatic selection of leukocytes in images of microscopic samples of peripheral blood and bone marrow, which is necessary for the automation of microscopic studies in the diagnosis of acute leukemia.

Further development of the proposed segmentation method is assumed in search of correct thresholds in the presence of defects in the image allocation and contacting leukocytes.

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