

Investigation of the influence of optical range sensor noise on the characteristics of the description of objects in cancer diagnosis

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Abstract. The influence of digital noise of the optical range sensor on the characteristics of microscopic objects of study was experimentally evaluated. A reference sample of smears, from which images of medical objects of research were obtained, was formed for the research. Blood cells were used as such objects. As a result of research textural signs are calculated and the analysis of their change is carried out. The obtained estimates allow to draw preliminary conclusions about the degree of noise influence.

Introduction

Currently, in the diagnosis of diseases of the blood system methods of pattern recognition in the analysis of microscopic images of bone marrow preparations are increasingly used. Even with the development of flow cytometry technology, it is impossible to form a complete picture of the disease without analyzing the data on cell morphology. Therefore, there are urgent problems of automation of visual microscopy processes for increasing the accuracy of the analysis results. The images are recorded by a CCD array and then processed on a computer. However, the distortion of signals caused by various kinds of noise, some of which are virtually unrecoverable at the hardware level, give a wrong idea about the object under study [1-13].

The aim of this work consists in assessing the effect of noise on the results of image recognition of blood cells in computer microscopy systems.

1. Materials and methods.

Evaluation of the influence of noise sensor optical range on the characteristics of the description of objects obtained in the course of microscopic studies was carried out on the preparations of the bone marrow.

Images of 367 B - and 359 T - lymphoblasts of patients with acute lymphoblastic leukemia were obtained for the experimental study. A series of 183 frames was formed for each cell nucleus. The images were then saved in the format bmp of size 2048×2048 with 12Mb volume and encoding RGB 24bit. The resulting frame was formed from the obtained series by averaging (to eliminate noise) and the unevenness of the sensitivity of the camera matrix on the resulting averaged image was corrected [14, 15]. As a characteristic to describe the cells used textural characteristics - "Entropy".

2. Experimental study



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An experiment was carried out on the obtained sample of corrected images.

Groups of images with different noise levels were formed for the obtained cell samples. For each of the obtained groups the average value of the characteristic "Entropy" was calculated. The graph of the dependence of the sample average value of the characteristic "Entropy" for two types of cells B (367 cells) and T (359 cells) on the noise level in the image is shown in Fig.1. Fig.2 shows the dependence of the standard deviation of the characteristic "Entropy" in the sample depending on the noise level in the image.

Then, 7 samples of 50 cells for each of the studied noise levels were formed from the cells of each type of B and T cells. For each sample the average value of the characteristic "Entropy", its standard deviation for the sample are calculated, the confidence interval for the average value of the characteristic for the sample is determined. To compare the samples of B and T types, 7 pairs of samples of 50 cells of B and T type were randomly formed and the distance between the nearest ends of the confidence intervals of the average values of the "entropy" characteristic for B and T cells for each of the studied noise levels was calculated for them. The dependence of the distance between the confidence intervals corresponding to the mean value of the characteristic in the sample of 50 cells on the noise level is shown in Fig.3.

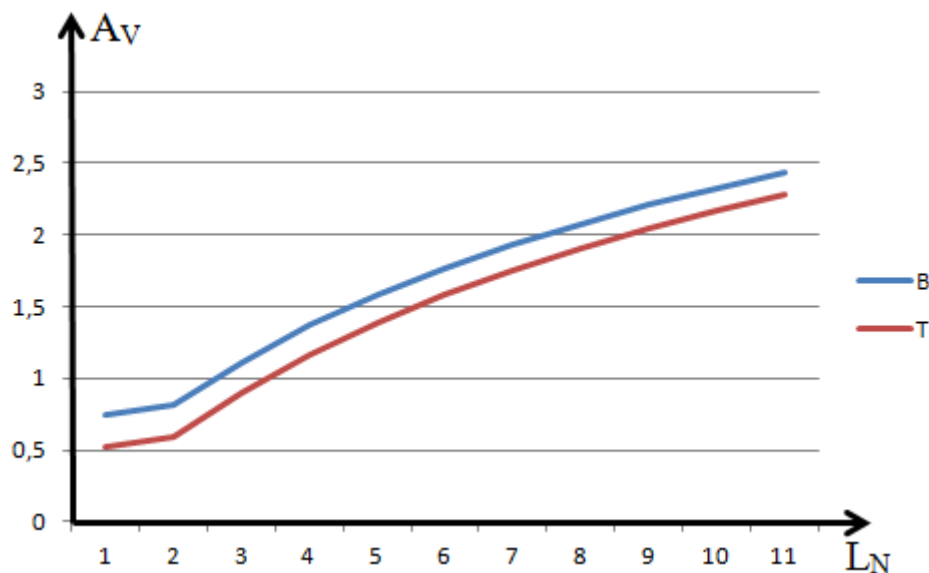


Figure 1. Dependences of the sample average value (A_v) of the characteristic "Entropy" for two types of cells B(367 cells) and T (359 cells) on the noise level (L_N)

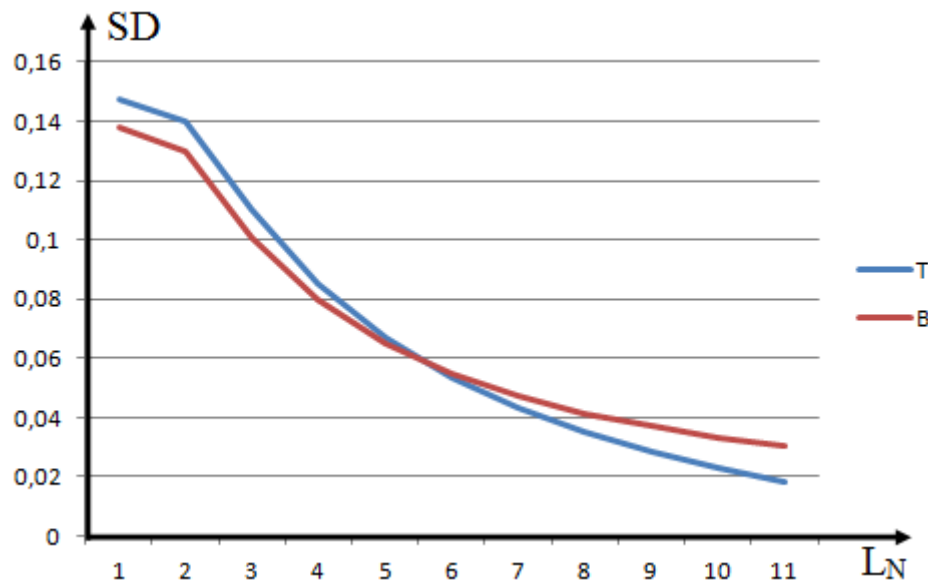


Figure 2. The dependence of the standard deviation (SD) of the characteristic "Entropy" on the sample for two types of cells B(367 cells) and T (359 cells) depending on the noise level (L_N) in the image

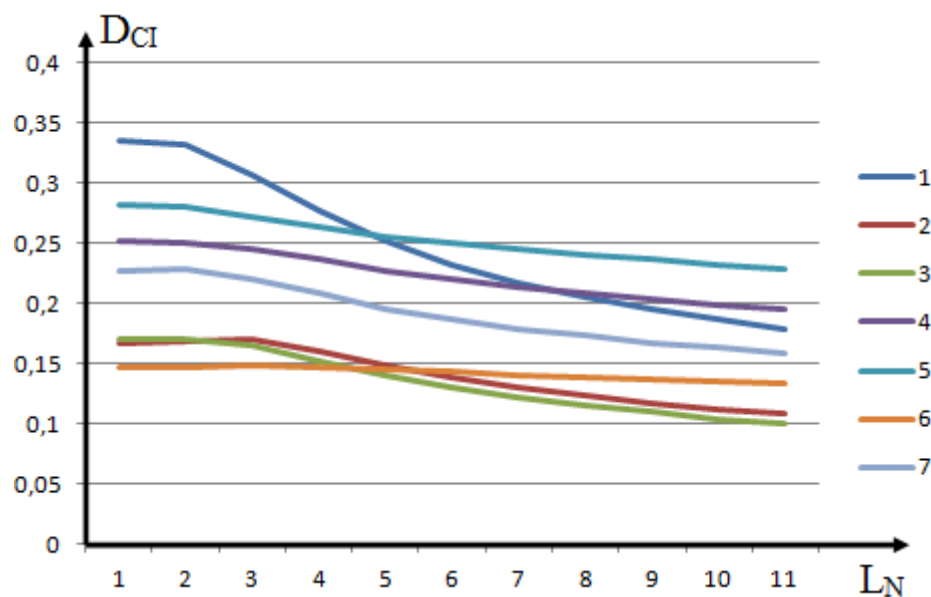


Figure 3. The dependence of the distance between the confidence intervals (D_{CI}) corresponding to the average value of the characteristic "Entropy" in a sample of 50 cells on the noise level (L_N)

3. Discussion of results

On the results of the experiment it can be concluded that the average value of the characteristic "Entropy" calculated for a group of 50 cells can be divided into B - and T - types of blast cells in acute lymphoblastic leukemia. It should also be noted that the value of the characteristic "Entropy" significantly depends on the noise level, so that the images obtained in systems with different noise levels cannot be used in the recognition of B and T cell types. This means that the recognition system must be configured individually for each microscopic image recording system. In the experiment, the noise level was reduced to one brightness gradation (with a possible 256 gradations for each of the

color components R G B). But even at this level of noise, the distribution of the values of the characteristic "Entropy" on samples of cells B and T type such that the confidence intervals of the characteristic values for the confidence probability $P=0.9$ intersect. At the same time, it is shown that if we estimate the average value of the characteristic "Entropy" for cells of the same type from a sample of 50 or more cells, the confidence intervals of the average value of the characteristic "Entropy" for the confidence probability $P=0.9$ for B and T type cells do not intersect.

Conclusion

In the course of this work, the influence of noise on the texture characteristics of bone marrow cells in the study of smears under a microscope was assessed. The obtained estimates show the effectiveness of noise reduction techniques to improve the accuracy of recognition of B and T type cells in the diagnosis of acute lymphoblastic leukemia.

In the course of further studies, work will be carried out to expand the objects of analysis.

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