Digital technologies in classical and liquid cytology

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Abstract. The paper proposes a model of the system of formation of panoramas for classical and liquid Cytology. The introduction shows the problems that make the resulting image is not informative for the expert doctor, as well as the factors that affect the quality of the panorama assembly. The proposed approach includes the following stages: preliminary shooting of a series of images of the observed slide zone with different settings of the focusing positions; analysis of a series of images with the allocation of "clear" focus zones; registration of the image frame of the observed slide zone with the necessary quality of "focus"; image filtering (noise reduction); evaluation of the shift of the image; store the received data (current coordinates); evaluation of the mutual position of the superposed fragments, correction of the coordinates of the overlapping zones overlapping fragments of each of the frames aligned. On its basis, a program with a graphical interface, designed to work with medical images (cytological preparations) and aimed at the assembly of the panorama.

1. Introduction

The cytological method of diagnosis is highly effective in the early diagnosis of breast cancer (over 90%) and cervical cancer (about 80%). In 70-90% of cases, the cause of false cytological responses is a poor collection of material for cytological research, in 10-30% - an erroneous interpretation of cytological data.

Cytological diagnosis of malignant tumors are based primarily on the morphology of the cell and in particular its nucleus.

The criteria of malignancy are not present in all cells, in some of them they are absent at all, in others they may not be expressed in full. It is necessary to pay attention to the features of the mutual arrangement of cells, the nature of intercellular connections. The conclusion is formulated on the basis of a set of features with a sufficient amount of cellular material.

If non-tumor or precancerous lesions are detected in time, it is possible to prevent the development of many diseases, including malignant tumors [1-6].

When forming panoramas including informative zones on cytological preparations, there are a number of problems that make the resulting image is not informative for the doctor expert.
Among the factors affecting the build quality of the panorama are the following: instability of steps of movement of the object stage in the scanning of the slide; the noise in the image; objects from the area of focus when scanning a product; the heterogeneity of the degree of focus on the space of the frame; uneven lighting across the frame; the heterogeneity of the space-filling of the preparation of the investigated material (from complete absence to excessive density) [7-11].

The aim of this work is to develop a model for the formation of a panoramic picture for classical and liquid Cytology.

2. System model
The model of the system of formation of a panoramic picture of the slides includes the following stages: pre-shooting a series of images of the observed area of the slide with different settings of focusing positions; analysis of a series of images with the allocation of zones of "clear" focus; registration of the image frame of the observed area of the slide with the required quality of "focus"; image filtering (noise suppression); evaluation of image shift; preservation of the data (current coordinates); evaluation of the mutual position of the combined fragments, correction of the alignment coordinates by the overlap zones of the fragments of each of the alignment frames.

![Figure 1. Images of cytological preparation. Lenses: 40×, 100×.](image)

Based on the analysis of typical images of cytological preparations (Fig.1) a model with double overlap is proposed as a search model: after finding the position of the cross-linked image in the line, an additional search is performed, with an already superimposed panorama. To find the optimal coordinate, the difference overlay algorithm is used. After the overlay, all pixels of the resulting image are summed. The resulting number is used as the value of the basic characteristic of the quality of combining fragments of two images. Accordingly, this procedure is performed for all overlaps in the search area. In the presence of competing hypotheses about the position of alignment, a comparative evaluation of the quality functions of the combination of fragments over the entire set of fragments of the panorama is made. The model of the system of formation of images of panoramic images is presented in Fig.2.

![Figure 2. Model of panoramic image formation system](image)
On figure 3 the generalized algorithm of the program is presented. First, the initial images are loaded in the form of a catalog, then the panorama is automatically assembled and the results are displayed on the screen. After that, the user can manually correct the obtained panorama and save the results corresponding to the different steps of the microscope micro-screw along the “Z” axis.

![Figure 3. Generalized algorithm of the program.](image)

3. Conclusion
The paper proposes a model of the system of formation of panoramas for classical and liquid Cytology. On its basis, a program with a graphical interface, designed to work with medical images (cytological preparations) and aimed at the assembly of the panorama.

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