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IMAGE PROCESSING TECHNIQUE IN THE STUDY OF CELL STRUCTURES OF BIOMEDICAL DATA

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ОБРОБКА ЗОБРАЖЕННЯ ПРИ ДОСЛІДЖЕННІ КЛІТИННИХ СТРУКТУР БІОМЕДИЧНИХ ДАНИХ

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Image processing methods are used in all areas of research. These methods provide additional information, a better understanding of the object that is being studied. Among the areas of using image processing methods, medicine occupies a special place. Biomedical data allow us to assess human health, to identify diseases in the early stages. Images of cellular structures of cytological preparations are one of the examples of biomedical data. Based on image analysis methods, we can isolate various components of cellular structures of cytological preparations. To do this, we apply the methods of wavelet analysis for different color components of the input image. Applying morphological analysis, we can identify individual cellular structures. The results are shown on the example of images of cellular structures of cytological preparations.

Keywords: *image processing, biomedical data, cell structures, wavelet analysis, color space, cytological preparations*

Introduction. The analysis of biomedical data is of practical importance. Such an analysis helps to make an initial preliminary assessment of the state of human health. At the same time, we can identify possible diseases in the early stages of their development. This allows for timely treatment and save the patient from a possible disease.

Analysis of recent research and publications. Biomedical data can be presented as a time series of data, descriptive statistics, or some image. Biomedical images can be obtained as a result of tomography, X-ray examination, registration of cellular structures under a microscope [1]. One of the most common methods for recording biomedical data is images obtained under a microscope.

For automatic analysis of biomedical data presented in the form of an image, various methods of image analysis are used [2, 3]. Among such methods, there are: methods for improving the quality of the original image, methods for removing noise in the image, methods for selecting areas of interest, methods for recognizing [2, 4]. We can also use various tools to implement image analysis procedures: the theory of fuzzy sets, the theory of groups, the ideology of wavelets [5, 6].

The purpose of the article. However, we must take into account the specifics of biomedical images. Therefore, it is important not to lose information as a result of the implementation of individual procedures for analyzing the original image. Also, one of the tasks is to obtain additional information as a result of applying various image processing procedures.

Thus, the main objective of this study is to consider such a sequence of procedures for analyzing the original image, as a result of which we can obtain additional information. This is an important task for the study of cellular structures whose images were obtained under a microscope.

Research results. To solve the goal of the study, we will use the wavelet analysis methodology. This methodology shows good results for image processing [7].

Wavelet methodology is based on finding the differences of gray levels in the original image. To search for such differences, we consider the original image: in rows, in columns. With the help of wavelets, we determine the differences in brightness levels separately for each row of the image and separately for each column of the image. Then, for the original image $B(i, j) = k$, where B is the input biomedical image size $M \times N$, (i, j) is the current coordinates of the points of the original image B $(i = \overline{1, M}, j = \overline{1, N})$, k is the brightness value of the image at the point $B(i, j)$, we have differential luminance values of a plurality of pixels for each line of the original image and a plurality of differential luminance values of pixels for each column of the original image B.

Then we select the most characteristic points of change in brightness – points that occur both in the processing of rows and in the processing of the columns of the original image. As a result, we have an image of differences that characterizes a certain area of interest. This image is the basis for further analysis. This procedure is described in detail in the work of the authors of [7].

It should also be borne in mind that microscopic images are usually color. This is due to the peculiarities of visualization of individual parts of such images. At the same time, wavelet analysis can be used only for black-white images. Thus, the procedure for transforming a color image into a black-white image is necessary. But with such a transition, we may lose some of the information.

One of the formats for representing color images is RGB. The image in RGB color system consists of three color channels - R (red), G (green) and B (blue) [8, 9]. Each color channel allows you to consider a specific frequency region of the image. This is very important for image analysis using wavelets. This allows you to take into account all the features of the image.

Thus, we propose to consider the original image $B(i, j) = k$ as a combination of three images:

$BR(i, j) = rk$ – original image in color channel R, where rk is the brightness value of the image at the point $BR(i, j)$;

$BG(i, j) = gk$ – original image in color channel G, where gk is the brightness value of the image at the point $BG(i, j)$;

$BB(i, j) = bk$ – original image in color channel B, where bk is the brightness value of the image at the point $BB(i, j)$;

Then we apply the wavelet analysis procedure for each color channel of the original image. We get three images that define the set of points of difference of brightness values in each color space. This provides additional information about the image we are analyzing. Based on this information, we can concretize various areas of interest.

Result of experimental studies. We will consider cellular structure which is presented on Fig. 1.

In Fig. 1 we can see: cells megaloblastic anemia, segments in the nucleus of neutrophils and erythrocytes.

The image in Fig. 1 is a typical example of the cell structure of a cytological preparation.

In Fig. 2 shows the results of the wavelet analysis for the data in Fig. 1.

We considered the original image without dividing it into separate color channels. To do this, we converted the original image (Fig. 1) to a black-white image (see Fig. 3). Then we applied wavelet processing (see Fig. 2).

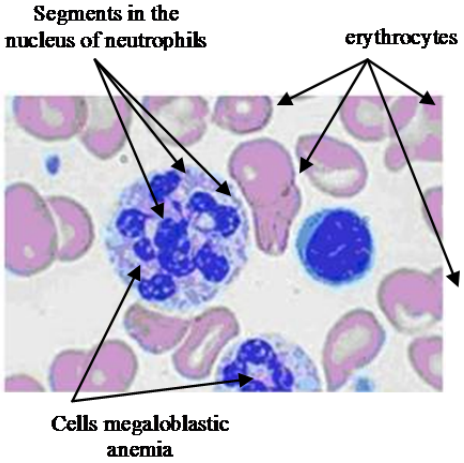

Fig. 1. Cell structure of a cytological preparation

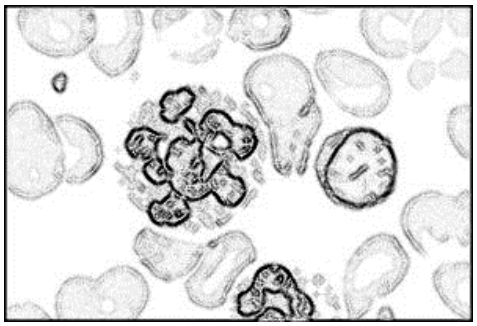

Fig. 2. Results of the wavelet analysis for the data in Fig. 1.

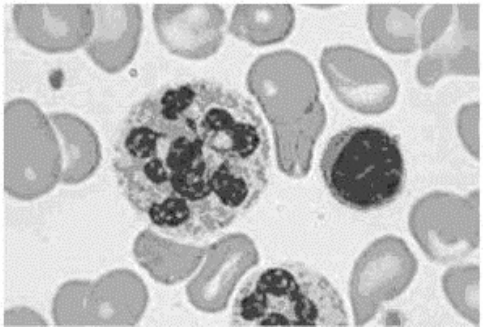

Fig. 3. Black-white image for the data in Fig. 1.

In Fig. 2 shows the different areas of interest. These areas of interest have the same degree of brightness to identify them (except for segments in the nucleus of neutrophils).

In Fig. 4 shows the results of the wavelet analysis for the R components the color space of the original image in Fig. 1.

In Fig. 5 shows the results of the wavelet analysis for the G components the color space of the original image in Fig. 1.

In Fig. 6 shows the results of the wavelet analysis for the B components the color space of the original image in Fig. 1.

For Fig. 4, Fig. 5 and Fig. 6, we see that the regions of interest have different degrees of brightness for their identification (in comparison with the data of Fig. 2).

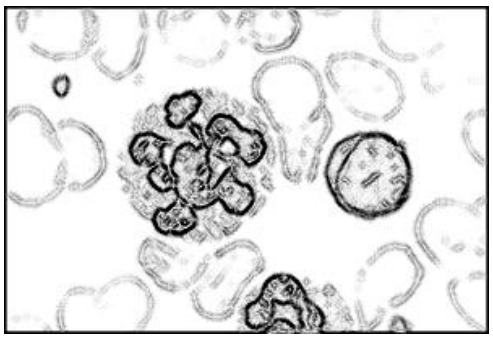

Fig. 4. Results of the wavelet analysis for the R components the color space of the original image in Fig. 1

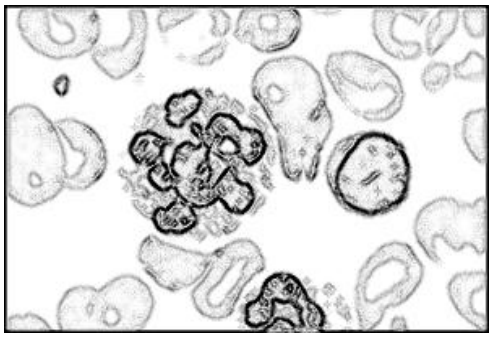

Fig. 5. Results of the wavelet analysis for the G components the color space of the original image in Fig. 1

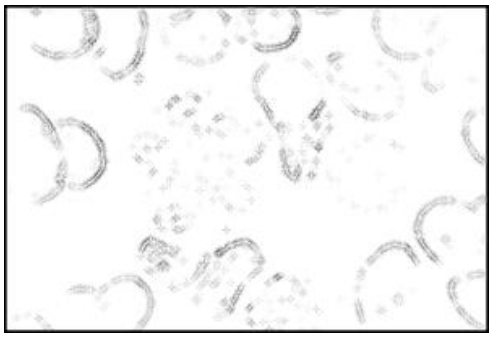

Fig. 6. Results of the wavelet analysis for the B components the color space of the original image in Fig. 1

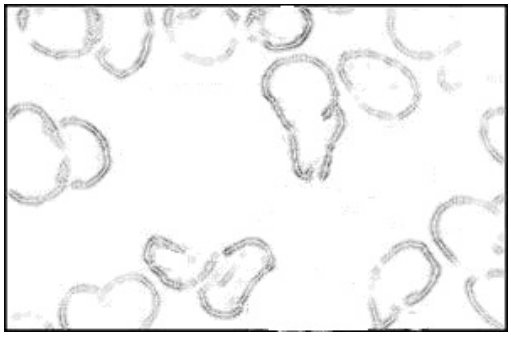

Fig. 7. Results of morphological analysis (images from Fig. 4 and Fig. 6. were used)

Thus, we have additional information. This allows for more accurate analysis. For this you can use morphological image analysis [10]. In Fig. 7 presents the results of morphological analysis for images in Fig. 4 and Fig. 6. As a result of this analysis, we identified erythrocytes.

In Fig. 8 presents the results of morphological analysis, which allow to isolate the cells of megaloblastic anemia.

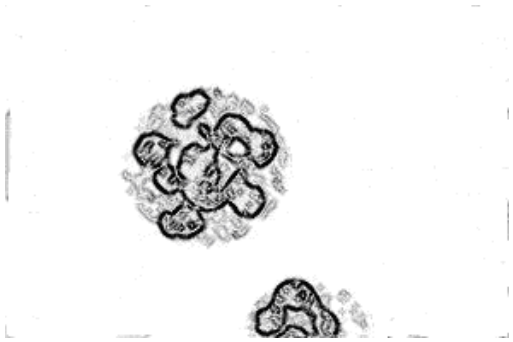

Fig. 8. Results of morphological analysis (images from Fig. 4, Fig. 5 and Fig. 6. were used)

We can specify a different morphology to identify the desired area of interest.

Conclusions. For more information about the objects of interest in the image, we used the wavelet methodology and the technique of decomposing the image into colored components. With the help of morphological analysis, we have identified various components of images of cellular structures of cytological preparations. For further research, it is necessary to automate the process of identifying components of images cell structures the cytological preparations.

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Ляшенко В.В., Кобилін О.А., Рязанцев О.І., Рязанцев І.О., Обробка зображення при дослідженні клітинних структур біомедичних даних

Методи обробки зображень використовуються у всіх областях досліджень. Ці методи дозволяють отримати додаткову інформацію, краще зрозуміти об'єкт, який досліджується. Серед напрямків використання методів обробки зображень особливе місце займає медицина. Біомедичні дані дозволяють оцінити здоров'я людини, виявити захворювання на ранніх стадіях. Зображення клітинних структур цитологічних препаратів - це один з прикладів біомедичних даних. На основі методів аналізу зображень ми можемо виділяти різні компоненти клітинних структур цитологічних препаратів. Для цього ми застосовуємо методи вейвлет аналізу для різних колірних компонент вхідного зображення. Застосувавши морфологічний аналіз ми можемо виділити окремі клітинни структури. Результати показані на прикладі зображень клітинних структур цитологічних препаратів.

Ключові слова: *обробка зображень, біомедичні дані, клітинні структури, вейвлет аналіз, колірний простір, цитологічні препарати*

Ляшенко В.В., Кобылин О.А., Рязанцев А.И., Рязанцев И.А., Обработка изображения при исследовании клеточных структур биомедицинских данных

Методы обработки изображений используются во всех областях исследований. Эти методы позволяют получить дополнительную информацию, лучше понять объект, который исследуется. Среди направлений использования методов обработки изображений особое место занимает медицина. Биомедицинские данные позволяют оценить здоровье человека, выявить заболевания на ранних стадиях. Изображения клеточных структур цитологических препаратов – это один из примеров биомедицинских данных. На основе методов анализа изображений мы можем выделять различные компоненты клеточных структур цитологических препаратов. Для этого мы применяем методы вейвлет анализа для разных цветовых компонент входного изображения. Применив морфологический анализ мы можем выделить отдельные клеточных структур. Результаты показаны на примере изображений клеточных структур цитологических препаратов.

Ключевые слова: *обработка изображений, биомедицинские данные, клеточные структуры, вейвлет анализ, цветовое пространство, цитологические препараты*

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