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Digital medical image as an object of processing and analysis

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Abstract: Digital image is a special source of information. This source not only represents a certain type of information, but also visualizes it. At the same time, processing and analysis of such information allows us to obtain additional data. Then a general idea of what is being studied is formed. Digital images are of particular importance when processing medical data. This allows us to obtain data on the microcosm of the patient and his individual organs, as a rule, without surgical intervention. For these purposes, various methods and approaches for image processing are used. The choice of specific medical image research tools depends on the problem that needs to be solved and the features of the input data presentation. The paper discusses some features of solving certain problems of processing and analysis in medical imaging. The results are presented for real medical images.

Key words: Image, Segmentation, Analysis, Classification, Contrast, Pre-processing, Recognition, Medical Imaging

Introduction

Digital technology is one of the tools that is constantly in the spotlight [1]-[3]. This type of tools allows for data processing and analysis for various areas of research. Among such tools, digital image processing should be highlighted [4]-[10]. This element of digital technology allows you to study data without direct contact with the object of study. Thus, the possibilities of analysis and decision-making remotely with the involvement of various specialists are expanded. It is also possible to objectively compare the results obtained and select the best one.

Among the individual areas of effective use of digital image processing, medical data processing is highlighted [11]-[19]. This is based on the fact that this type of medical data processing allows for examination of various foci of potential disease damage to various human organs. In this case, a detailed study of the patient's microcosm is possible. This makes it possible not only to conduct analysis, but also to provide visualization of potential areas of study. Also in this case, it is possible to obtain additional information during such an analysis.

Various methods and approaches are used to implement digital processing of medical images [20]-[23]. Conventionally, they can be divided into:

image pre-processing methods that improve the quality of visualization of primary data and increase the efficiency of their subsequent processing;

methods of segmentation and classification of primary data that allow identifying potential areas of interest;

data identification methods, which are a tool for specifying potential areas of research;

recognition methods that ensure effective decision-making in the process of medical research.

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The choice of a particular approach for analyzing medical images is determined by the specific research task and the characteristics of the presented input images.

Thus, the purpose of this work is to demonstrate the different types of challenges that confront researchers in the field of medical imaging. Attention will also be drawn to some features of solving such problems of processing and analyzing medical images. To solve this problem, the work provides a brief review of the literature, and also discusses specific issues for a number of real medical images.

Related works

Processing and analysis of medical images is constantly in the focus of attention of researchers.

M. Puttagunta and S. Ravi explore the principles of using artificial neural networks to understand medical image analysis [24]. At the same time, the authors note that medical imaging plays an important role in various clinical applications. This is of great importance for the justification of medical procedures, monitoring and diagnosis of various diseases. For these purposes, the authors use a deep learning approach (DLA). This approach can be used to detect the presence or absence of a disease. However, any analysis of medical images involves the use of some preliminary procedures: noise reduction, improving the quality of data perception, changing contrast.

The study by L. Cai, J. Gao and D. Zhao paid attention to the issues of classification and segmentation of medical images [25]. The authors also emphasize that medical images belong to big medical data. This justifies increased attention to medical imaging. In this review, the authors consider various areas of using deep learning in intelligent visualization. The issues of preliminary processing of source data and its impact on the accuracy of segmentation and classification are also addressed.

In [26] explored various methods for extracting additional information from medical images using deep learning approaches. The authors highlight that data augmentation has become a popular method for increasing the size of the training dataset. The work provides an extensive set of literature sources that consider basic, deformable, deep learning. It is shown how this affects the increase in data. This allows us to justify the reliability of the created models.

In [27], the authors pay attention to natural analyzers of medical images, similar to what happens when processing various linguistic constructs. It is noted that such analyzers are successfully used in the analysis of medical data. The paper provides an overview of the main approaches for such analysis of visual data. The issues of the architecture of such converters, learning paradigms, and increasing the efficiency of the model in interaction with other methods are also considered.

The authors of the study [28] consider the issues of data classification from medical images. For these purposes, first of all, a number of features are selected that describe a certain set of data or objects. This topic plays an important role in the prognosis and diagnosis of diseases. However, the authors note the complexity of solving this problem. To solve this problem, we use optimal deep learning (DL). Research subjects include lung cancer, brain imaging and Alzheimer's disease. To build an optimal model, methods of preprocessing input images are also used. This allows you to generate the necessary set of characteristics in each specific case.

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H. Guan and M. Liu say that it is important to study the subject area before analyzing medical images [29]. Based on this, the authors provide an overview of domain adaptation methods in medical image analysis. Here, special attention is paid to the motivation for using such methods. Issues of adapting the subject area for various tasks of medical image analysis and using reference medical image data sets are also explored. Overall, this improves the efficiency of medical imaging.

In [30], the problematic aspects of medical image classification using quantum neural networks are studied. This research is based on machine learning methods. Among such methods, the authors highlight quantum machine learning methods. This makes it possible to improve the performance of machine learning applications, both using quantum algorithms and quantum neural networks [30]. The article discusses two methods of quantum neural networks for classifying medical images. The authors note that the results showed the promise of the methods studied and the possibility of limitations of modern quantum equipment.

The work of Z. Li, X. Zhang, H. Müller and S. Zhang is devoted to the complex analysis of medical images [31]. For these purposes, the paper presents a critical review of relevant studies. In particular, the authors review modern approaches to large-scale analysis of medical images. However, we must not forget about classical approaches, which are important in the preliminary stages of analyzing input images. The work also provides a comprehensive overview of algorithms and techniques related to the core processes in the pipeline, including feature representation, feature indexing, search, etc. [31]. Based on this, the paper proposes evaluations of large-scale medical retrieval of medical images.

Thus, it should be noted the importance of considering the processing and analysis of medical images when diagnosing possible diseases and the possibility of determining procedures for its treatment. Moreover, one of the key stages of such processing and analysis is the preliminary stage.

Features of the preliminary stage in the process of medical image analysis

As stated earlier, the process of processing and analyzing digital medical images, which include medical images, consists of several stages (Fig. 1).

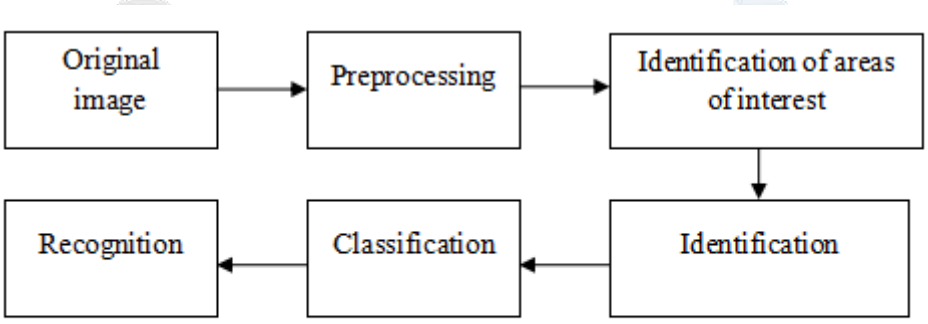

Figure 1: Image analysis as a series of sequential processing stages

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Here we present a conditional division of the ideology of image processing into separate stages. These steps can be mapped depending on the problem that needs to be solved. At the same time, in Fig. 1 shows the key stages that are implemented in image processing

The preliminary stage of digital image processing includes a number of procedures, each of which has its own characteristics. It is these features that determine the final result of processing. Therefore, it is important to take them into account.

Among such procedures and the features of their use in the analysis of medical images, the following should be highlighted:

– a noise reduction procedure that allows you to get rid of random inclusions in the field of view and unnecessary objects. At the same time, it should be taken into account that it is also possible to remove small details, which are important elements of the medical image. Therefore, the noise reduction procedure should be used very carefully. Among the tools for implementing such procedures, various types of filters should be noted;

– a contrasting procedure that allows you to emphasize less noticeable differences in brightness and increase the degree of detail in the image. We can also generally improve the overall visualization of what we are seeing. At the same time, an excessive increase can worsen the overall picture. Therefore, the contrast procedure should also be used carefully.

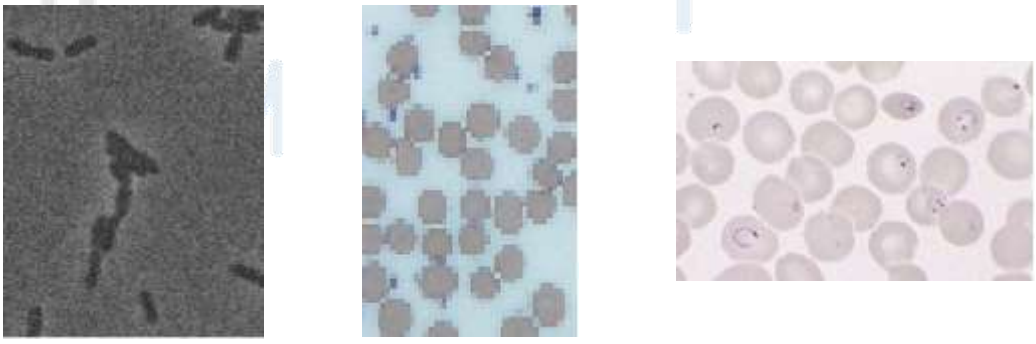
It should also be noted that the combined use of contrast and noise reduction procedures is possible to enhance the visualization and perception of medical images. The basis for such a combination is determined by both the type of input image and the problems that need to be solved.

At the same time, it should be emphasized that the preliminary stage of image processing determines the subsequent effectiveness of the corresponding analysis. Therefore, it is important to carefully consider all preliminary stage procedures.

Thus, the preliminary stage is key when analyzing medical images, which generally determines the need for this study. Based on this, some examples of medical images are shown below and the specifics of their processing at the preliminary stage are shown.

Some examples of preliminary medical image analysis

Below are some medical images that may need to be pre-processed.



a) b) c)

Figure 2: Examples of medical images

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We see different images. In Fig. 2a shows a noisy image, and Fig. 2b and Fig. 2c it is necessary to find small objects – platelets and malaria cells.

Let's present an example of processing a noisy and non-noisy image (processed image). Our goal will be to binarize the image to identify elongated objects. In Fig. 3 shows the result of processing a noisy image.

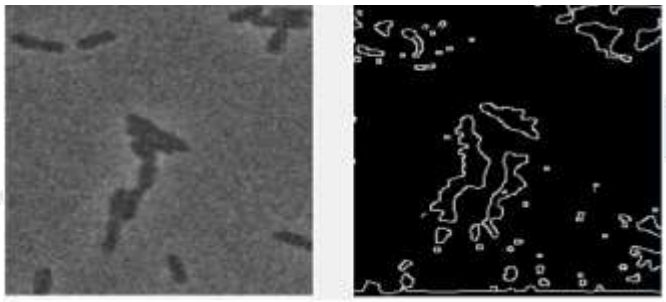

Figure 3: Result of processing a noisy image

In Fig. 4 shows the result of processing a non-noisy (processed) image.

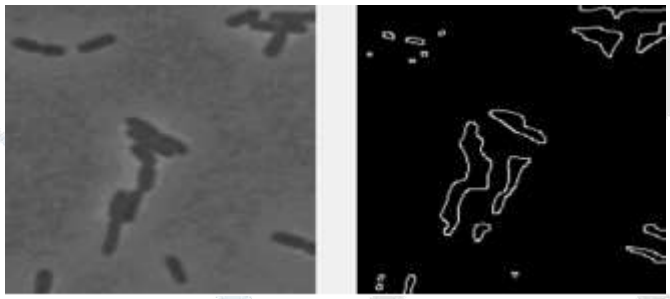

Figure 4: Result of processing a non-noisy image

Comparing Fig. 3 and Fig. 4, it should be noted that when processing a noisy image, we see many false detections of the necessary objects (see Fig. 3). In a non-noisy image, the detection of false objects is much less. Thus, in this case, noise removal is a justified procedure.

In Fig. 5 shows the results of image filtering Fig. 2b.

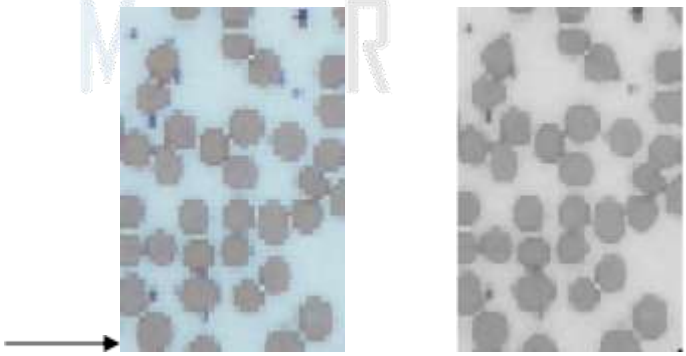

Figure 5: Result of filtering the image in Fig. 2b

In Fig. 6 shows an example of overuse of the contrast procedure.

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Figure 6: Example of overuse of contrast procedure

We see that not only the intensity of the brightness of the dots that are characteristic of malaria cells has changed. Also, a lot of false underlining's appeared on the image, which complicates the process of further analysis of such an image.

Thus, due care must be taken in each case to use various pre-processing procedures for medical images. This is especially important when the area of interest includes objects with small geometric dimensions.

Conclusion

The article discusses some problematic aspects of the analysis of digital medical images as an object of research. A critical analysis of a number of literary sources was carried out. The importance of carrying out a preliminary stage when processing and analyzing medical images is shown. Features of the use of individual procedures that are used at the preliminary stage of image analysis are noted. Specific examples show some of the nuances of using such procedures. The purpose of further research is to analyze the conditions for using various procedures for the preliminary stage of medical image processing.

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