ISSN (E): 2181-4570 ResearchBib Impact Factor: 6,4 / 2023

Contrasting as a Method of Processing Medical Images in the Study of Fatty Liver Disease

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Abstract:

Diagnosis of diseases is one of the priorities in the development of modern medicine. Various data sources can be used for these purposes. Among such sources, medical images should be singled out, which reflect the microcosm of the phenomena under study. The study of medical images is possible based on the use of various image processing techniques. These techniques allow you to prepare the input image for research and perform the necessary analysis. One of the image processing techniques is contrasting the input image. This procedure makes it possible to improve the quality of perception of a medical image, to make a preliminary stage of its processing. On the example of images that contain foci of fatty liver lesions, the procedure for contrasting the input image is considered. Examples for real medical images are given, the possibility and expediency of using the contrasting procedure are discussed.

Key words: Contrasting, Analysis, Medical Imaging, Image Processing Techniques, Fatty Liver Disease

Introduction

Medical images are a source of information about the patient's condition, possible diseases [1], [2]. This is necessary both for conducting scheduled examinations and for monitoring the course of the prescribed treatment, determining the feasibility of its adjustment. Such information can be processed remotely and carried out without contact. At the same time, these data reflect information about the microcosm of the

ISSN (E): 2181-4570 ResearchBib Impact Factor: 6,4 / 2023

patient and his individual organs, which allows for accurate and efficient diagnosis and detection of various diseases.

Among the various human diseases, we pay attention to fatty liver disease [3]-[5]. Such a disease is dangerous and very difficult in its early diagnosis [6], [7]. The manifestation of this disease is the presence of many foci of fatty liver tissue lesions. Analysis of relevant medical images helps diagnose fatty liver disease.

To solve the problem, you can use various methods of image processing [8]-[13]. The main purpose of using these methods is to identify foci of liver damage and determine their total area. This allows you to choose a method of treatment and monitor the course of the disease, evaluate the effectiveness of its treatment.

Pre-processing methods are used to improve the quality of medical image analysis. Among these methods, one can single out the procedure of contrasting. This improves the quality of visualization, further processing of the input image, and identification of areas of interest. At the same time, we can say that it is necessary to have a reasonable compromise between visualization and image processing. In this context, it is important to take into account the scope of digital image processing methods, the task facing researchers.

Thus, the main purpose of this article is to review the procedure for contrasting medical images that can show the presence of fatty liver disease. We also note that this work is a continuation of our earlier research in this area [14], [15].

Brief critical review of the literature

Contrasting the input image as a method of preliminary analysis is widely used in various medical studies.

Before we turn to a brief analysis of such approaches, we should also say about the use of contrast agents in medical imaging [16]. This allows you to get high-quality images and better study the problem that is displayed in the image. Nevertheless, the problem of using the input image contrasting procedure remains relevant.

S. Perumal and T. Velmurugan consider various methods of image contrast as a preliminary stage of their analysis [17]. The authors note the importance of this stage, especially after the removal of unnecessary details. This allows you to improve the visualization of specific areas of research, to facilitate the process of diagnosing the disease. The paper emphasizes that for these purposes it is necessary to use complex

ISSN (E): 2181-4570 ResearchBib Impact Factor: 6,4 / 2023

filtering, noise removal and image contrast. However, it is also important not to lose important details for later analysis.

R. Kaur and S. Kaur conduct a comparative analysis of image contrast methods used in medical diagnostics [18]. The authors emphasize the importance of such an analysis for the purposes of improving visualization. The paper also points out the complexity of processing medical images. At the same time, the stage of image contrasting is an important component of the analysis of medical images. The paper explores such methods as: average filter, bilateral ratinex, imadjust and sigmoid function.

A. Gandhamal, S. Talbar, S. Gajre, A. F. M. Hani and D. Kumar consider a generalized contrast enhancement method for medical images [19]. This method is based on the S-curve transformation of the local gray level. The paper focuses on the importance of exploring the possibilities of such an approach. This is due to the fact that in this case a significant difference is achieved between the minimum and maximum gray values and the gradient of the image. This allows you to highlight complex boundaries of areas of interest, improve diagnostic results.

G. Bhatnagar, Q. J. Wu and Z. Liu explore the possibilities of contrast enhancement for multimodal fusion and medical image analysis [20]. The purpose of such a study is that the combination of medical images plays an important role in diagnostics, various clinical applications. In this case, contrast methods play a significant role.

T. K. Agarwal, M. Tiwari and S. S. Lamba study the possibilities of contrasting medical images based on changing the histogram of the input image using homomorphic filtering [21]. The paper notes that methods based on histogram modification to increase contrast are used for all types of medical images. This approach allows improving visualization, to conduct better diagnostics. The authors also note that this approach can be used as a pre-processing step for understanding and analyzing medical images.

K. Somasundaram and P. Kalavathi explore the issues of changing the contrast of medical images based on gamma correction [22]. The authors note that it is the non-linearity of brightness that necessitates the use of a number of pre-processing procedures for the input image. Among such procedures, an important place is given to contrasting the input image. In this case, it is important to implement an automatic

ISSN (E): 2181-4570 ResearchBib Impact Factor: 6,4 / 2023

procedure for changing the image contrast. To understand the results obtained, standard approaches to assessing image quality were used.

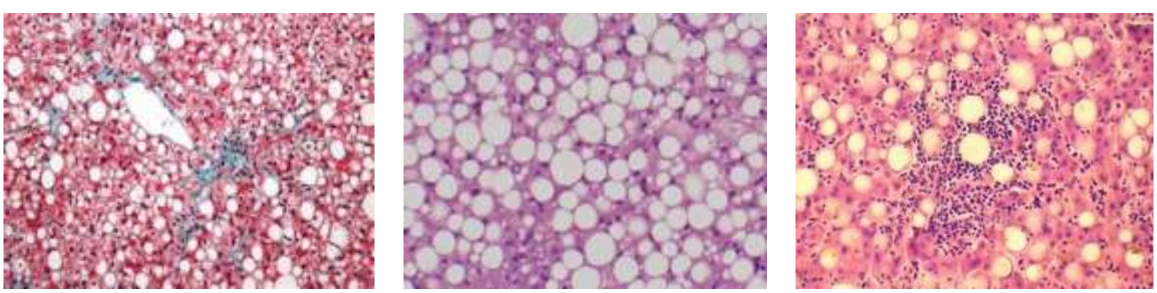
Z. Yu and C. Bajaj explore an adaptive method for changing the contrast of medical digital images [23]. The authors also emphasize that this is a very fast contrasting method. It is based on local manipulation of contrast. To confirm the results obtained, various real digital images are considered in the work. These images include brain MRI, chest CT images, and mammography images [23].

M. Tsuneki explores the possibilities of using deep learning models for the analysis of medical images [24]. One of the objects of such an analysis is the methods of image preprocessing, where the procedures for contrasting the input image are distinguished. The author emphasizes that the approaches under consideration can be used for both detection and segmentation of areas of interest. This makes it possible to increase the accuracy of diagnostics, to clarify the procedures for treating the patient.

Thus, we see that the procedure for contrasting the input image is an important step in the study of medical images. However, the question of the applicability of such a procedure remains open and depends on the scope of its application.

General preliminary questions for image contrast of liver tissue with fatty lesions

First of all, let's look at digital images that depict fatty liver lesions (Figure 1).



a) b) c)

Figure 1: Examples of digital images with foci of fatty liver lesions

We see that the images of fatty liver lesions are different. They have different colors and textures. Relatively the same are the outlines of fatty lesions. These outlines

ISSN (E): 2181-4570 ResearchBib Impact Factor: 6,4 / 2023

are presented in the form of rounded or slightly elongated shapes. The color scheme of such lesions is also different, but differs from the general texture.

To change the contrast, we can use various methods: contrasting with histogram equalization, adaptive histogram equalization with contrast limiting, multivariate filtering with a given filter type, dynamic range stretching, using the fuzzy masking method, and much more.

The simplest and most common approach to contrasting an image is to use the equalization method (histogram equalization). As shown above, this method is widely used in the study of medical images. At the same time, we can set the range of the histogram of the output image in some given interval of its possible alignment. This allows making and investigating estimates of the change in contrast of acquired images.

Various tools can be used to compare images after contrasting. We will use the following: entrop – entropy, which shows the change in the measure of uncertainty. The higher this value, the more details are visible in the image; niqe – is a natural image quality estimator. A lower score indicates a better quality of perception; brisque – is a blind/baseless image spatial quality estimator. A lower score indicates a better quality of perception.

For the above images, we have the following initial indicators: Figure 1a: entrop – 7.6953; niqe – 9.2432; brisque – 43.7207; Figure 1b: entrop – 6.7919; niqe – 3.9749; brisque – 38.5681; Figure 1c: entrop – 7.4259; niqe – 4.0142; brisque – 17.4202.

Results

So, we consider equalization as a method of contrasting. At the same time, we are looking at the change in image quality parameters, taking into account different intervals for equalizing the histogram of the output image in the range from 2 to 1024 with a multiplicity of 2.

Figure 2 show the respective scores (entrop, niqe and brisque) for Figure 1a.

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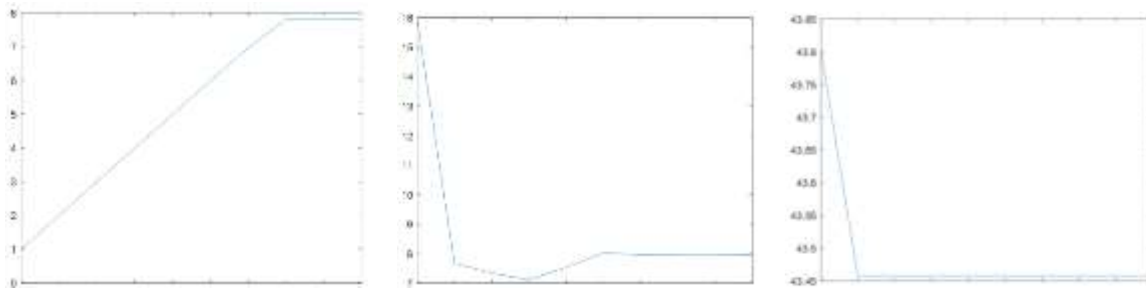
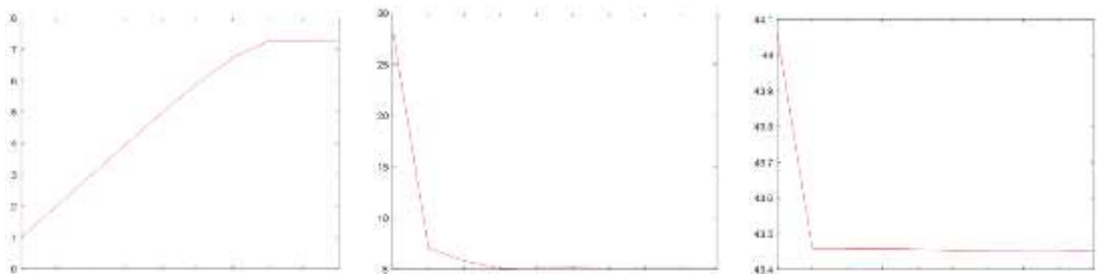
ISSN (E): 2181-4570 ResearchBib Impact Factor: 6,4 / 2023



a) entrop b) niqe c) brisque

Figure 2: Contrast quality scores for Figure 1a

Figure 3 show the respective scores (entrop, niqe and brisque) for Figure 1b.

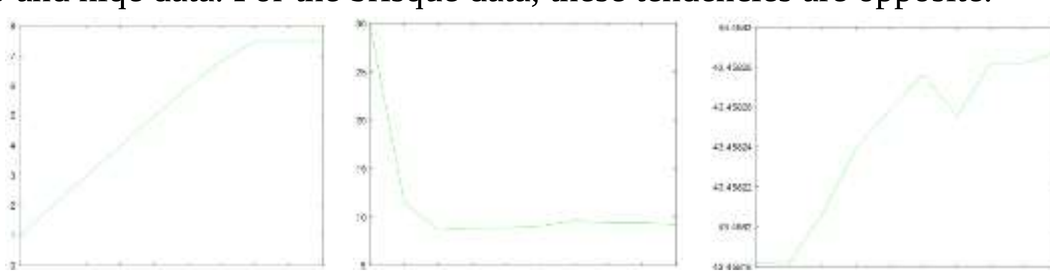


a) entrop b) niqe c) brisque

Figure 3: Contrast quality scores for Figure 1b

The data in Figure 2 and Figure 3 show the same trends in the change in quality indicators when evaluating the obtained images after contrasting. The essence of these trends is to achieve a certain level of contrast quality, when further changes in contrast are no longer appropriate.

Corresponding trends can also be seen in Figure 4 for the Figure 1c data for the entrop and niqe data. For the brisque data, these tendencies are opposite.



a) entrop b) niqe c) brisque

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Figure 4: Contrast quality scores for Figure 1c

But we must take into account that the main purpose of contrasting is the further processing of the image. In our case, this is an effective identification of fatty foci of liver damage. Therefore, we will consider how the selection of lesions occurs under equal conditions for their identification, but for different conditions for their contrasting. For each of the examples, we will consider the first and last contrast levels of the original images.

Figure 5 shows the results of detection of fatty lesions for different levels of contrast of the original image in Figure 1a. Figure 5a – the original image after the first contrast level. Figure 5b – selection of lesions in accordance with Figure 5a. Figure 5c – identification of lesions. Figure 5d – is the original image after the last contrast level. Figure 5e – identification of lesions according to Figure 5d. Figure 5f – identification of lesions.

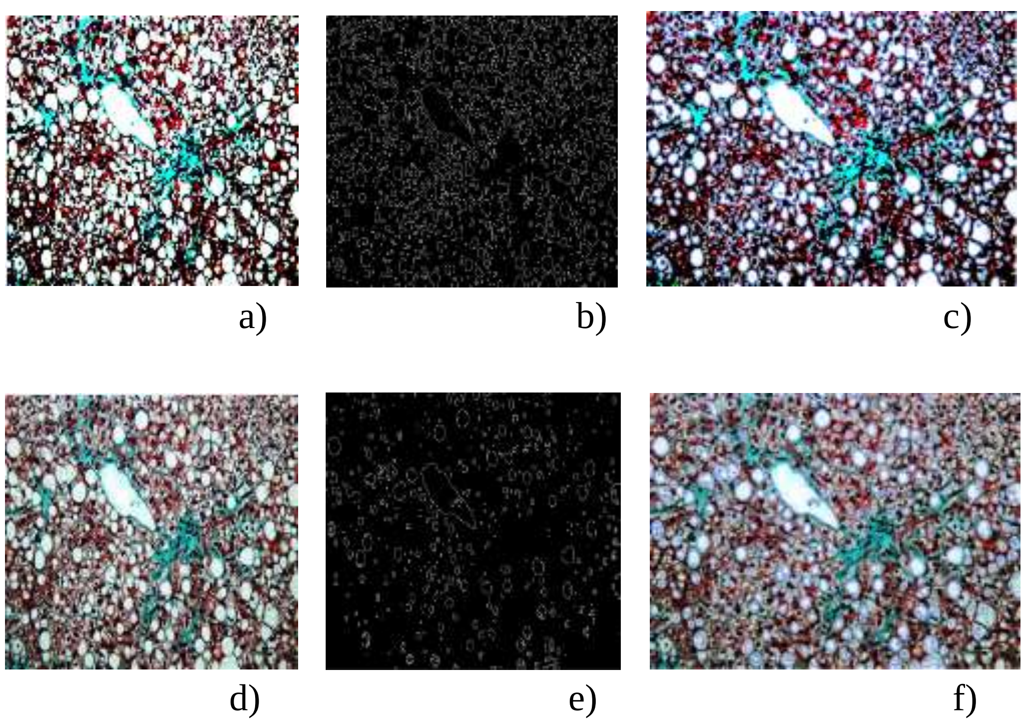

Figure 5: Results of detection of fatty lesions for different contrast levels of the original image in Figure 1a

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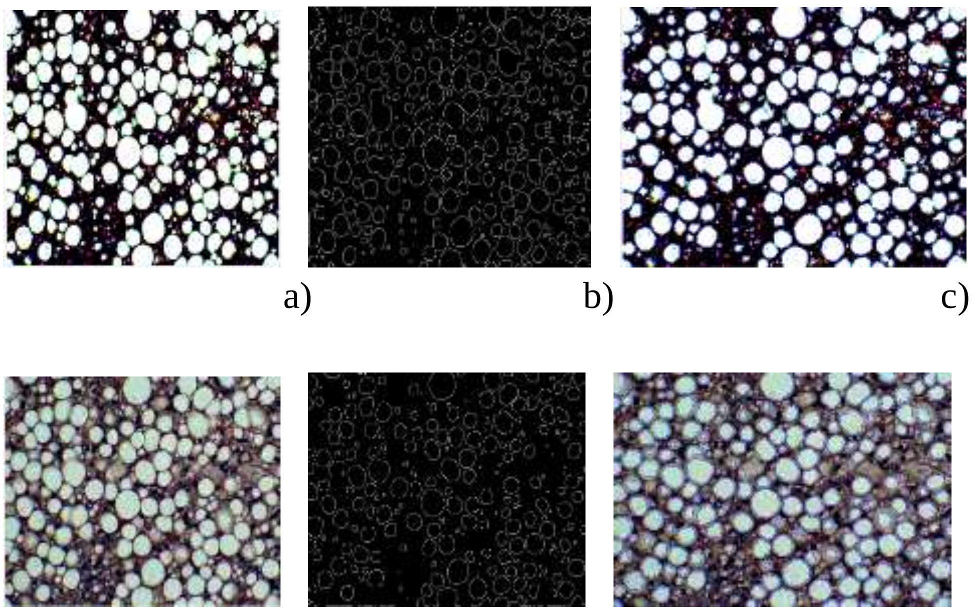
Visually, we note better detail for Figure 5d than for Figure 5a. But in terms of further processing are the data of Figure 5a.

Figure 6 shows the results of detection of fatty lesions for different levels of contrast of the original image in Figure 1b (captions are similar to Figure 5).

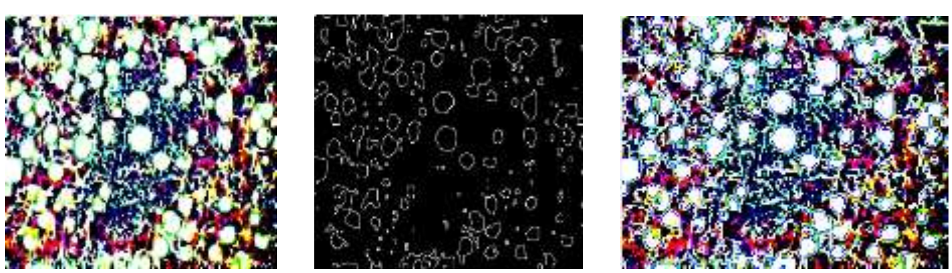


a) b) c)

d) e) f)

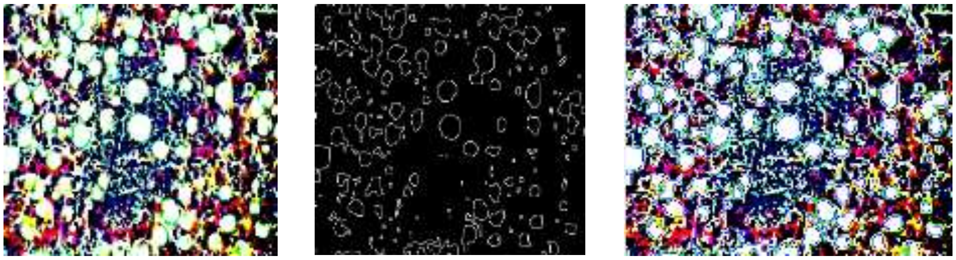
Figure 6: Results of detection of fatty lesions for different contrast levels of the original image in Figure 1b

Figure 7 shows the results of processing Figure 1c.



a) b) c)

JOURNAL OF UNIVERSAL SCIENCE RESEARCH
ISSN (E): 2181-4570 ResearchBib Impact Factor: 6,4 / 2023



d) e) f)

Figure 7: Results of detection of fatty lesions for different contrast levels of the original image in Figure 1c

It should be noted that the results presented in Figure 6 are better than the results in Figure 5. This can be explained by the fact that the input image in Figure 1b is clearer and less complex compared to Figure 1a.

The results presented in Figure 7 are somewhat inconsistent. This is due to the fact that the general background in Figure 1c is the most complex. Also of note are conflicting data regarding the application of the contrast procedure to Figure 1c (see data in Figure 4).

Conclusion

Thus, the article discusses some issues of the possibility and expediency of contrasting the input image in case of detection of fatty lesions of the liver. The study used real images.

Contrasting has been shown to significantly improve the perception of the input image. However, this also depends on the texture of the input image and the overall complexity of the background where the fatty lesions can be seen. The complexity is also due to the processing of color images.

For further processing of images after contrasting, false and insufficiently objective results may appear. To eliminate this, more extensive studies are needed on the choice of contrast method in solving the problem of detecting fatty lesions of liver tissues. It is also important to consider the combined application of the contrasting procedure with filtering and noise removal. This is the basis for further research.

ISSN (E): 2181-4570 ResearchBib Impact Factor: 6,4 / 2023

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