Invectigation of segmentation methods for highlighting areas of interests on lung X-rays

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Abstract — The article presents various segmentation approaches implemented using the Scikit-Learn library and the Python programming language. A comparative analysis of their effectiveness has been carried out to improve the accuracy of identifying areas of interest in the task of diagnosing lung diseases. The data set used for the study was obtained from the database of patients of the clinic "Road Clinical Hospital at Samara station of JSC Russian Railways".

I. INTRODUCTION

In order to prevent a complex course of the disease, timely diagnosis and accurate diagnosis are necessary. Lung X-rays are commonly used in pulmonology. Since chest X-ray examination is a relatively fast and cheap procedure, it can be used as an appropriate diagnostic tool for screening respiratory diseases such as pneumonia and tuberculosis. The topic is of practical interest, since in recent years the use of technical means and digital image recognition technologies has become widespread to accelerate the analysis of medical images.

The goal of the work is a comparative analysis of various approaches to lung segmentation. Segmentation is the division of an image into several segments with subsequent simplification of the analysis. To solve this task, we have on hand an unmarked database of patients of the clinic "Road Clinical Hospital at Samara station of JSC Russian Railways". The database includes radiographs of patients of different genders, older than 18 years. All images are stored in the format (.bmp) with a resolution of 512x512. For our task, it is necessary to allocate areas, for this the expert doctor manually marked up the data in the dataset. As a method of calculating the numerical characteristics, the Haralik features were used. On their basis, segmentation was carried out by a certain set of image analysis methods.

II. THE INVESTIGATED MEDICAL IMAGE SEGMENTATION APPROACHES

Textural features. The approach based on texture analysis is common for finding pathologies in patients on lung images. The analysis technology for solving this problem includes the following stages: feature extraction, model training on a sample of images and subsequent testing on working data. To highlight the features, a texture analysis of the image was used, namely Haralick features. The algorithm of this method is described below. These features were applied in order to quantify the pixels of the image. The descriptor of the Haralik texture was proposed in the article.

TABLE I. RESULTS OF EXPERIMENTAL INVESTIGATIONS

		Performance indicators			
		Time, s	The accuracy of determining the human body	Lung Accuracy	Background accuracy
Algorithms	Discriminant Analysis	6.277	0.73	0.68	0.74
	KNN algorithm	6.823	0.83	0.9	0.65
	Logistic regression	13.751	0.68	0.69	0.79
	Decision tree	5.045	0.92	0.91	0.72
	Random forest	147.5	0.89	0.92	0.66

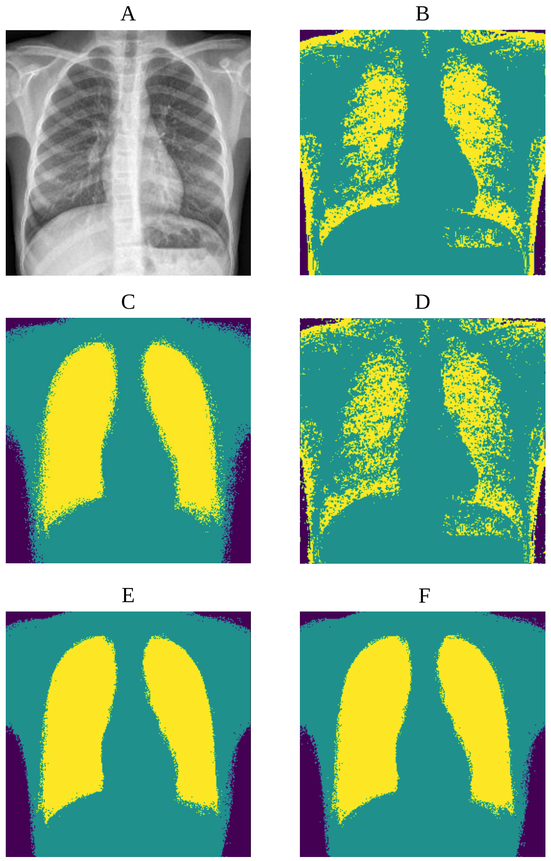

Fig. 2. Results of experimental investigations a) Start Image b) Discriminant Analysis c) Method K-neighbors d) Logistic regression e) Decision tree f) Random forest

Segmentation methods. Image segmentation was carried out in two stages: feature extraction with preliminary preparation of the image and model training with subsequent segmentation. Before performing image analysis, some preliminary operations were performed: converting images to grayscale and normalizing images in order to change the range of pixel contrast values. The result of this step is a clearer and more contrasting radiograph of the lungs in shades of gray. At the next stage, masks with separate zones are combined into one whole for each image. After that, the data is divided into training and test data, the model is trained and the test images are segmented. The following methods of image segmentation were used in the work: discriminant analysis, KNN method, logistic regression, decision tree and Random forest.

III. RESULTS OF THE EXPERIMENTAL STUDY

Dataset. As mentioned earlier, there is a database of patients of the clinic "Road Clinical Hospital at Samara station of JSC Russian Railways". The lung radiographs were marked up by an expert doctor. An example of the image and masks is shown in Figure 1.

Fig. 1. Analyzed masks: a) Lung mask b) Body mask

Table 1 below shows the numerical values of the precision metric. This metric shows the ability to distinguish this class from other classes. There is also an initial image (Fig. 2a) with the results of segmentation of the lung X-ray.

Results of experiment. From the presented calculations, it can be concluded that the decision tree under experimental conditions, together with the presented data, is the most effective, since the method is fast and accurate in segmentation of lung X-rays. Discriminant analysis showed lung segmentation close to the value of 0.7 of the precision metric, which is a acceptable indicator. The same result can be traced in the logistic regression method.

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