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Morphological transformation of x-ray imaging as a method supplementing the process of detecting tubercular changes of the lungs

Introduction

Radiological examination is a rudimentary diagnostic method of the contemporary phthisiology, both in the process of diagnosis and during the evaluation of disease process dynamics. In most cases it takes the form of an overview chest image, most frequently performed in poste-anterior projection, yet sometimes in side projection. The image cost is relatively low and it is widely available. This examination is truly crucial for it allows to gather the essential information on the patient's clinical state. However, the proper diagnosis is not viable to be established in the course of single examination therefore another should follow. This has harmful impact on patient as he receives another portions of health-hazardous radiation. In this paper, the analyzed x-ray images will be only these regarding the chest. This selections has been made as the article focuses on lung diseases, tuberculosis in particular. These images, comprised of shades of grayness are among factors affecting diagnostician's decision. The ailment which is to undergo an analysis is distinctly hazardous for patient, therefore it is vital to perform the diagnosis in the shortest possible time and apply proper treatment. A large number of x-ray images are performed in emergency cases. These circumstances require the doctor perpetrating the diagnostics to act hastily. It is crucial to reduce the necessity of performing additional x-ray images. The essence of research is to transform the x-ray image so that it streamlines the process of decision making for the person responsible for it. For this purpose, the use of x-ray images morphological transformations with Matlab application and has been tested and original methods required by lung diagnostics has been used.

Data and methods

The research has been conducted in the group of 25 x-ray images depicting human chest. The images appeared in digital form and were deprived of personal data of a given patient. Tuberculosis was the sought disease. With the intention of streamlining the search for pathological changes the images were divided into 4 parts, matching proper sections of the lungs (Fig. 1).

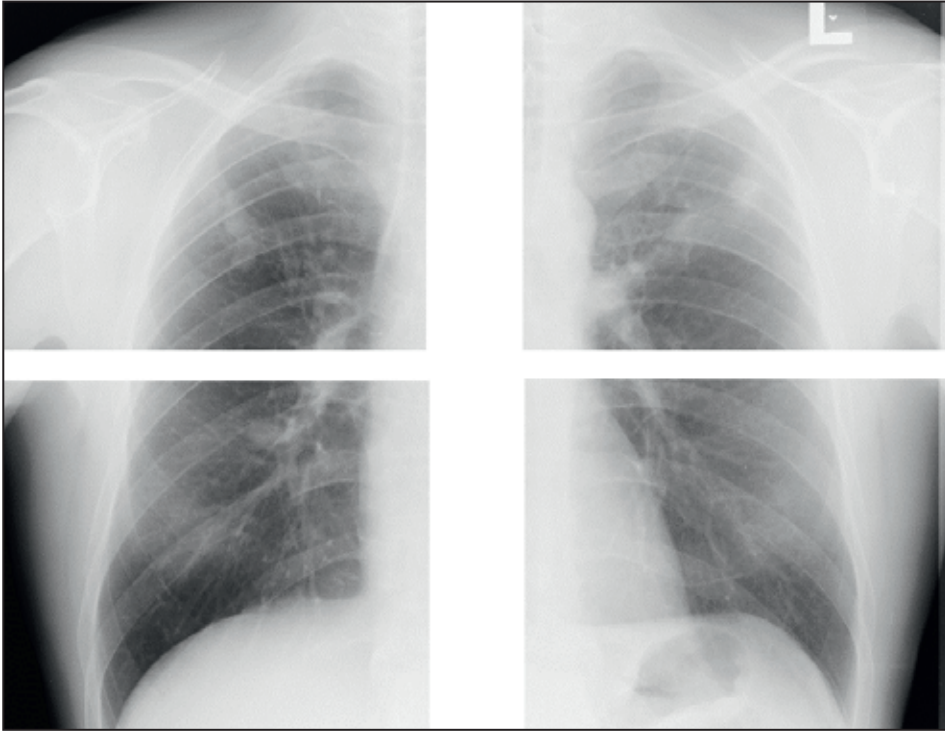


Fig. 1. A sample tested X-ray image

Tuberculosis is characterized by characteristic changes in lung parenchyma, which can have either exudative or productive nature. However it is not uncommon to observe a simultaneous presence of both types of these changes. Infiltration of lung tissue is a correspondent of exudative change whereas focus of tubercular granulation called tubercle corresponds with productive changes. Both infiltration and characteristic granulation are prone to necrosis, caseation and lysis with the creation of puncture. In the period of conglutination the infiltration undergoes a re-sorption or fibroid changes develop which may lead to cirrhosis. Calcifications are also quite frequent.

Using the Matlab application a method containing the process of opening and differentiating between the background and the basic image has been created. The process of opening $O(L,SE)$, where L is the image and SE is a structural element is consecutively performed process of erosion and dilatation. This process can be defined in the following form:

$$O(L,SE) = L \circ SE = D(E(L,SE),SE)$$

where

D – process of dilatation

E – process of erosion

For the structural element the 'disk' with 500 radius has been employed because of the high resolution of researched images and correction of pathological changes structures, which were sought and which were to be individualized for the diagnostic requirements. Opening process properties are of essential nature:

Duality:

$$C^c(L,SE) = O(L^c,SE)$$

Translation:

$$O(L + X,SE) = O(L,SE) + x$$

Anti-extensity:

$$O(L,SE) \subseteq L$$

Idempotence:

$$O(O(L,SE),SE) = O(L,SE)$$

The above-mentioned properties are important during the practical implementation of opening process algorithms. Another element of this method is the approximation of examined image surface and the use of subtraction function where the background is subtracted from the basic image, however the logical difference SUB has not been used, as it affects the given picture in a different manner.

Results and discussion

Research has been conducted on 25 x-ray images in digital form. The aim was to devise a method with substantial impact on the rate and efficiency of lung affections diagnosis, tuberculosis in this case. In the course of performed research the following resultative picture has been obtained (Fig. 2).

Owing to the employment of the researched method an individualizing effect has been achieved which allows to individualize the pathological changes in the lungs, pointing directly to progressing tuberculosis. In comparison with the basic image (Fig. 1) the transformed x-ray image accentuates changes in lung parenchyma. Even better prominence is achieved with the section-divided image (Fig. 3), corresponding the four sections of lung: upper right and left, bottom right and left. This division aim was to streamline diagnostic actions even more. Results of examination were evaluated by radiology specialist. All inadequacies in the preliminary stages of examination were adjusted in cooperation with a specialist.

Subsequently, the indications of pathological changes have been made to mark more clearly the places seeking particular attention of the diagnostician, the result presented in the picture below (Fig. 4).

Employed method along with its final result has been positively evaluated by a specialist. Images transformed in this way (Fig. 3) having positive impact on the

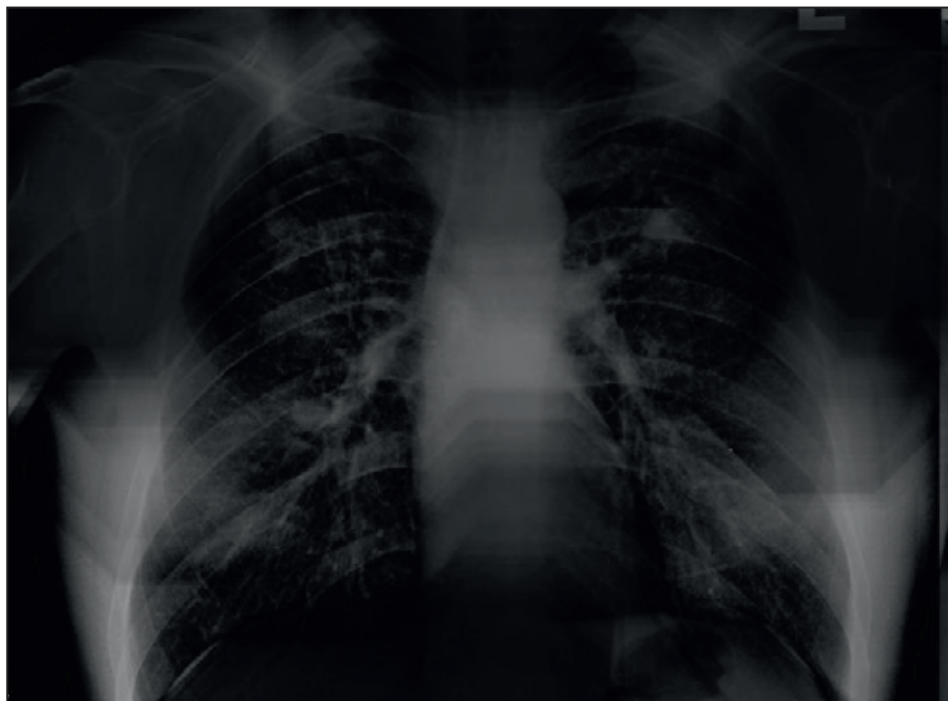


Fig. 2. X-ray after the transformation

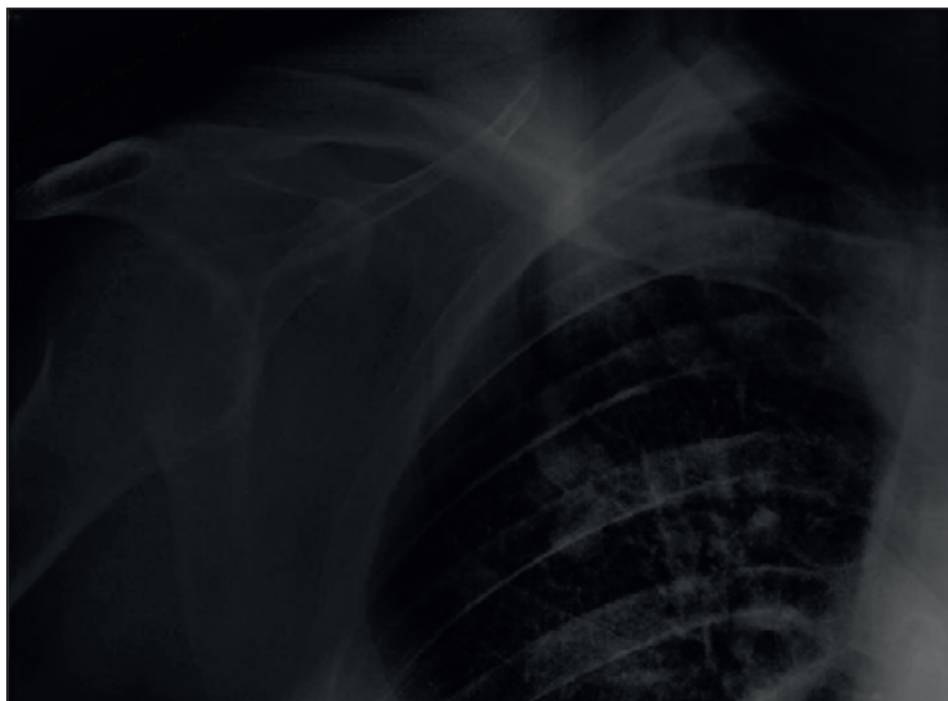


Fig. 3. Segment of x-ray image, right lung, upper part



Fig. 4. Right lung, upper part, marked

diagnostic process enable quicker indication of pathological changes. It is quite crucial under the circumstances of longer and longer queues of patients waiting for a specialist's appointment. Each augmentation of diagnostic effectiveness is a real advantage for the patients as we will be channeled for proper treatment more quickly which in turn may mean a lack of necessity to undergo another x-ray examinations what boils down to receiving a smaller portion of non-indifferent to health radiation. Currently, a more precise research is being conducted namely how shorter in time the diagnosis with the employment of given method will be. Also the answer for question with what accuracy the tubercular changes are individualized on the x-ray images subjected to modifications.

Conclusions

The employment of morphological transformations allowed to observe pathological changes in the lungs. Specialist's view on the subject after performing preliminary research was positive which allows further research on streamlining the method and supplementing it with another algorithms. However, before that being done, a more precise research will be conducted on how much the employment of a given method affects the functionality of providing a diagnosis and how it boosts its efficiency. The main target is to obtain a resultative x-ray image with full indication of every kind of tubercular changes or such, which comprise a symptom of advancing tuberculosis. Obtaining a full methodology is aimed at quicker diagnosis

of the patient and simultaneously on more efficient clinical actions. It is estimated that x-ray images still have a long future ahead as one of rudimentary diagnostic methods in phthisiology, therefore it is so important to support diagnosticians by means of proper modifications of these images.

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Abstract

X-radiation (abbreviated as x-ray) examination is still the rudimentary diagnostic method for a range of afflictions. X-ray image is nothing else but a set of grayness points. The modification of this image by means of employing morphological transformations is aimed at individualizing tubercular changes. In a number of cases x-ray image is the diagnostic base used in contemporary phthisiology. The application of morphological transformation of the image targets to sharpen the pathological changes. With that, the establishment of diagnosis is said to be quicker and more accurate. There is no need to perform supplementary x-ray imaging which is beneficial for the patient as he is not exposed to another portions of health-detrimental radiation. Furthermore, the diagnostic difficulties which could cause the usage of supplementary methods such as x-ray computed tomography are undergoing the process of diminishment.

Key words: Matlab, x-ray, tuberculosis, morphological transformations

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