СЕКЦИЯ «СИСТЕМЫ МАШИННОГО И ГЛУБОКОГО ОБУЧЕНИЯ»

DETECTING VASCULAR ABNORMALITIES IN LUNGS BASED ON ROUTINE X-RAY SCREENING IMAGES AND DEEP LEARNING METHODS

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In this paper, we study the problem of detecting typical vascular abnormalities of lungs that visually manifest themselves as a prominent vascularity of the roots of lungs. The study is capitalizing on a large dataset consisting of chest X-ray images of 15,600 people acquired as a result of computer-supported telemedicine screening of the population of subjects aged 18 years and older. The image training set consisted of 13,400 chest images, including 6,700 cases of pathology and 6,700 cases of the norm. The test set was composed from 2,200 images including 1,100 images of each class. Detecting vascular abnormalities was done by way of X-ray image classification using recent methods based on Convolutional Neural Networks. As a result, it was found that the presence of pathological changes can be recognized with the accuracy around 94%.

Keywords: *deep learning, screening, chest x-ray, roots of lungs, neural networks.*

Introduction. It is known that pathology of the pulmonary vasculature involves a wide range of various disorders [1, 2]. Despite that some of them are benign, disruption of the pulmonary vasculature is often incompatible with life, making these conditions critical to identify with the help of corresponding imaging modalities. Examining the pulmonary vascular pathologies includes evaluation of the condition of pulmonary arteries, pulmonary veins and bronchial arteries. This particular work is dealing with the problem of computerized assessment of the pulmonary venous abnormalities [2]. More specifically, we concentrating on the detection of abnormalities of lung roots, which are known as relatively complicated structures that consist mainly of the major bronchi as well as the pulmonary arteries and veins. Visually, the pathological vascularity of lung roots manifested in prominent, and often extensively-ramified veins [1].

This study is based on the analysis of chest X-ray images and it is aimed at providing the computerized support of early detection of vascular abnormalities during the massive screening of the population.

Materials. All chest X-ray images used in this study were natively digital and were taken from a population screening data storage system. Along with the images, the image database contained information on the gender and age of the examined subjects along with the textual data describing visible pathological changes of the lungs, the cerebrovascular system, and the skeleton.

Initially, all the images were presented as single-channel 16-bit DICOM files. Original image sizes vary from 520x576 to 2800x2536 pixels. At the pre-processing stage all of them were suitably converted to 8-bit grayscale representation using adaptive, quantile-based intensity range conversion algorithm and downscaled to the 512x512 and 256x256 pixel resolution.

The study image sample consisted of chest images of 15,600 people aged 18 years and older. The image training set consisted of 13,400 chest images, including 6,700 cases of pathology and 6,700 cases on the norm. A separate test set was composed from 2,200 images including 1,100 images of each of two classes. Typical examples of images of each class are given in Fig. 1.

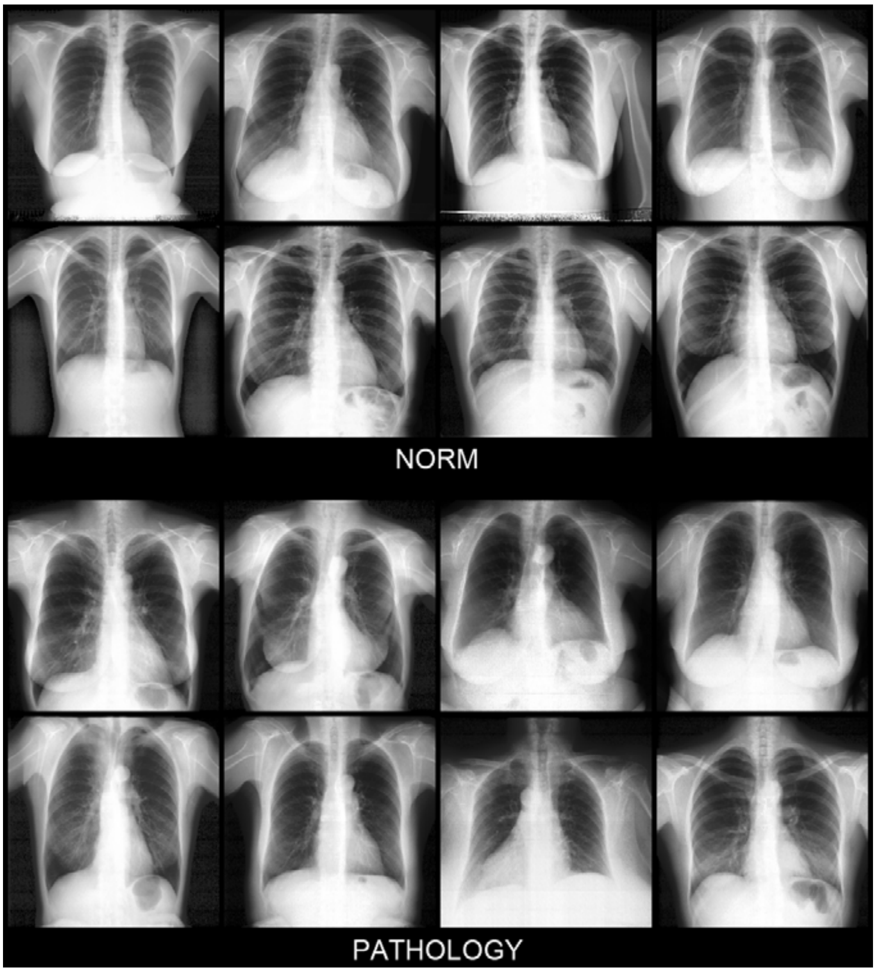

Fig. 1. Chest image examples in norm (top panel) and with presence of vascular abnormalities of lung roots (bottom panel).

Methods. Image classification was performed using conventional architectures of Convolutional Neural Networks (CNNs) such as Efficient Net B0 and B2 with 4,010,110 and 7,703,812 trainable parameters respectively, more recent architecture composed of variants of ResNet named BiT-M R50x1

(23,504,450 trainable parameters), and the MobileNet v3 with 1,532,018 parameters. Both 512x512 and 256x256 image sizes were tested separately in exactly the same way. In all the occasions, no regions of lung roots were segmented. This is because of commonly known ability of CNNs to detect key image regions automatically given that the image datasets being employed are sufficiently large.

Results. All four CNN architectures have provided pretty similar results with only marginal differences of classification accuracy of subjects with normal lung roots and roots with pathological changes detectable by radiologists (Fig. 2). The overall value of the classification accuracy varied around 0.94.

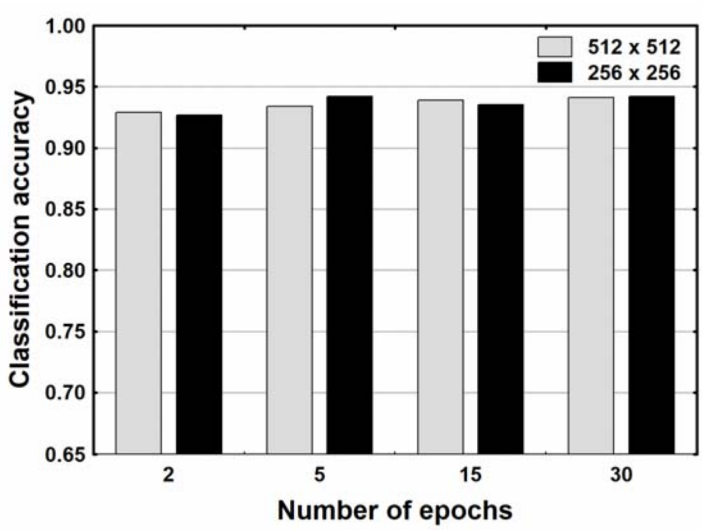

Fig. 2. The classification accuracy values depending the number of training epochs.

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