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TECHNICAL NOTE

Enhancement of radiographic images in patients with lung nodules

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Abstract

Detection of lung nodules in a chest Radiograph is very difficult due to sensitivity to noise, lighting, and similar disturbances of the blood vessels and trachea. Therefore, such images need to be carefully examined to identify and characterize lung lesions. However, human interpretations are usually contradictory and may cause confusion. Current works propose an image processing technique based on frequency domain processing to clarify X-ray radiographic images taken in patients with a variety of lung lesions. The Picture Archiving and Communication Systems workstation allows transferring radiographic data from DICOM into JPEG image formats. In the preprocessing phase, the lung nodules are identified by an experienced chest radiologist and used for extracting regions of interest. Subsequently, low-pass followed by emphasis high-pass frequency filters are applied to enhance the images with appropriate cut-off frequencies. It has been found that high-frequency domain image filtering enhances the morphological features of lung masses. Enhanced images are then visually arbitrated by an expert radiologist. We found that the characteristics of lung lesions are easily identified after this process.

Lung cancer remains the most common cancer-related cause of death worldwide. Death subsequent to lung cancer alone outnumbers deaths from breast, prostate and colon cancers combined. According to the American Cancer Society, the overall 5-year survival rate is less than 15%. However when lung cancer is found in the early stages, the 5-year survival rate increases to more than 50%. Currently, only 15% of lung cancer is detected in the early, most treatable stages.

Chest radiography is the most frequently performed radiological imaging study and also one of the most challenging.[1] Although, chest radiograph can detect early lung cancer, as a new study from the National Cancer Institute (NCI) has illustrated, the false positive rate is still high. Furthermore, chest radiograph used for detecting lung cancer is the second most common cause for malpractice cases among radiologists as a result of observer errors including recognition, decision making and lesion conspicuity.

In the era of digital diagnostic radiography, denoising and enhancement have an important potential role in obtaining as much easily interpretable diagnostic information as possible without increasing the radiation dose to the patient.[2] Furthermore, due to the increasing usage of high resolution and high precision images with a limited number of human experts, the computational efficiency of the denoising and enhancement becomes more important.

Because of the large difference in the densities of the lung and other structures, the chest radiograph image uses a wide-range intensity distribution, which creates difficulty for focussing.[3,4] In this paper we propose an algorithm for the enhancement of chest radiographic images of lung lesions in patients with malignant and benign lung lesions for better detection, decision making, particularly in determining the growth rate of the nodule, and characterization of the disease.

Image processing techniques based on frequency domain analysis via Fourier transformation is proposed to enhance chest radiographic images of lung lesions. Our work methodology is formulated so that the suggested enhancement method applies the filtering in the frequency domain including low-pass filtering, basic high-pass filtering and high-frequency emphasis filtering.[5]