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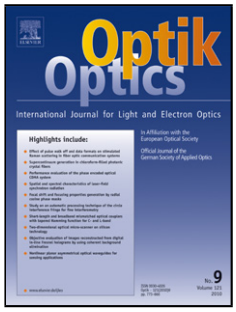

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Investigating single image super-resolution algorithm with deep learning using convolutional neural network for chest digital tomosynthesis

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ABSTRACT

Numerous efforts have been continuously made toward the realization of high spatial resolution images for medical imaging devices. Specifically, the image super-resolution technique with deep learning using convolutional neural network (CNN) has been making excellent advancements recently. Accordingly, this study is focused on developing a single image super-resolution (SISR) algorithm using deep CNN (DCNN) with supervised learning that can drastically improve the spatial resolution of chest digital tomosynthesis (CDT) images. In addition, we attempt to demonstrate the superiority of the SISR algorithm by a quantitative analysis. The proposed SISR algorithm uses a total of 5000 training CDT images (low-resolution and high-resolution) and a fully CNN based on residual structure. The image performance was analyzed using various parameters, such as intensity profile (full width at half maximum), contrast to noise ratio, coefficient of variation, and normalized noise power spectrum parameters, and the results demonstrated that the proposed SISR algorithm significantly improves the spatial resolution of the images. Further, the noise properties of the images obtained with the SISR algorithm were similar to those of the low-resolution images with up-sampling. Thus, we successfully developed the deep learning architectures in this study to improve the spatial resolution of the CDT reconstructed images.

Keywords: Single image super-resolution algorithm; Deep learning; Deep convolutional neural network; Chest digital tomosynthesis; Quantitative evaluation of image performance.

1. Introduction

X-rays, which were discovered by Wilhelm Röntgen in 1895, are widely used for the diagnosis and treatment of various diseases, in the field of medicine. The most basic diagnosis method using X-rays is general imaging, in which images are obtained in a single direction. X-rays have the advantage of low cost and being relatively simple to observe anatomical structures. However, they have limited capability in representing the overlapping