PH239-SD-TUB3

Comparative Evaluation of Super-Resolution Methods Using Sparse Coding and Deep Convolutional Neural Network for Improving Image Quality of Extended Images in Chest Radiography

Tuesday, Nov. 29 12:45PM - 1:15PM Room: PH Community, Learning Center Station #3

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PURPOSE

Radiologists detect small diagnostic signals such as lung nodule with zooming on a detail, however simple image magnification methods tend to generate over-smoothed images with jagged artifact. The purpose of this study was to improve the image quality of extended images in chest radiography using learning-based Super-Resolution (SR) techniques.

METHOD AND MATERIALS

One hundred fifty four radiographs (matrix size: 2048x2048, pixel size: 0.175 mm, and 12 bits) with nodules (average diameter±std: 17.24±7.50 mm, diameter range: 5-60 mm) from Japanese Society of Radiological Technology dataset were used for this study. We applied two SR methods, Sparse Coding Super-Resolution (ScSR) and Super-Resolution Convolutional Neural Network (SRCNN). ScSR constructs extended images by embedding optimal patches selected from a dictionary, coupled high and low resolution images represented as downscaled images of high resolution ones. SRCNN constructs using directly learned end-to-end mapping, represented as a deep convolutional neural network that takes the low resolution image as input and outputs as the high resolution one. In our study, we magnified cropped images focused on nodules (matrix size: 320x320) up to 2 times (x2.0) and 4 times (x4.0). We compared the image quality of SR schemes and the traditional enlarging schemes, Nearest Neighbor (NN) and Bilinear (BL) interpolations. Image noise was evaluated quantitatively by measuring peak signal-to-noise ratio (PSNR) and image perceived quality was also evaluated by computing structural similarity (SSIM).

RESULTS

In SR schemes (x2.0), the mean±std of PSNR for ScSR and SRCNN were 41.47 ± 2.34 dB and 41.82 ± 2.49 dB respectively, which were higher than those of NN (39.87 ± 2.24 dB, p<.001 and p<.001 respectively), and BL (40.39 ± 2.32, p<.001 and p<.001 respectively) and those of SSIM for ScSR and SRCNN were 0.944 ± 0.028 and 0.947 ± 0.029 respectively, which were higher than those of NN (0.924 ± 0.033, p<.001 and p<.001 respectively), and BL (0.928 ± 0.035, p<.001 and p<.001 respectively), followed the same trend for 4 times (x4.0).

CONCLUSION

SR methods significantly outperformed traditional interpolation methods in observing small lung structures in chest radiographs.

CLINICAL RELEVANCE/APPLICATION

SR methods can provide substantial high image quality of enlarged images on chest X-rays, leading to more accurate diagnosis of small lung diseases.