Transfer Generative Adversarial Network for Multimodal CT Image Super-Resolution
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Abstract:
We propose a multimodal transfer learning method Transfer-GAN based on generative adversarial network (GAN) to produce realistic multimodal CT images including none-contrast CT (NCCT), CT Perfusion (CTP), and CT Angiography (CTA) to achieve high diagnostic image quality. With the hypothesis that multimodal images from the same patient are highly correlated in structural features, transferring and integrating the shared and complementary information from different modalities can be beneficial for high-resolution multimodal CT image generation. To achieve this, we present a novel transfer learning technique with GAN structure and demonstrate that information from NCCT can be used to recover high-quality CTP images, and CTP images can be used for CTA images super-resolution. Our model is evaluated on 415 NCCT, 3,696 CTP, and 271 CTA slices, which are collected from nine patients from the same protocol with the scanning sequence of NCCT, CTP, and CTA. The performance regarding peak-signal-to-noise-ratio (PSNR) and structural similarity (SSIM) index are compared by training the network with and without transfer learning for different modalities. In the complete transfer learning pipeline, we first train our GAN model with NCCT images, then finetune on CTP images and following by CTA images. To evaluate the model performance, we perform one-tailed paired t-tests with $\alpha = 0.05$ to compare the improvements among different models. The experiment result indicates our approach can improve CTP image quality by learning from NCCT images and can improve CTA image quality by learning from CTP images, thus, provides a practical solution for multimodal CT image quality enhancement.

Keywords:
Multimodal CT Imaging, Image Super Resolution, Deep Learning, Generative Adversarial Network, Acute Stroke Imaging

Summary:
Multimodal computed tomography (CT) scans, including none-contrast CT (NCCT), CT Perfusion (CTP), and CT Angiography (CTA) are widely used in acute stroke diagnosis and treatment planning. While each imaging modality is for different visualization purposes such as anatomical structures and functional information, image quality is obtained variously. In this work, we aim at enhancing the image quality for all modalities by using deep learning technology. Through our experiments, we demonstrate that by using transfer learning and generative adversarial network, NCCT images are beneficial for CTP image reconstruction, and CTP images are helpful for CTA image quality enhancement.