PETGAN: Enhancing Low-Dose PET Imaging Using GAN-Based Denoising for Improved Oncology Diagnostics

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Abstract:

Positron Emission Tomography (PET) is an essential imaging tool in oncology used to map metabolic activity in tissues. But normal dose PET scans result in high-radiation exposure to patients, particularly relevant for paediatric, geriatric and frequent-follower patients. Low-dose PET scanning is one of the ways to lower radiation dose and has been one of the most popular methods in PET reduction; however, it generates a lot of noise which results in degrading the quality of diagnosis. In this paper, a novel GAN-based framework PETGAN has been proposed to improve low-dose PET scans by generating high-quality, denoised images with keeping significant diagnostic details. The model is trained on the ACRIN-FDG-PET dataset where paired low-dose and full-dose PET scans are available, enabling the generator to learn an accurate mapping from noisy to clean imaging. PETGAN contains a generator based on the U-Net and a Patch GAN discriminator which are trained to balance adversarial, perceptual, and reconstruction losses maintaining clinical authenticity. The experimental results show that the enhanced images have higher image clarity, with an SSIM of 0.89 and a PSNR of 32.8 dB, and can be utilized for accurate tumor detection and staging. PETGAN provides a potential AI-based strategy for radiation-free and cost-effective oncologic imaging.

Keywords:

PETGAN, Medical Image Denoising, Generative Adversarial Networks (GAN), U-Net, PatchGAN, Oncology Imaging.