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Deep Learning Image Denoising for a cost-effective WT-PET design with sparse detector coverage

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This work presents a method for denoising images of a sparse detector design of the Walk-Through PET (WT-PET). This is a cost-effective long axial field-of-view (AFOV) PET scanner with patients being scanned while standing between two vertical flat panels of monolithic detectors. This configuration of the WT-PET promises to achieve higher patient throughput and lower system cost than other cylindrical long AFOV PET scanners, given the reduction in detector volume/surface. To further reduce the WT-PET system cost, axial gaps are introduced uniformly along the AFOV with a 70% detector coverage (sparse WT-PET). To address the higher image noise coming from the design's sparsity and reduced scan time (less than 1 minute), we implement a deep learning (DL) solution for image denoising. The fully populated system (full WT-PET) is simulated in GATE, and images of XCAT anthropomorphic phantoms were reconstructed with MLEM in full WT-PET and 70% sparse WT-PET modes. To train the 2D neural network, input-target pair used 20s sparse WT-PET and 40s full WT-PET reconstructed images, respectively. The DL model was tested on two XCAT and the NEMA IQ phantoms. Contrast recovery coefficient, contrast-to-noise ratio and background variability were calculated for quantification. The results suggest that when combined with DL-based denoising, the sparse WT-PET design based on 70% detector coverage with scans of less than 30s gives good images where noise is reduced, and image quality preserved.

Field

Systems and applications

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