PET Image Deblurring using Adaptive Dictionary Learning

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**Objective:** The aim of this work is to deblur PET images while suppressing Poisson noise effects using adaptive dictionary learning (DL) techniques.

**Methods:** The model that relates a blurred and noisy PET image to the desired image is described as a linear transform $y=Hm+n$ where $m$ is the desired image, $H$ is a blur kernel, $n$ is Poisson noise and $y$ is the blurred image. The approach we follow to recover $m$ involves the sparse representation of $y$ over a learned dictionary, since the image has lots of repeated patterns, edges, textures and smooth regions. The recovery is based on an optimization of a cost function having four major terms: adaptive dictionary learning term, sparsity term, regularization term, and MLEM estimation term of the Poisson noise. The optimization is solved by a variable splitting method that introduces additional variables. We simulated a 128×128 Hoffman brain PET image (baseline) with varying kernel types and sizes (Gaussian 9×9, $\sigma=5.4$mm; Uniform 5×5, $\sigma=2.9$mm) with additive Poisson noise (Blurred). Image recovery was performed once when the kernel type was included in the model optimization and once with the model blinded to the kernel type. The recovered image was compared to the baseline as well as another recovery algorithm PIDSPLIT+ (Setzer et. al.) by calculating PSNR (Peak SNR) and normalized average differences in pixel intensities (NADPI) of line profiles across the images.

**Results:** For known kernel types, the PSNR of the Gaussian (uniform) was 28.73 (25.1) and 25.18 (23.4) for DL and PIDSPLIT+ respectively. For blinded deblurring the PSNRs were 25.32 and 22.86 for DL and PIDSPLIT+ respectively. NADPI between baseline and DL, and baseline and blurred for the Gaussian kernel was 2.5 and 10.8 respectively.

**Conclusion:** PET image deblurring using dictionary learning seems to be a good approach to restore image resolution in presence of Poisson noise.