PhD Thesis title: 'Non-uniform Resolution and Partial Volume Recovery in Tomographic Image Reconstruction Methods**'**

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ABSTRACT:

Acquired data in tomographic imaging systems are subject to physical or detector based image degrading effects. These effects need to be considered and modeled in order to optimize resolution recovery. However, accurate modeling of the physics of data and acquisition processes still lead to an ill-posed reconstruction problem because of incomplete and noisy real data. Reconstructed images are always a compromise between resolution and noise;therefore, noise processes also need to be fully considered for optimum bias variance trade off. Image degrading effects and noise are generally modeled in the reconstruction methods and statistical iterative methods can better model these effectsas compared to the analytical methodsalong with noise processes. Regularization is used to better condition the problem whereas explicit regularization methods are considered better to model various noise processes withan extended control over the reconstructed image quality.Emission physics,through object distribution properties,are modeled in the form of a prior function. Smoothing and edge-preserving priors are commonly used and it has been shown that smoothing priors over-smooth images in high count areas and result in spatially non-uniform and nonlinear resolution response. Uniform resolution response is desirable for image comparison and other image processing tasks, such as segmentation and registration. This work proposes methods, based on median root priors (MRPs) in maximum-a-posterior MAP estimators, to obtain images with almost uniform and linear resolution characteristics, using nonlinearity of MRPs as a correction tool. Results indicate that MRPs perform better in terms of response linearity, spatial uniformity and parameter sensitivity, as compared to quadratic priors (QPs) and total variation TV priors. Hybrid priors, comprised of MRPs and QPs, have been developed and analyzed for their activity recovery performance in two popular partial volume correction PVC methods with an analysis of list-mode data reconstructions showing that MPRs perform better than QPs in different situations.

References to author publications that relate specifically to the dissertation:

1) Ahmad M. and Todd-Pokropek A., "Evaluation of Resolution Properties of Median Priors in List-Mode Reconstruction Methods for PET", *IEEE Nuclear Science Symposium Conference Record*, 2009.
2) Ahmad A. and Todd-Pokropek A., "Comparison of Noise Performance for Penalized-Likelihood Image Reconstruction Methods with Uniform Resolution Estimators", *IEEE Nuclear Science Symposium Conference Record*, Oct. 19-25, 2008.
3) Ahmad M. and Todd-Pokropek A., "Median based Priors for Non-Uniform Resolution Compensation in Tomographic Image Reconstruction", *Modeling and Simulation (MS 2008)*, 26-28 May, Canada 2008.
4) Ahmad M. and Todd-Pokropek A., "Non-uniform resolution compensation in tomographic image reconstruction methods using median based priors", *IEEE Nuclear Science Symposium Conference Record*, Vol. 6, Issue, Oct. 26-Nov. 3, Page(s):4447 – 4451, 2007.
5) Ahmad M. and Todd-Pokropek A., "Non-uniform Resolution Recovery Using Median Priors in Tomographic Image Reconstruction Methods", *Lecture Notes in Computer Science (LNCS)*, Volume 4673/2007, Pages 270-277, August 2007.
6) Ahmad M. and Todd-Pokropek A., "Partial Volume Correction using Median Priors in Penalized-Likelihood Image Reconstruction Methods", *IEEE Nuclear Science Symposium Conference Record,* Vol. 4, Issue Oct. 29 -Nov. 1, Page(s):2099 – 2102, 2006.
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8) Ahmad M. and Todd Pokropek A., "Impulse response investigations of median and quadratic priors in penalized-likelihood image reconstruction methods", presented at (2006) 11th Symposium on Radiation Measurements and Applications (SORMA), University of Michigan, Ann Arbor, USA, 23-28 May 2006.