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Comparison of Lesion Detection and Quantification in MAP Reconstruction with Gaussian and Non-Gaussian Priors

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Abstract

Statistical image reconstruction methods based on maximum a posteriori (MAP) principle have been developed for emission tomography. The prior distribution of the unknown image plays an important role in MAP reconstruction. The most commonly used prior are Gaussian priors, whose logarithm has a quadratic form. Gaussian priors are relatively easy to analyze. It has been shown that the effect of a Gaussian prior can be approximated by linear filtering a maximum likelihood (ML) reconstruction. As a result, sharp edges in reconstructed images are not preserved. To preserve sharp transitions, non-Gaussian priors have been proposed. However, their effect on clinical tasks is less obvious. In this paper, we compare MAP reconstruction with Gaussian and non-Gaussian priors for lesion detection and region of interest quantification using computer simulation. We evaluate three representative priors: Gaussian prior, Huber prior, and Geman-McClure prior. We simulate imaging a prostate tumor using positron emission tomography (PET). The detectability of a known tumor in either a fixed background or a random background is measured using a channelized Hotelling observer. The bias-variance tradeoff curves are calculated for quantification of the total tumor activity. The results show that for the detection and quantification tasks, the Gaussian prior is as effective as non-Gaussian priors.