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Medical Imaging Module of Choice: PET Scans

Positron Emission Tomography – PET for short – is evolving into a quantitative discipline where a large number of metrics are computed in the intensity and gray-level matrix domains; this discipline has been termed as radiomics. Radiomics of PET images have shown promise as a diagnostic, prognostic, and predictive tool in the treatment of cancer. It is also being used with other medical fields and implemented into their decision support systems.

Most Common Types of Noise Found in Images:

PET features are very sensitive and very easily altered by external noise factors. The most prominent artifacts include random variations in photon counting caused by the statistical nature of X-rays, and electronic noise. The former is related to the number of photons detected (correlated with signal and image texture), commonly referred to as quantum noise, and the latter is inherent to the detector and independent of the number of photons detected, commonly referred to as dark noise, caused by the electronic components that make up the detector.

A variety of modality-specific factors may contribute to image noise, where they contain varying levels of image noise due to the different mechanisms of detection and image reconstruction. PET image noise is caused by the random nature of radioactive decay.

PET images are usually affected by partial volume effects, tumor motion, source to background ratio, patient weight, and signal loss. Noise may be amplified by other factors such as detectors, electronics and recorder systems, reconstruction algorithms, convolution kernels, modes of attenuation correction, and radioactive decay correction. Electronic noise is considered spatial frequency independent, and typically considered as uncorrelated noise.

Filters Used to Resolve Noise:

Image noise is an unavoidable component of medical imaging. Smoothing filters can be used to reduce noise, but they cannot eliminate noise completely, and may also reduce the signal of interest as well.

Reconstruction algorithms can be applied to the image in the frequency and spatial domains, aiming to eliminate the foretold noise artifacts. Gaussian and Hanning filters of different sizes are used to produce almost identical results.

Other methods, which are commonly used in tumor-noise segmentation, include threshold based, gradient based, and fuzzy Bayesian based methods. Simple thresholding methods may lead to imperfect delineation of the tumor, however the inaccurate delineation will not change the behavior of the image metrics since the error will have the same effect at the different count levels.

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