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Refining Position Estimates of PET Detector Blocks with Stochastic Gradient Descent

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Mechanical misalignments of PET detectors, resulting from manufacturing imprecisions, significantly compromise image quality. Precise position estimation becomes crucial amidst the complexities of evolving whole-body imaging systems and the introduction of new scanner technologies. Traditional methods utilize single point source measurements. We propose an alignment strategy that works for arbitrary tracer distributions. Our method optimizes transaxial alignment parameters to match a differentiable approximation of the sinogram with the analytical solution for tracer line integral distributions, given by the Radon transformation. We utilize the Adam optimizer and use an adaptive normalization strategy and convex hull regularization to counteract effects of missing data due to gaps between detector elements. Our study utilized GATE simulations of a small animal PET scanner with intentionally introduced detector misalignments. We assessed our method's efficacy by comparing found detector configurations against the ground truth. Results indicate the method's potential in estimating detector alignment with $\sim 300\mu m$ precision, albeit with limitations towards y-axis rotations due to their minimal impact on the sinogram. In conclusion, our approach presents a viable solution for PET detector alignment, offering a foundation for future enhancements, including z-axis alignment and additional corrections for effects like attenuation, scatter or randoms.

Field

Systems and applications

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