Title: Compensation of Missing Data in Xtrim Preclinical PET Sinograms via Gantry Wobbling

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Background: The Xtrim preclinical PET scanner was designed for small animal PET imaging. The system consists of ten detector blocks that are separated by 4mm gaps, resulting in gaps in the sinogram. Furthermore, detector-block failures may occur, causing gaps in the acquired projection data. Filling such data gaps can mitigate artifacts and other degradations in the reconstructed images.

Objective: The purpose of our study is to compensate the sinograms for missing data by utilizing partial rotation of the gantry during data acquisition.

Methods: We implemented continuous wobble motion during data collection by partial rotation of the gantry around the center of the field of view (CFOV) in the transaxial plane. To simulate partial rotation of the gantry to compensate for missing data in sinograms, we used the Gate Monte Carlo code. The rotation angle changed from 0 to 360° for optimizing wobble angle motion. For performance evaluation of the proposed correction method, we collected data for from IQ phantom NEMA-NU4 and preclinical PET HotRod phantom QRM during gantry wobbling. In addition, we compared images obtained using our method to those reconstructed from data without gap-filling. Data acquisition and image reconstruction were implemented using in-house developed software using MATLAB.

Results: The simulation results showed that gap-compensation by partial rotation of the gantry could control gap artifacts, as well as Poisson random noise. When the wobble motion was implemented during data collection by partial rotation, the quantitative results showed that the proposed method producing %MSE values lower than 5%. Images from data gap-filled using the proposed method were artifacts free, and image quality was slightly improved.

Conclusion: We observed that gantry wobbling improved the reconstructed images, both quantitatively and visually. The proposed technique can be used to compensate for missing data in the projection-space, and with detector failure artifacts in high-resolution preclinical PET scanners. Overall, the proposed gap-filling method utilizing partial rotation of gantry during data acquisition is an effective method of repairing missed data in preclinical PET sinograms.

Keywords: Positron emission tomography, Gap-filling, Missing Projection, MicroPET