QUANTUM APPROACH TO THE IMAGE RECONSTRUCTION PROBLEM

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The abstract presented here briefly introduces a quantum approach to the image-from-projections problem. The concept is schematically illustrated in Figure 1 as a diagram of the reconstruction procedure. This paradigm can be applied to Computed Tomography (CT), Positron Emission Tomography (PET), and Time-of-Flight (TOF) PET imaging techniques. The proposed approach is based on a continuous-to-continuous data model, in which each quantum of information (an X-ray quantum or a pair of gamma quanta) is modeled separately. Additionally, the reconstruction problem is formulated as a shift-invariant system.

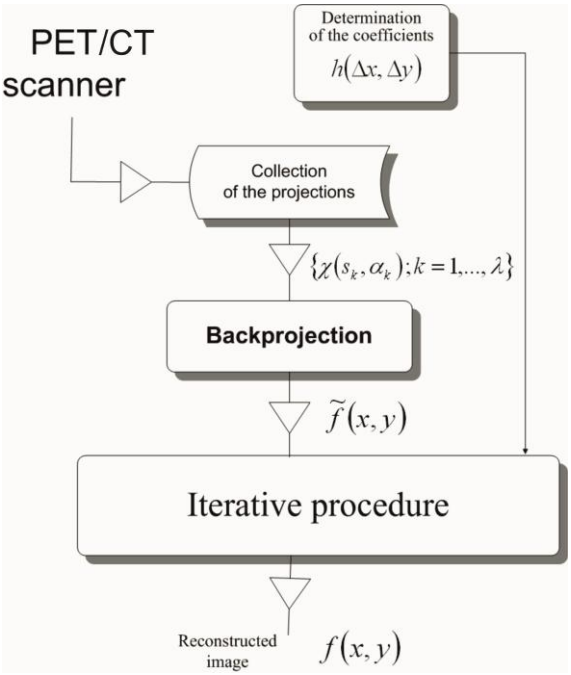

Fig. 1. The continuous measurement system

This problem is addressed while considering the statistical principles of CT and PET scanners during the measurement process. It has been shown that a statistical reconstruction method for both CT and PET can be based on a generally unique continuous-to-continuous (C–C) data model. As a result, in the case of CT and PET, partitioning the reconstructed image into blocks can be avoided. The proposed approach significantly reduces computational complexity, primarily due to the use of an FFT algorithm. Computer simulations have demonstrated that the formulated reconstruction algorithms operate successfully, enabling the generation of images with very high resolution.

References

[1] Cierniak, R., A new MLEM reconstruction algorithm for ultra-low dose PET. In: Nguyen, NT., *et al.* Advances in Computational Collective Intelligence. ICCCI 2024, Leipzig, 9-11.09.2024. Communications in Computer and Information Science, 2024, 2166, 406-418. Springer, Cham. https://doi.org/10.1007/978-3-031-70259-4_31.

[2] P. Pluta, R. Cierniak, M. Waligóra, A new statistical reconstruction method with rebinning as a technique for reducing the dose in CT scanners utilizing a flying focal spot, Computer Methods and Programs in Biomedicine, 2025, 270, 108903. https://doi.org/10.1016/j.cmpb.2025.108903.