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PET Image Reconstruction by Density Estimation

PET (positron emission tomography) scans are still in the experimental phase, as one of the newest breast cancer diagnostic techniques. It is becoming the new standard in neurology, oncology and cardiology. PET, like other nuclear medicine diagnostic and treatment technique involves the use of radiation. Because of negative impact of radioactivity to our body the radiation doses in PET should be small.

The existing computing algorithms for PET can be divided into two broad categories: analytical and iterative methods. In the analytical approach the relation between the picture and its projections is expressed by a set of integral equations which are then solved analytically. Iterative methods can be further divided into deterministic and stochastic approaches. The ART (Algebraic Reconstructed Technique) algorithm, developed and first used by Gordon, et al., in the reconstruction of biological material in early 1970s, is an example of deterministic technique. The stochastic approach, like EM (expectation maximization) algorithm, bases on the assumption that radioactive emissions follow Poisson statistics. The algorithm combines unique and properties of the Poisson process and the maximum likelihood method of estimation.

The proposed kernel density estimation algorithm falls also into the category of iterative methods. In this approach each coincidence event is considered individually. The estimate location of the annihilation event that caused each coincidence event bases on the previously assigned location of events processed earlier. To accomplish this, we construct a probability distribution along each coincidence line. This is generated from previous annihilation points by density estimation. It has been observed that density estimation approach to PET can reconstruct an image of the existing tumor using significantly lower data than the standard CT algorithms, like Fourier back-projection. Therefore, it might be a very promising technique allowing to reduce the radiation dose for patients.