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Study and Optimization of Positioning Algorithms for Monolithic PET Detector Blocks

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We are developing a PET insert for existing MRI equipment to be used in clinical PET/MR studies of the human brain. The proposed scanner is based on annihilation gamma detection with monolithic blocks of cerium-doped lutetium yttrium orthosilicate (LYSO:Ce) coupled to magnetically-compatible APD matrices. The light distribution generated on the LYSO:Ce block provides the impinging position of the 511 keV photons by means of a positioning algorithm. Several positioning methods, from the simplest Anger Logic to more sophisticate supervised learning Neural Networks (NN), can be implemented to extract the incidence position of gammas directly from the APD signals. Finally, an optimal method based on a two step Feed Forward Neural Network has been selected. It allows us to reach a resolution at detector level of 2 mm, and acquire images of point sources using a first BrainPET prototype consisting of two monolithic blocks working in coincidence [1].
In order to obtain an efficient positioning method for the complete scanner, an optimization process has been carried out. Neural networks provide a straightforward positioning of the acquired data once they have been trained. Therefore the critical work was finding a training procedure that reduces the data acquisition and processing time without introducing a noticeable degradation of the spatial resolution.
A grouping process and posterior selection of the training data has been done regarding to similitude of the light distribution of the events which have one common incident coordinate (transversal or longitudinal). This way the amount of training data can be reduced to about 5% of the initial number with a degradation of spatial resolution of less than 10%.

[1] I. Sarasola et al. "Coincidence Imaging with Monolithic Detector Blocks for a Human Brain PET Scanner," 2009 IEEE Nuclear Science Symp. Conf. Rec., 2009, pp. 2669-2673.

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Poster

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