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#9-170 Unveiling the easyPET/CT

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Multimodal imaging systems, such as micro-PET/CT scanners, are essential tools in preclinical research, enabling the acquisition of both anatomical and physiological information in a single imaging session. In these systems, CT-based attenuation maps can be applied to PET data as a correction factor, enhancing the molecular image quality and enable precise PET quantification.

The easyPET.3D is a compact benchtop micro-PET system, based on a patented technology by Aveiro University in Portugal. This scanner features two opposing detector arrays (16x2) designed to detect coincidence events. Its innovative scanning technique leverages two axes of rotation: one rotates the detectors 360º (axial rotation), while the other performs a fan motion for each position of the 360º, defining the full field-of-view.

This work explores a novel approach to integrating CT functionality into the easyPET.3D, without adding complexity and volume to the system, using the existing PET detectors to detect low energy (< 60 keV) photons, typically used for CT. An Americium-241 (241Am) radioactive source is used as the radiation source. It is positioned above and centered with one of the detector arrays (not used in CT acquisition mode), while the other array measures the incoming radiation from 241Am source.

Experimental tests were conducted on the scintillation detectors in the easyPET/CT system, which use a combination of LYSO:Ce (Lutetium Yttrium Orthosilicate Cerium doped) crystals and Hamamatsu SiPM (S13360-1350PE) sensors. The results showed that the detectors could detect the 241Am emissions, confirming that the system has a high dynamic range. These detectors successfully measured both the 241Am energy peaks (26.3 keV and 59.5 keV) and the peak from Sodium-22 (511 keV) with a single gain setting. The detection of the two emission energies of 241Am open the opportunity of dual-energy imaging, which could ease material differentiation in phantoms or, ultimately, tissue contrast in live animal studies.

The proposed CT system was simulated in GATE v9.0. A cylindrical phantom (3.2 cm of diameter and 4 cm of height) filled with air and containing copper wires of different diameters (1 mm, 0.5 mm, 0.25 mm, 0.125 mm, and 0.0625 mm) was used. Simulation results indicate that the proposed CT system can resolve objects as small as 0.125 mm, which aligns well with the intended goal of imaging small animals.

The simulation results were further validated by replicating the phantom in the experimental setup. The sinograms obtained experimentally showed detectable data for objects of 1 mm, 0.5 mm and 0.2 mm; however, using the inverse radon transform, only the 1 mm and 0.5 mm objects were visible in the reconstructed image. This could be probably overcome using another reconstruction methods, like iterative ones, or increasing the statistics of acquisition. On the other hand, achieving submillimeter resolution, with detection down to 0.2 mm, suggests that the easyPET/CT system holds significant potential for preclinical applications without additional dedicated CT detectors.

Given the unique detector configuration, the next step includes developing a custom iterative image reconstruction solution to optimize image quality. Following this, we will evaluate system performance and characterization to further refine the CT capabilities of this multimodal system.

Primary author: OLIVEIRA, Regina (University of Aveiro)

Co-authors: Dr SILVA, Ana Luísa (University of Aveiro); Dr VELOSO, João (University of Aveiro); Dr CORREIA, Pedro (University of Aveiro); Dr ENCARNAÇÃO, Pedro (University of Aveiro)

Presenter: OLIVEIRA, Regina (University of Aveiro)

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