A Compact CT/SPECT Dual-Modality System

Several imaging systems based on CZT arrays have been constructed at CGRI. The simplest, called the *spot imager*, uses a parallel-bore collimator with 260 µm × 260 µm square bores on a 380-µm pitch, matching that of the CZT pixel array. The *spot imager* serves as a handheld device for small-area preclinical imaging, but it has also been built into a dual-modality CT/SPECT mouse imager as shown in Figure 1a [Kastis, 2004]. The mouse is rotated around a vertical axis to acquire projection data for both modalities, and the SPECT component delivers sub-millimeter spatial resolution [Kastis, 2002]. This makes it possible to visualize detailed functional features, such as the renal calices in mouse kidneys shown in Figure 1c, that have not been previously accessible via gamma-ray imaging techniques. However, because the system has only a single camera, the sensitivity of this CT/SPECT mouse imager is lower than in the FastSPECT systems, and tomographic acquisitions require typically 30 minutes.

The X-ray camera is a CCD/phosphor screen detector manufactured by Dalsa-MedOptics (AC series). It consists of a Kodak KAF-1001E series 1024 × 1024 pixel CCD array with an active area of 24.5 mm × 24.5 mm. The CCD is coupled via a 2:1 fiberoptic taper to a gadolinium oxysulfide phosphor screen which increases the active area to 50 mm × 50 mm. The X-ray tube is an Oxford Instruments model XTF5000/75 with a 0.005-inch Be window. It has a stationary tungsten anode and a 130-µm spot size. The X-ray and gamma-ray cameras are mounted orthogonally to each other, as shown in Fig. 1. The X-ray projections are collected with a cone-beam geometry in a step-and-shoot fashion, and final tomographic images are reconstructed with an iterative algorithm.

The full potential of functional imaging can be realized only when areas of tracer uptake can be unambiguously assigned to organs or other anatomical features. Because well-chosen radiotracers may have excellent uptake in the target (for example, a tumor), but rapidly clear from surrounding tissues, SPECT images sometimes contain few recognizable anatomical features. The addition of independently measured, but co-registered anatomical information, overcomes this limitation. The CT/SPECT system described above provides high-quality images from both modalities and will be a useful instrument for supporting biomedical research in a variety of fields.

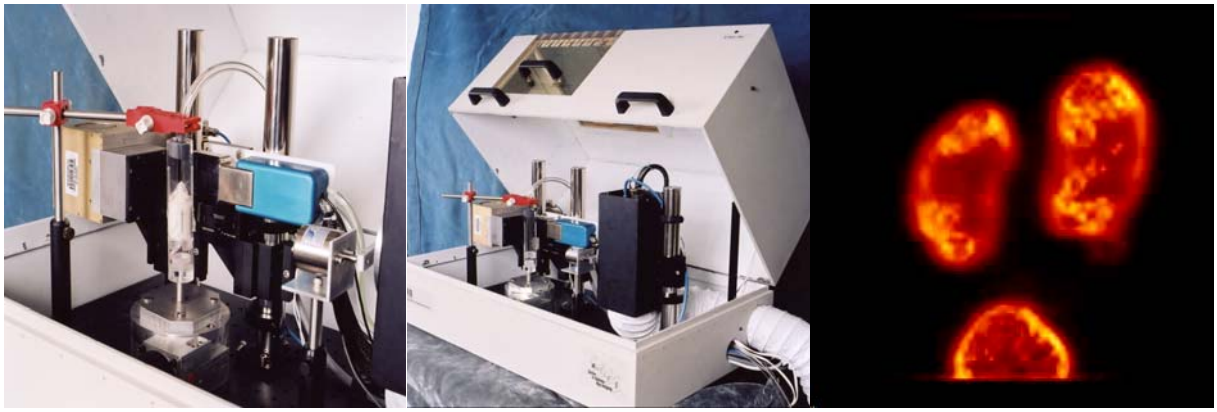

Figure 1. (a) The CT/SPECT dual-modality system showing CZT SPECT detector and X-ray CCD detector, (b) an overall view of the tabletop enclosure, and (c) ^{99m}Tc-glucarate images of mouse kidneys and bladder.

G.A. Kastis, L.R. Furenlid, D.W. Wilson, T.E. Peterson, H.B. Barber, and H.H. Barrett, Compact CT/SPECT small-animal imaging system, *IEEE Trans. Nucl. Sci.*, 51(1), 63-67, 2004.

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