Development of a ring scanning gamma CT system and image reconstruction with insufficient projection data

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Gamma CT imaging can be applied to large imaging targets such as distillation columns, which were previously investigated only by gamma radiation density profiling. Multiple detectors surrounding the outer circumference of a vessel still pose challenges as the CT imaging system is complicated and bulky. So we propose a circular scanning system combining a single pair of gamma-ray source and detector to minimize the size of the measurement system. Although the proposed system takes fewer projections per scanning period compared to a multiple detector system, it may find applications where the system size is critical and measurement targets remain sufficiently stable during scanning. Unlike computed tomography using an X-ray tube, a low photon-flux occurs in that using gamma rays. At 50 cm from the source, a typical tube current of 200 mA in an X-ray CT system would produce an equivalent activity reaching 4.14 x 10^15 Bq, revealing an unrealistic counterpart of a radioactive source. To correctly process sparsely sampled and highly noisy data retrieved from the system, we used total-variation minimization for image reconstruction and compared its performance to that of other methods on images in 64 x 64 matrices with 180, 90, and 45 projections. The insufficient projection data retrieve higher quality images for iterative reconstruction, expectation maximization, and projection onto convex sets with total variation than for the conventional filtered back-projection.