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Linear approximation of single-shot dual-energy computed tomography with a multilayer detector

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Stacking two imaging detectors in tandem configures a multilayer detector, and the front detector measures relatively low-energy photons whereas the rear detector measures relatively high-energy photons survived from their transports through the front detector layer. This energy separation in the multilayer detector facilitates dual-energy (DE) imaging. Different phosphor thicknesses between the two detector layers provides a unique characteristic, known as unsharp masking-like effect, in the resultant DE images as shown in Fig. 1. This characteristic results from the weighted combination of different modulation-transfer functions (MTFs) of the corresponding two detector layers [1].
We are developing a single-shot DE computed tomography (CT) technique [2]. For a better design of the multilayer detector and its application to DE-CT, it is important to understand the effect of the subtraction DE algorithm on the resultant DE images. In this study, we develop a simple signal-formation model in DE-CT incorporating filtered backprojection and weight-log subtraction for image and DE reconstructions, respectively. We validate the developed model in comparisons with the measured MTF results obtained for operation parameters such as subtraction weights and reconstruction filters. This study will be helpful to understand the principle and physics underlying the single-shot DE-CT based on the multilayer detector, and from which we may elaborate the system design and find appropriate applications.

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