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Feasibility of scintillators and imaging assessment of a flat-panel X-ray detector with dual-layer structure

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In recent years, digital flat-panel detectors with indirect X-ray imaging technology have been widely used in many medical imaging such as radiography, fluoroscopy and cone-beam CT as well as non-destructive testing (NDT) applications. These indirect X-ray imaging technology is based on the integration of a thin film transistor (TFT) array with large area scintillating screens such as typical CsI, GOS materials. Currently, dual-energy (DE) imaging based diagnostic task using a dual-layer a-Si flat panel detector structure provides the material separation (e.g. soft and bone tissues) in anatomy so that it can be seen well.

In this work, the dual-layer based a-Si array backplanes with top layer as low energy imager and bottom layer as high energy imager were configured for dual X-ray energy imaging tasks. A prototype dual energy detector consists of a TFT array with a 43cm x 43cm active area with 3,072x3,072 pixel array and 140um pixel pitch. Different scintillation components such as columnar CsI:Tl and granular Gd2O2S:Tb(GOS) screens with various thickness and middle spectral filters were used and proposed the optimal X-ray imaging characterization. The specific scintillators in dual-layer configuration structure were selected and investigated for image quality assessment at various X-ray exposure protocols.

To analyze X-ray imaging characterization in the proposed dual-layer X-ray flat panel detector, different scintillating screens were directly integrated on the prototype a-Si array backplanes. The different X-ray parameter indexes such as the detector sensitivity to X-ray exposure dose, signal-to-noise-ratio (SNR) and modulation transfer function (MTF) and chest phantom imaging were measured and evaluated under practical imaging systems with 60-120kVp tube voltage and adjustable tube current. The feasible test results with a dual-layer flat panel detector using different configuration of top and bottom layer scintillators and separation filter showed the initial possibility to perform dual-energy material decomposition with single X-ray exposure.

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