PhD Thesis title: 'Evaluation of digital x-ray detectors for medical imaging applications'

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ABSTRACT:

Digital x-ray detectors are now the detector of choice in many X-ray examinations. They have been accepted into clinical practice over the past decade but there are still ongoing developments in their technology. Complementary metal oxide semiconductor (CMOS) active pixel sensors (APS) are a novel digital technology that offers advantages compared to some of the more established approaches (charge-coupled devices (CCD), thin film transistor arrays (TFT) and CMOS passive pixel sensors (PPS)). This thesis looks at the performance of these new sensors and attempts to identify their role in future medical imaging applications. Standard electro-optical and x-ray performance evaluations of two novel CMOS APS, namely the large Area Sensor (LAS) and Dexela CMOS x-ray detector, are presented. The evaluation was made in terms of the photon transfer curve (PTC), the modulation transfer function (MTF), the normalized noise power spectrum (NNPS) and the resultant detective quantum efficiency (DQE). Modifications were introduced to extend the standard methods to overcome technical limitations. The performance of these detectors was compared to three commercial systems (Remote RadEye HR (CMOS APS), Hamamatsu C9732DK (CMOS PPS) and Anrad SMAM (a-Se TFT)) at beam qualities (28 kV for mammography and 52 kV and 74 kV for general radiography) based on the IEC standards. Both the LAS and Dexela CMOS detectors demonstrate enhanced performance. The effect of the CMOS APS inherent nonlinearity on the x-ray performance was also evaluated. Finally, the measured performance parameters were used to simulate images for different mammographic imaging tasks in order to establish possible areas of application for the new sensors. Two software phantoms (one representing a 3-D breast and the other the CDMAM test tool) were used to simulate a range of mammographic conditions. The results show that both novel CMOS APS detectors offer high image quality compared to the commercial detector systems.

References to author publications that relate specifically to the dissertation:

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