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CHARACTERIZATION OF DIGITAL DETECTORS USED IN X-RAY IMAGING

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Introduction: Recent measurements introduced in quality control protocols indicate large variations in the evaluated parameters, pointing out as main cause the different detectors used. The objective of this work was to characterize, in terms of pre-sampling modulation transfer function (MTF), normalized noise power spectrum (NNPS) and detective quantum efficiency (DQE), two digital detectors, determining their basic physical parameters of resolution and noise at different dose levels.

Material and method: Two computed radiography (CR) detectors, Carestream EHR-M3 and Carestream GP-2 (used in mammography and general radiography, respectively), were characterized in terms of Signal Transfer Property (STP), MTF, NNPS and DQE, in the range of 1 to 1100 µGy. The dosimeters were RTI Piranha and PTW Unidos E with PTW Freiburg ionization chamber, respectively. STP measures the relationship between the input (air Kerma) and the output (pixel value) detector signals. The MTF describes the variation of contrast with spatial frequency and was determined using a stainless steel MTF edge of thickness 1.0 mm. The NNPS describes the variance of pixel values divided among its frequency components and was calculated from uniformly exposed images. The DQE is a metric for performance evaluation and was calculated from MTF and NNPS. The basic performance of the detectors was determined in terms of these parameters using quality control protocols (EUREF e IEC).

Results: CR systems showed a logarithmic response in the tested dose range ($R^2 > 0.99$). The presampling MTF of the detector EHR-M3 was found to be 0.59, 0.23 and 0.15 at 2, 4 and 5 mm^{-1}, respectively. For the detector GP-2, presampling MTF values for the same frequencies were 0.26, 0.08 and 0.06, respectively. Superior performance of EHR-M3 detector in terms of MTF was expected. NNPS increased as dose decreased for both detectors. Figure 1 shows MTF and NNPS at different dose levels for EHR-M3 detector using 28 kV_P. DQE increased with decreasing dose for both detectors. Figure 2 shows DQE at different dose levels for EHR-M3 detector using 28 kV_P. The findings show that the DQE is also influenced by the properties of the detector.

Conclusions: A quantitative technical characterization of digital detectors was achieved for a variety of dose values, in the mammography and general radiography energy ranges.

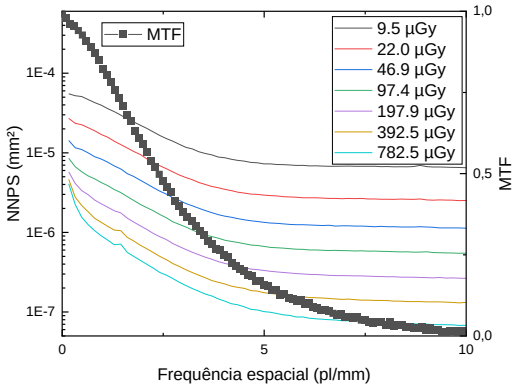

Figure 1: MTF and NNPS using 28 kV_P and Mo/Mo anode/filter combination for EHR-M3 detector.

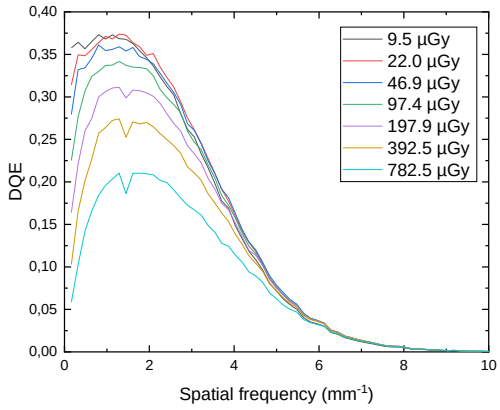

Figure 2: DQE at 28 kV_P and Mo/Mo anode/filter combination for EHR-M3 detector.

References:

1. EUREF, Luxembourg: EUREF, 2013.
2. IEC 62220-1, Geneva: IEC, 2015.