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New methodology to assess spatiotemporal image quality on fluoroscopy devices

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The planar formulation of the noise equivalent quanta (NEQ) and detective quantum efficiency (DQE) used to assess the image quality of projection images does not deal with the influence of temporal resolution on signal blurring and image noise. These metrics require correction factors based on temporal resolution when used for dynamic imaging systems such as fluoroscopy. Additionally, the standard NEQ and detector DQE are determined on pre-processed images in scatter-free conditions for effective energies produced by additional aluminium or copper filters that are not representative of clinical fluoroscopic procedures. In this work, we developed a method to measure 'frame NEQ' and 'frame system DQE' which include the temporal frequency bandwidth and consider the anti-scatter grid, the detector and the image processing procedures for beam qualities with scatter fractions representative of clinical use.Approach. We used a solid water phantom to simulate a patient and a thin copper disc to measure the spatial resolution. The copper disc, set in uniform rectilinear motion in the image plane, assessed the temporal resolution. These new metrics were tested on two fluoroscopy systems, a C-arm and a floor-mounted cardiology, for multiple parameters: phantom thicknesses from 5 to 20 cm, frame rates from 3 to 30 fps, spatial and temporal image processing of different weights.Main results.The frame NEQ correctly described the image quality for different scatter conditions, temporal resolutions and image processing techniques. The frame system DQE varied between 0.38 and 0.65 within the different beam and scatter conditions, and correctly mitigated the influence of spatial and temporal image processing.Significance.This study introduces and validates an unbiased formulation of in-plane NEQ and system DQE to assess the spatiotemporal image quality of fluoroscopy systems.

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