A novel approach for evaluating the quality of a digital X-ray image

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Introduction. The quality of an x-ray image is extremely important for diagnostic radiology. The analogue approach still in use to estimate image quality employs a visual evaluation of the test object displayed features. Such an approach is rather subjective and depends on the skill of the evaluator.

In contrast, an x-ray digital image allows for the digitalization of quality parameters directly from the image, thereby improving the reliability of the quality test.

A digital image data array is used to evaluate quality, producing a pixel distribution over brightness related to the quality parameters of the image. Variance and an average of these brightness histograms correlate to x-ray image contrast and lateral resolution (confidence 0,99) which in turn depends on mAs and high voltage [1, 2].

The present article targets the use of image digitalization in order to achieve a digital quality evaluation of digital x-ray image in radiography.

Materials and methods. The x-ray machine "Bucky Diagnost" was employed to supply a flow of radiation. All digital images were acquired using exposures in manual mode. The voltage (kV) was equal to 70 and 50 and the milliampere seconds (mAs) were selected from the 0.5-15 and 20-130 range respectively. The Source Image Distance (SID) was 1 m. The irradiated field was sized to 19x25 cm for each exposure.

The test plate "ETR-1" was applied as the test object. The digital cassette "Kodak" (medium sensitivity) was supplied as the x-ray detector.

Images were provided by a digitizer "KODAK DIRECT VIEW 500". All digital images were burned onto a CD in the DICOM format.

Black (the 1^{st}), grey (the 4^{th}) and white (the 7^{th}) areas of each image (Fig. 1) were analyzed. A number 27556 (166 x 166) of pixels composed each area. DICOM images were transferred to JPG format, where pixels brightness was then digitalized using the software designed.

Histograms of digitalized pixels distribution over brightness (Fig. 2) were constructed using "Microsoft Excel" program.

Average (M(x)), mode (max(x)) and variance (D(x)) as the parameters of the histograms were calculated. F-test was employed to verify differences between the obtained statistics (confidence 0.99) [3].

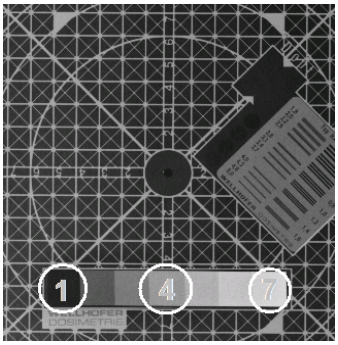

Fig. 1. The analyzed areas of the test object digital image

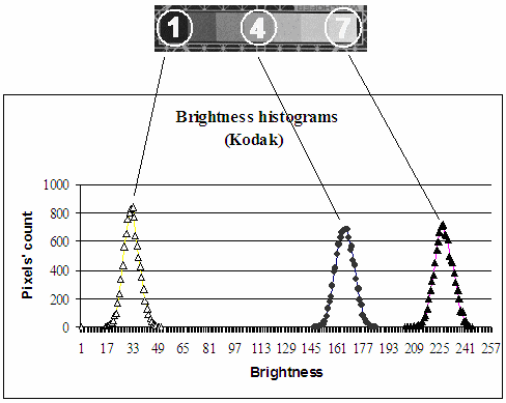

Fig. 2. Brightness histograms

Results. All above parameters of the histograms correlate to mAs, voltage and brightness (Fig. 3-6). The greatest influence of mAs on M(x), max(x) and D(x) are provided by mAs < 5 and 50 mAs values for 70 and 50 kV respectively. This means that uniformity of the image brightness does not depend on mAs > 5 and 50 values for 70 and 50 kV respectively.

The parameter D(x) is smaller for the lower brightness, which means that its uniformity is higher.

Conclusion. The results demonstrate that image brightness digitalization could become the starting point to achieve a quality assessment for x-ray diagnostic equipment. Average (M(x)), mode (max(x)) and variance (D(x)) of the brightness statistics are the parameters that characterize the quality of the x-ray beam.

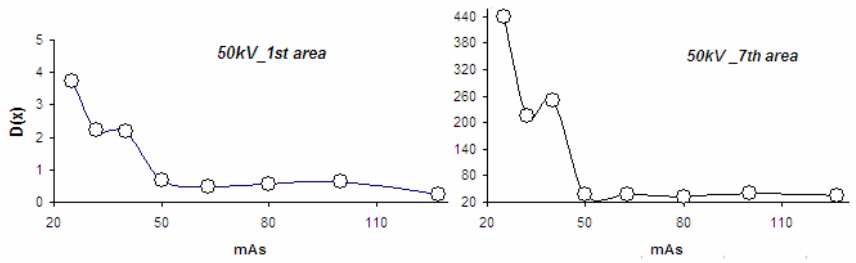

Fig. 3. D(x) of brightness histograms at 50 kV

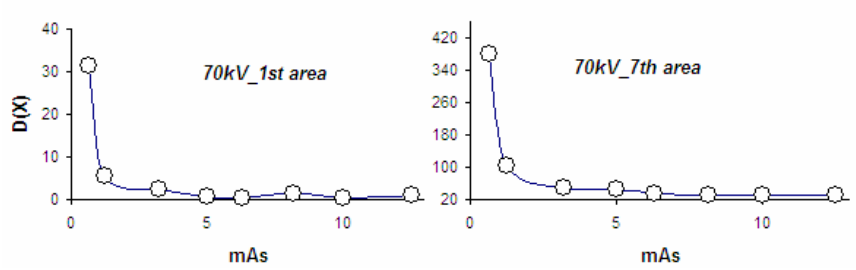

Fig. 4. D(x) of brightness histograms at 70 kV

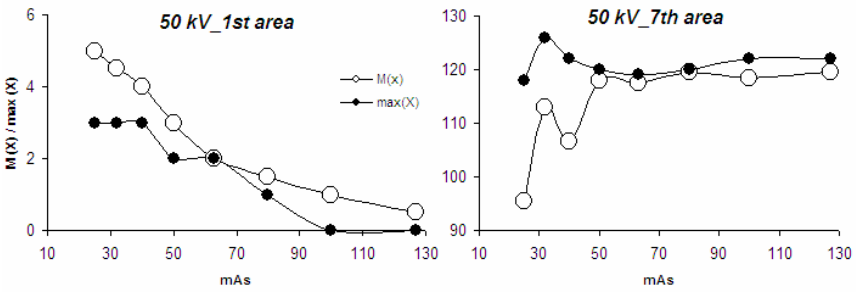

Fig. 5. M(x)/max(x) of brightness histograms at 50 kV

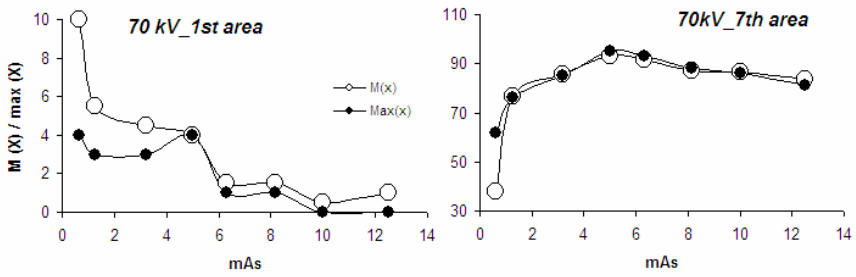

Fig. 6. M(x)/max(x) of brightness histograms at 70 kV

References

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The quality of an x-ray image is extremely important for diagnostic radiology. An analogue approach typically in use to estimate the quality is a visual evaluation of the test object image being analyzed. Such an approach is rather subjective, however, and depends on the skill of the evaluator. In contrast, an x-ray digital image allows for the digitalization of quality parameters directly from the image, thereby improving the reliability of the quality test.

A digital image data array is used to evaluate quality, producing a pixel distribution over brightness related to the quality parameters of the image. Variance and an average of these brightness histograms correlate to x-ray image contrast and lateral resolution (confidence 0,99) which in turn depends on mAs and high voltage.

The results demonstrate that the above approach could become the starting point for a quality assessment of x-ray equipment used in diagnostic radiology.