

FOCAL SPOT SIZE IMPACT TO DIGITAL X-RAY IMAGE BRIGHTNESS STATISTICS

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Abstract

Quality control (QC) tests play a crucial role for patients' dose management in diagnostic radiography. X-ray tube focal spot size is the most important index for QC of x-ray machines. The focal spot size is typically estimated using pinhole or the star pattern. However, the results by such the techniques are rather subjective. This disadvantage could be decreased in digital radiography when an image brightness distribution histogram is in use. Average value of brightness correlates to the focal spot size (significance 0.99). This technique does not require any test object. The results demonstrate that the above approach could become an important part of the QC for digital x-ray diagnostic radiography equipment.

Key words: *Digital radiography quality assurance, focal spot size*

Introduction

Quality control (QC) tests play a crucial role for patients' dose management in diagnostic radiography. Evaluation of changes in an x-ray tube focal spot size is one of the most important measurements used for QC in medical x-ray facilities. Usually focal spot size is estimated using pinhole or the star pattern. However, these techniques are enough expensive, and the results acquired in such measurements are rather subjective. In contrast, an x-ray image brightness distribution histogram is a more reliable tool, which allows estimating changes of focal spot size digitally, using mathematical/statistical approach. The tool makes it possible to determine quite small (a decimal part of millimeter) changes of focal spot size. Average value of brightness correlates to the focal spot size (significance 0.99). This technique does not require any phantom, test object or other special expensive equipment and any printed hardcopy of a digital x-ray image being analyzed. The whole process goes on digitally straight on the screen, thereby improving the reliability of the quality test and reducing all related costs. The results demonstrate that the above approach could become an important part of the QC for digital x-ray diagnostic radiography equipment.

Methods

The x-ray machine "Digital Diagnost" was employed to supply a flow of radiation. Digital images were acquired in manual mode. The voltage was equal to 81 kV and the milliampere seconds were 2mAs. All images were acquired using both a small focal spot size (0.6 mm) and a large focal spot size (1.2 mm). The x-ray tube was placed at 1m distance from digital detector. Collimator was adjusted to size 19x25 cm for all images. No phantoms or test objects were in use. All images were acquired in DICOM format. Using Print Screen (PrtSc) button the images were transferred to Paint. Here, in Paint, each image was divided to separate areas (50x50 pixels each area) in directions, according to a transparent template (Fig. 1) fixed to the monitor screen. Each area was saved as separate TIFF-image. The TIFF-images were transferred using software designed, hence pixels' distribution over brightness for each TIFF-image was produced. The data was processed using excel program. As a result, an average brightness was calculated for each extracted area. The results were compared using T-test (significance 0.99).

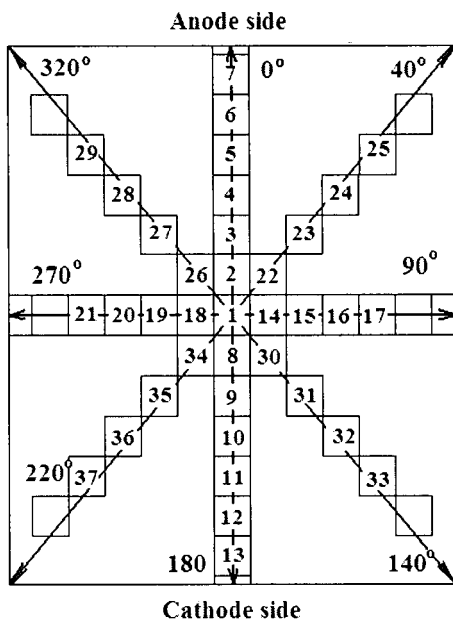


Fig. 1. The transparent template

Results and Discussion

The results represented on the figures 2 - 5 demonstrate that brightness of images, acquired with large focal spot is more intense than brightness of images, acquired with small focal spot.

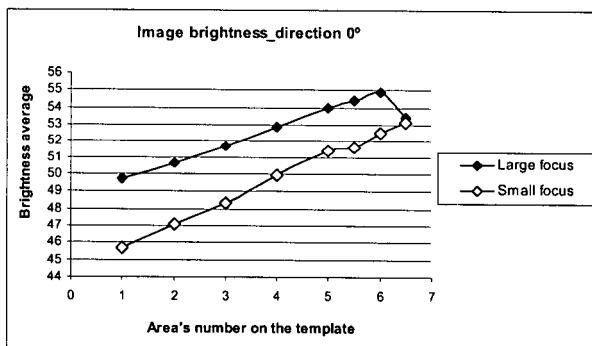


Fig. 2. Image brightness changes

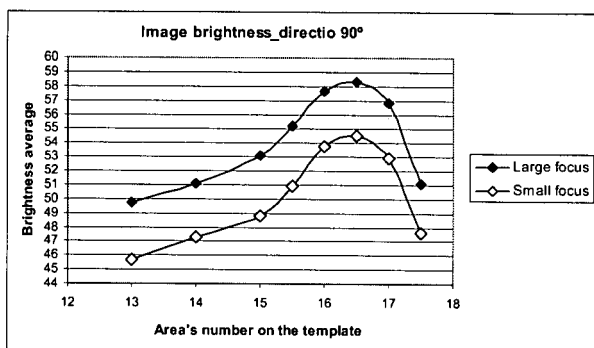


Fig. 3. Image brightness changes

This happens, because x-ray beam intensity produced with large focus reduces due to higher scattering in comparison with small focus beam. The relevance is the same in all direction, showed on the template. Besides, so called “heel effect” is well visible. The brightness of image on “anode side” is superior (Fig. 2), because the beam intensity there is less, in turn, brightness at “cathode side” is less (Fig. 4), for the beam intensity here is higher. Using T-test (significance 0.99) it was determined that brightness distribution is different for images acquired with large focal spot and for images acquired with small focal spot.

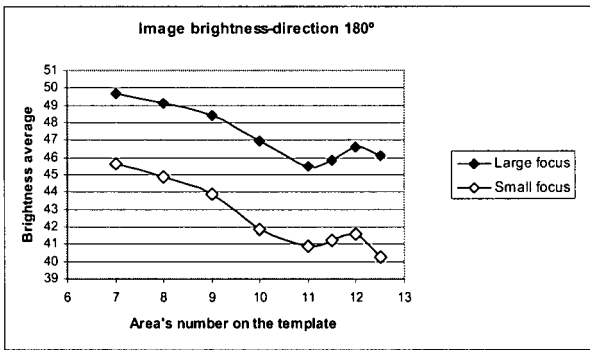


Fig. 4. Image brightness changes

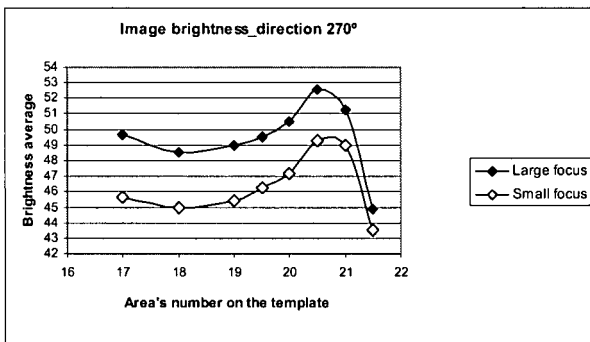


Fig. 5. Image brightness changes

There is decided to make more investigations (using 60kV and 100kV energies) to enlarge application's range of the approach.

Conclusions. The results demonstrate that the above approach could become an important part of the QC for digital x-ray diagnostic radiography equipment, particularly, to observe changes in focal spot size. Brightness average is the parameters, which characterize the changes.