Using a Homogeneity Test as Weekly Quality Control on Digital Mammography Units

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Abstract. In the Netherlands a number of (screening) trials with digital mammography equipment have been started since 1999. In this paper results from the weekly QC procedure are given. It seems that the homogeneity test as described in the addendum to the European protocol is able to detect detector problems and flat field calibration problems. However, visual inspection remains necessary. For the CR system in the trials the homogeneity test did not find many problems. Either the homogeneity test is not effective and other tests might be more appropriate or this CR system does not have relevant image quality variations and therefore might not require weekly quality control.

1 Introduction

In the Netherlands a number of (screening) trials with digital mammography have been started. The first trial began in 1999, in which digital mammography was tested in a clinical environment. For this purpose a GE Senographe 2000D was installed in the Radboud University Nijmegen Medical Centre. In 2002 the second trial started at a static screening site in Utrecht with a Lorad Selenia system. In this trial digital mammography was evaluated in a screening environment. In 2004 two more trials with mobile digital screening units were started. In these trials a Fuji FCR Profect and an Agfa DM 1000 system were installed in the screening units.

2 Methods and Materials

In the trials technical quality control is performed on all mammography units according to the European Guidelines for screening mammography [1]. Part of this quality control is a (weekly) evaluation of the stability of the mammography unit and homogeneity of the digital images [2].

For this weekly evaluation the radiographers image a homogeneous block of PMMA, covering the whole detector, under clinical conditions (fully automatic mode, compression paddle present). The resulting unprocessed image is sent to the physics section of the National Reference Centre in Nijmegen. The image is evaluated using a self-made software program, which is made available via internet (*www.euref.org*).

In this program an ROI is chosen (for our purpose: 0.5 cm by 0.5 cm) in the upper right corner of the image. This ROI is moved in steps of half ROI size over the whole image. For each ROI the average pixel value and standard deviation are determined and Signal-to-Noise Ratio (SNR) is calculated as pixel value over standard deviation.

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The pixel value and SNR in each ROI are plotted in surface plots as function of position on the detector. Besides this the program checks for pixel values which deviate significantly (>30%) from the mean value in each ROI. These pixels are suspected to be uncorrected bad pixels. The images are also evaluated visually for artefacts smaller than the ROI size using a DICOM viewer with small window width. In this paper this whole procedure is referred to as a homogeneity test.

The homogeneity test is performed weekly. However, for the Lorad and Agfa systems the radiographers have to perform a flat field calibration weekly. In this calibration a number of images of a homogeneous PMMA block are made in order to determine the gain and offset for each detector element. For these systems the homogeneity test is performed twice a week, just before and right after the flat field calibration.

3 Results

3.1 Typical 'Normal' Output of the Homogeneity Test

For DR systems, the surface plot, in which pixel value is plotted as function of position on the detector, is expected to be flat due to the flat field calibration, which is performed. For CR systems however, pixel values are expected to decrease towards nipple and lateral sides due to the heel and geometric effects. For both DR and CR systems it is expected that SNR will decrease towards nipple and lateral sides due to the same effects. In figure 1 an example of the output of the homogeneity test software is given for a DR system.

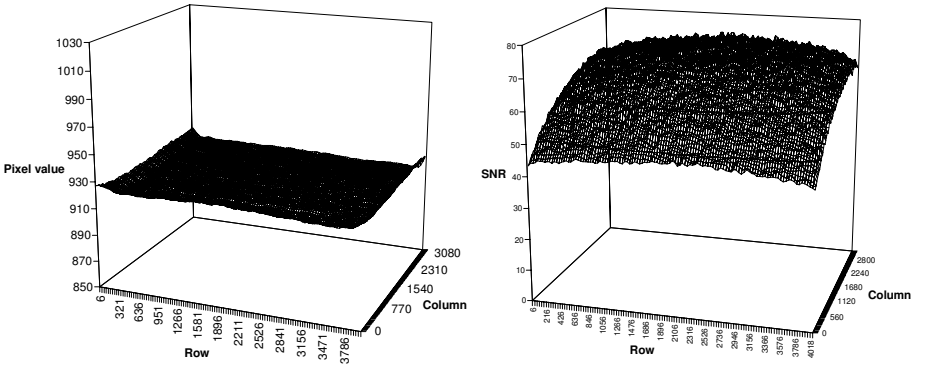

Fig. 1. Output of the homogeneity test on a DR system, a: pixel value plotted as function of psition on the detector, b: SNR plotted as function of position on the detector

3.2 Problems with Homogeneity

In the digital mammography trials a number of homogeneity problems have been observed. These problems can be divided into two subclasses:

1. Image receptor problems
2. Calibration procedure problems