Initial Results of the Daily Quality Control of Medical Screen Devices Using a Dynamic Pattern in a Digital Mammography Environment

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Abstract. In digital mammography it is of utmost importance that the quality of screen devices is checked on a regularly basis. The EUREF guidelines propose to do this daily using the AAPMtg18-QC pattern. In this paper we report our initial results with the use of an alternative, recently developed, dynamic pattern ("MoniQA") and a scoring scheme.

As soon as the observers are familiar with the procedure, the measurements are very stable and we could not observe big variations in the quality of the monitor. In order to control the intrinsic quality of the monitor, the number of quality control checks could thus be reduced. The global working condition (such as the ambient light level) is controlled as well with the proposed procedure and this may be of great interest, especially during the start-up of digital mammography (screening) units: it is very informative to trace the influences of different light sources (such as (occasional) viewing boxes).

1 Introduction

For an optimal visualisation of medical images on screen devices it is of utmost importance that the quality of these monitors can be guaranteed. This is especially the case for digital mammography and even more if they are being used for screening purposes. Therefore the European Guidelines for Quality Assurance in Breast Screening (EUREF) [(1)] propose a quality control procedure, both for long-term as well as for constancy checking (daily quality control, DQC). Their guidelines are based upon the results of the AAPMtg18 [(2)]. Another well-known and often used protocol is the DIN protocol [(3)], which uses the SMPTE-pattern [(4)] and the DIN-IEC pattern. Daily quality control is performed by scoring dedicated patterns (Fig. 1a, b and c) to check the different, important parameters of display devices (luminance, resolution, geometric distortion and general image quality). These patterns are quite complex, making their evaluation difficult. They are also static and by that over time the results of the evaluations will be biased due to a learning effect. Recently a new type of patterns, dynamic patterns, have been introduced. These patterns are randomly created according to certain rules. An example is the "MoniQA pattern" (Fig. 1d and e). A previous study showed that this pattern can be used as a valid alternative for the DQC procedure as proposed by the European Guidelines (the AAPMtg18 DQC procedure)

Susan M. Astley et al. (Eds.): IWDM 2006, LNCS 4046, pp. 416 – 423, 2006.

and the DIN protocol. The study also showed that a protocol based on this MoniQA pattern results in a faster evaluation than the other two mentioned protocols [5].

The MoniQA pattern was used in present study. The pattern includes elements to check a medical screen device for luminance (using 4 sets of 5 random low contrast characters and a gradient bar with random low contrast characters), resolution (via line pair patterns at Nyquist and half-Nyquist frequency), geometric distortions (by drawing a standard grid and thin lines in the corners of the pattern to check the use of the full display area) and general image quality artefacts (including a high contrast element -the hourglass- to check for ghosting and blurring). All these items have to be evaluated separately and we have now combined the results into a global score.

In this study we report on the initial results of the application of this dynamic pattern in our digital mammography environment over a longer time period and on a series of workstations for general radiology modalities. A larger European trial is on-going.

2 Methods and Materials

Over a time period of eight months we performed daily quality control (DQC) on six dual-head workstations using the MoniQA pattern. With dedicated software, the results were sent automatically to a central computer in the medical physics group of our hospital for on-line quality control monitoring [6]. One of the tested workstations was dedicated for mammography (BARCO 5MP CRT monochrome). On this workstation, the DQC was done by a random person out of a group of 4 radiographers (so each observer did the test about once a week). On the other workstations (4 workstations with Siemens 1.3MP CRT monochrome monitors and 1 workstation with Siemens 1.3MP CRT colour monitors) always the same radiologist performed all controls. All observers started after one common teaching session of 15 minutes.

The results of the evaluations were monitored for each screen device. The total score was calculated as follows: an ideal screen that passes all tests gets 100 points; for each reported malfunction, points are subtracted according to the seriousness of the malfunction. I.e. it is not such a big issue if a least visible character of a random character set can not be read. Therefore we subtract less points than if there was a problem with a resolution pattern, for which we subtract 5 points. For a random low contrast character we subtract the difference of the grey scale value with the background.

The MoniQA Pattern had been applied on various monitors dedicated for digital mammography (Barco LCD, Barco CRT, Eizo LCD, Siemens LCD, Siemens CRT). We did acceptance checking of these systems and we noticed that quite often the MoniQA score for an accepted system was between 90 and 100 points. We have also applied this pattern on a large number of monitors for general radiology from different vendors (Barco, Eizo, Totoku, NEC) and of different types (CRT and LCD) and sizes (2MPand 3MP). The experience we had with all these systems gave us an indication to propose an acceptable level of 90 and an achievable level of 95. An ideal screen would then be 100 points.