Performance Comparison of Different DR Detectors Using Simplified $e$DQE Approach

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OBJECTIVE

Simplification of eDQE formalism by excluding the beam stop measurements

Comparison of different system performance in terms of eDQE

Use of eDQE for the optimization of clinical image qualities
DETECTIVE QUANTUM EFFICIENCY - DQE

\[ \text{DQE}(f) = \frac{\text{MTF}(f)^2}{\text{NNPS}(f) \cdot \text{K.q}} \]
EFFECTIVE DETECTIVE QUANTUM EFFICIENCY - EDQE -

$$eDQE(f) = \frac{MTF(f)^2 (1 - SF)^2}{NNPS(f) \cdot TF \cdot Kq}$$

Performance of the system as a whole

*Samei et al Med. Phys. 2009*
INCLUSION OF SCATTER DATA TO THE MTF

Use of Beam Stop Technique

\[
SF = \frac{PV_{\text{Atten.}}}{PV_{\text{Backg.}}}
\]

MTF no scatter

MTF x (1-SF)
INCLUSION OF SCATTER DATA TO THE MTF

- No truncation and windowing of LSF
- Include all the tail of LSF with a large ROI
- No normalization of the zero frequency to unity for MTF
COMPARISON OF TWO TECHNIQUE

Increasing ROI size (mm)

10 cm PMMA

10 cm PMMA

SF = 0.38

SF = 0.44

25 cm PMMA

25 cm PMMA
## TECHNICAL CHARACTERISTICS OF THE FOUR SYSTEM EVALUATED

<table>
<thead>
<tr>
<th></th>
<th>Kodak DRX-1</th>
<th>Kodak DRX-1C</th>
<th>Toshiba FDX4343R</th>
<th>Philips l Pixium 4600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion phosphor</td>
<td>Gd$_2$O$_2$S:Tb</td>
<td>CsI</td>
<td>CsI</td>
<td>CsI</td>
</tr>
<tr>
<td>Pixel area</td>
<td>35x43cm</td>
<td>43x43cm</td>
<td>43x43cm</td>
<td>43x43cm</td>
</tr>
<tr>
<td>Pixel matrix</td>
<td>2544x3056</td>
<td>3072x2560</td>
<td>3008x3072</td>
<td>3001x3001</td>
</tr>
<tr>
<td>Pixel pitch</td>
<td>139µm</td>
<td>143µm</td>
<td>143µm</td>
<td>143µm</td>
</tr>
<tr>
<td>Grid type</td>
<td>Stationary</td>
<td>Stationary</td>
<td>Moving</td>
<td></td>
</tr>
<tr>
<td>Grid ratio</td>
<td>10:1</td>
<td>12:1</td>
<td>12:1</td>
<td></td>
</tr>
<tr>
<td>Focal spot size (mm)</td>
<td>2.0</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
</tr>
</tbody>
</table>
ACQUISITION GEOMETRIES

IEC Methodology

Low scatter, focus unsharpness (G2)

Beam hardening filtering (G1)

Scatter + focus unsharpness (G3)

90 kVp, 25 cm PMMA, AEC control, AK measurements in the Bucky
Signal Transfer Property (STP)

Signal Transfer Properties Functions

<table>
<thead>
<tr>
<th>Systems</th>
<th>RQA Geometry</th>
<th>G1 Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRX-1C</td>
<td>$y = 435.62 \ln(K) + 1166$</td>
<td>$y = 515.71 \ln(K) + 947.45$</td>
</tr>
<tr>
<td>DRX-1</td>
<td>$y = 442.29 \ln(K) + 1180.9$</td>
<td>$y = 416.89 \ln(K) + 1071.6$</td>
</tr>
<tr>
<td>Toshiba FDX4343R</td>
<td>$y = 164.83K + 53.535$</td>
<td>$y = 144.87K + 56.106$</td>
</tr>
<tr>
<td>Pixium 4600</td>
<td>$y = 2509.9 \ln(K) + 14450$</td>
<td>$y = 2560.8 \ln(K) + 14593$</td>
</tr>
</tbody>
</table>
MTF RESULTS FOR DIFFERENT DIGITAL RADIOGRAPHY SYSTEMS

RQA7

G1

G3

freq(mm⁻¹)

MTF

freq(mm⁻¹)

MTF

freq(mm⁻¹)

MTF
NNPS RESULTS FOR DIFFERENT DIGITAL RADIOGRAPHY SYSTEMS

- DRX-1C (5.64 µGy)
- DRX-1 (5.17 µGy)
- FDX4343R (5.06 µGy)
- Pixium 4600-II (4.6 µGy)

G1
- DRX-1C (4.99 µGy)
- DRX-1 (4.69 µGy)
- FDX4343R (4.7 µGy)
- Pixium 4600-II (5.12 µGy)

G3
- DRX-1C (4.87 µGy)
- DRX-1 (4.39 µGy)
- FDX4343R (5.4 µGy)
- Pixium 4600-II (5.09 µGy)
DQE-EDQE RESULTS FOR DIFFERENT DIGITAL RADIOGRAPHY SYSTEMS

RQA

freq(mm⁻¹)

DQE

DRX-1C(5.71µGy)
DRX-1(5.17µGy)
FDX4343R(5.06µGy)
Pixium 4600-II(4.66µGy)

G1

freq(mm⁻¹)

DQE

DRX-1C(4.99µGy)
DRX-1(4.69µGy)
FDX4343R(4.7µGy)
Pixium 4600-II(5.12µGy)

G3

eDQE

DRX-1C(4.87µGy)
DRX-1(4.39µGy)
FDX4343R(5.4µGy)
Pixium 4600-II(5.09µGy)
COMPARISON OF THREE GEOMETRIES FOR DRX -1C SYSTEM

Optimization of clinical image quality
CONCLUSION

Could we simplify the eDQE procedure?

Could we do some standardization for eDQE?

Why to measure the eDQE?

Optimization of the clinical techniques

Comparison of the clinical performance of different systems

Reliable definition of speed for digital system
Thank you

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