Image quality
Technical/physical aspects
Nationella kvalitetsdokument för digital radiologi AG1

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Requirements on QA-tests

- Objective
- High precision
- Quick and simple
- Available
- (Universal and automatic)
Inspiration from

Statens strålskyddsinstitut
Projekt P1069.98

Utvärdering av datortomograferos doseeffektivitet

Peter Hägglund, Rolf Johansson och Göran Wickman
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Method

- Objective measures to characterise imaging systems (or detector) performance exists – i.e. MTF, NPS, NEQ and DQE
  - Difficult to adapt and time-consuming

- but simple visual evaluation of test phantoms are often used in practice …
  - # of visible low- and high-contrast details
  - Simple but rather imprecise (subjective)
Suggestion

- **LDI**: _Low-contrast Detection Index_
  
is
  - Objective
  - Precise
  - Reproducible
  - Semi-quick?
Material

- Leeds To10 phantom (SN174)
- Philips Digital Diagnost (2001)
- 4 x 5 cm PMMA blocks
- Barracuda MPD kerma-meter
- Same image processing (Unique) ‘Bäcken’
- FDA=100 cm
- 25 x 25 cm field size
- No table top cushion
- Manuel exposure
Material

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A circular ROI is applied. Average p.v. and s.d. is measured.
Measure p.v. and s.d. on top and beside the detail.
Method

Uncorrected

Pixel value

Contrast Detail

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Method

Uncorrected

Contrast Detail

Pixel value

bkg+SD

obj-SD

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Method

Uncorrected linear reg, LDI

Pixelvärde

Kontrastdetalj nr

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Method

Corrected linear reg, LDI

Pixel value

Contrast Detail

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Corrected linear reg, LDI

Pixel value

Contrast Detail

bkg+SD
obj-SD
Linjär (obj-SD)
Linjär (bkg+SD)
Method

Corrected log reg, LDI

Pixel value

Contrast Detail

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

bkg+SD
obj-SD
Logg. (obj-SD)
Logg. (bkg+SD)
Repeat 3-5 times
Method

5 image samples

\[ \text{LDI} = 4.91 \pm 0.06 \]

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Results: **Uncertainty**

![Graph showing uncertainty in LDI with increasing number of sample images. The graph plots the number of sample images on the x-axis, and the 2 standard deviations in LDI on the y-axis, with a downward trend indicating reduced uncertainty as the number of sample images increases.]
Results: Uncertainty

Number of sample images in estimate of LDI

\[ 2 \text{ S.D. in LDI (\%)} \]

3 images samples are recommended
Uncertainty
Uncertainty

• Uncertainty is stable with
  - Bit-depth
  - Detector dose
Uncertainty

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- BUT very important to set up and align the phantom and x-ray unit in a consistent way!
Uncertainty

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• Keep detailed notations and document x-ray unit set up (photograph)
Uncertainty

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Applications / tests of method

- LDIs dependence on
  - bit-depth
  - kV
  - ESAK
Results: Different Bit depth

81kV, ESAK=1.3mGy

Mann-Whitney
p=0.91

±2S.D.

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Results: Different kV

ESAK=1.3mGy

±2S.D.

Tube Voltage (kV)

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Results: Different ESAK

81 kV

±2S.D.
Results: Correlations

Subjective v.s. Objective assessment

Visuell (subjective) assessment vs. LDI (objective) assessment

$r^2 = 0.90$

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Conclusions and further work

- LDI method seem ´appropriate´ for QA-test
- Further tests and validations of sensitivity to different
  - image processing schemes
  - dynamic range of image data
  - X-ray units
  - sizes of contrast detail
  - test phantoms
- Automatic image assessment with software
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Comments ?!
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• Please send comments and suggestions for improvement to
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