Image quality, evaluation, optimization and object recognition in the reproduction of medical radiographs

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DIGITAL RADIOGRAPHY

COMPUTED RADIOGRAPHY

SCANNED PROJECTION RADIOGRAPHY

INDIRECT DIGITAL RADIOGRAPHY

INDIRECT DIGITAL RADIOGRAPHY

DIRECT DIGITAL RADIOGRAPHY

PHOTOSTIMULABLE PHOSPOR

SODIUM IODIDE SCINTILLATOR
  Photodiode

CESIUM IODIDE
  GADOLINIUM
  OXYSULFIDE
  THIN-FILM
  TRANSISTOR

CESIUM IODIDE
  CCD

AMORPHOUS SELENIUM
  TFT

e.g
CAPTURE ELEMENT

COLLECTION ELEMENT

e.g
MAJOR COMPONENTS OF A DIGITAL IMAGING SYSTEM

- Image Preprocessing
- Image Postprocessing

Raw Digital Data acquisition

Image Display
ADVANTAGES OF DIGITAL RADIOLOGY

• The image receptor can be optimized independently from the image display and storage

• Digital image processing can improve the image visualization (e.g. contrast enhancement)

• Computer – aided diagnosis can be implemented to assist radiologists in finding subtle abnormalities
RADIOGRAPHIC IMAGE QUALITY

• Is the exactness of representation of the patient’s anatomy on an image
• Refers to the fidelity with which the anatomical structure that is being examined is imaged on the radiograph
• DQE – most recognised metric of image quality performance for digital radiographic systems → measure the efficiency of the detector
DIAGNOSTIC REQUIREMENTS

• IMAGE CRITERIA – these refer to characteristic features of the normal radiographic image whose degree of visibility is conveyed by the following:
  Visualization - an anatomical feature is detectable but details are not fully reproduced
  Reproduction - the details of anatomical features are visible but not necessarily clearly defined
  Visually sharp reproduction - the anatomical details are clearly defined
Wong et al suggests the following objective measures of IMAGE QUALITY:

- **Density resolution** (total number of distinct grey level values in the image)
- **Spatial resolution** (number of pixels to represent the image)
- **Point spread function** (reflects the sharpness of points)
- **Line spread function** (reflects the sharpness of lines)
- **Edge spread function** (reflects the sharpness of edges)
FILL FACTOR — the percentage of the pixel face that is sensitive to the x-rays, approx 80%, therefore 20% of the x-ray beam does not contribute to the image.

As pixel size is reduced, spatial resolution improves but at the expense of the patient radiation dose.

A dilemma for DR!!!
**DIGITAL IMAGE ARTIFACTS**

An artifact is any false visual feature on a medical image that simulates or obscures tissue and interferes with diagnosis.

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DIGITAL IMAGING  (Image quality in the reproduction of radiographs)

- Resolution
- Number of grey levels
- Optics, sensor, signal (image information)
- Spatial Frequency Response
- MTF - detail reproduction
- Opto - Electronic Conversion function (OECF)
- Dynamic range
- Signal to noise ratio (SNR)
- Tone reproduction
- Viewing conditions
- Observer - physiological and psychological characteristics
Nikon Coolpix 990 Camera at 2048 X 1536 pixels higher settings increased the file size without adding significant details
DIGITAL CAMERAS

CHEST IMAGES

• Complex
• Depend on the analysis of soft tissues
• Depend on greyscale values of the images

SKULL

• Easier to diagnose
• Abnormalities more easily identifiable
• Image compression DEGRADES image quality consider: perceptually lossless compression
• Visual image quality → important criterion for measuring compression performance
Image compression would have to be optimized based on the types of images generated, interpreted for primary diagnosis, stored and transmitted to remote sites for clinical review

- Correlation between IMAGE QUALITY and TECHNICAL FACTORS
The PSYCHOPHYSICAL approach to image quality considers the discriminability of images in the light of the abilities, constraints and illusions of human perception.
OBJECT RECOGNITION IN MEDICAL RADIOGRAPHYS

• Impaired when an object is presented in an unfamiliar orientation

PATTERN RECOGNITION

• Image quality must be of an optimal standard
EVALUATION OF IMAGES

• Involvement of radiologist, trainee radiologist and physicist
• Standardised viewing box, view station and monitor
• Image appearance differences
• The imaging chain
OPTIMIZATION OF IMAGING PROCESS

• Viewing conditions MUST be ideal
• Constant image quality – standardized digital imaging techniques
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