RADT-1352: DIGITAL IMAGE ACQUISITION AND EVALUATION

Cuyahoga Community College

Viewing: RADT-1352 : Digital Image Acquisition and Evaluation

Board of Trustees:
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Academic Term:
Fall 2025

Subject Code
RADT - Radiography

Course Number:
1352

Title:
Digital Image Acquisition and Evaluation

Catalog Description:
Analysis and application of radiographic factors influencing the acquisition and evaluation of the digital radiographic image. Students are required to conduct X-ray exposure experiments, under supervision, using standard energized imaging equipment.

Credit Hour(s):
3

Lecture Hour(s):
2

Lab Hour(s):
3

Requisites

Prerequisite and Corequisite
RADT-1301 Fundamentals of Radiography, and departmental approval.

Outcomes

Course Outcome(s):
Safely operate radiographic equipment and ancillary devices to produce quality radiographic images.

Objective(s):

1. Develop exposure charts for various systems.
2. Describe the principal advantages and disadvantages of fixed and variable kilovoltage peak (kVp) systems.
3. Explain technical, procedural, and clinical factors affecting image appearance.
4. Manipulate techniques for casts, pathologies, geriatric body mass index (BMI), and contrast medias.
5. State the steps necessary and considerations for proper use of automatic exposure control (AEC) devices.
6. Explain the X-ray tube and circuit and how it allows AEC to properly function.
7. Discuss how patient position/anatomy can alter AEC techniques.
8. Properly utilize ancillary devices such as grids, filters, and collimators, and apply correct technical manipulations to yield quality images.
9. Identify grid errors and properly correct for them.
10. Calculate heat units and understand tube rating charts.
11. Describe why heat units are important for X-ray tube safety and longevity.

Course Outcome(s):
Identify processes of image acquisition and display.

Objective(s):

1. Demonstrate appropriate digital image identification and annotation.
2. Define brightness, gray scale, spatial resolution, and distortion as it relates to digital imaging.
3. Compare the differences between digital receptor components including direct and indirect radiology imaging.
4. Compare indirect digital image receptors including thin-film transistors (TFT), charge coupled devices (CCD) and complementary metal oxide semiconductors (CMOS).
5. Differentiate between analog and digital imaging.
6. Outline the steps of image production for computed radiography (CR)/ photostimulable phosphor (PSP) imaging from the latent image production through the image reader to become a digital image.
7. Outline the digital image processing steps from acquisition through image display.
8. Describe the steps for the analog-to-digital converter (ADC).
9. Evaluate digital imaging characteristics including pixel and matrix sizes.
10. Evaluate and compare spatial resolution and contrast resolution.
11. Describe pre and post corrective actions that can be taken to improve digital image appearance.
12. Define the ideal detective quantum efficiency (DQE), modulation transfer function (MTF) and Signal to noise ratio (SNR).
13. Describe how values of interest (VOI) can change when the region of interest (ROI) is modified and when this can be beneficial to the radiograph.

Course Outcome(s):

Establish a knowledge base of factors that govern the image production process.

Objective(s):

1. Discuss different quality management techniques and programs.
2. Apply quality control measures to imaging equipment and accessories.
3. Recognize patient-related and equipment-related artifacts.
4. Describe latent image formation as it relates to digital computed radiography.
5. Demonstrate how scatter radiation adversely affects the digital image and provide methods to reduce scatter.
6. Describe how altering distances (e.g., SID, SOD, OID, angling) will affect the radiographic image.
7. Describe various methods of assessing spatial resolution.
8. Discuss factors that influence exposure index values.
9. Identify factors and potential errors that will affect the creation of the histogram and therefore the image that is displayed.

Course Outcome(s):

Identify processes of post processing manipulations, archiving and retrieval.

Objective(s):

1. Discuss the computer processing and image display process.
2. List the CR reader steps and different part functions.
3. Describe the digital image acquisition process and associated errors.
4. Modify images related to digital imaging including post-production manipulation.
5. Outline various image enhancement processes that may be used in digital.
6. Describe the composition and function of each layer of a PSP plate.
7. Discuss display monitors, including viewing conditions and spatial resolution.
8. Describe windowing and leveling in the digital image and its usage in radiology.
9. Outline various imaging acquisition errors and their causes including histogram analysis errors, rescaling, and dead pixel correction.
10. Analyze and compare histograms of specific images.

Course Outcome(s):

Evaluate the hierarchy of imaging informatics.

Objective(s):

1. Recognize the mechanisms for transfer, storage, and remote assessment of medical images.
2. List common downtime procedures for radiologic technologists.

3. Differentiate between digital imaging and communication in medicine (DICOM) and medical image management and processing system/picture archiving and communication system (MIMPS/PACS.)
4. Differentiate between radiology information system (RIS) and hospital/health information system (HIS).
5. Discuss electronic medical record (EMR.)

Course Outcome(s):

Use critical thinking skills to analyze images and resolve technical issues including those related to equipment, patient pathology, and digital post processing.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Employ radiographic equipment of various types.
2. Extrapolate a technique chart from a limited number of phantom test images.
3. Differentiate between different vendor-specific exposure indicator values.
4. Define and describe how to remedy quantum mottle and avoid exposure saturation.
5. Convert exposures based on radiographic rules using the exposure maintenance law, the inverse square law, the fifteen percent rule, the law of reciprocity, and grid usage.
6. Appropriately use and correct techniques when using collimation, grids, or filters.

Methods of Evaluation:

1. Homework assignments
2. Lab assignments
3. Quizzes
4. Lab evaluation including critical thinking exercises
5. Tests
6. Final comprehensive exam

Course Content Outline:

1. Technique charts
    a. Fixed kVp/variable milliampere-seconds (mAs)
    b. Variable kVp/fixed mAs
        i. Automated systems
    c. AEC
    d. Anatomically programmed technique (APR)
    e. Special considerations
        i. Casts
        ii. Pathologic factors
        iii. Age (e.g., pediatric, geriatric)
        iv. BMI
        v. Contrast media
        vi. Grids
2. Distance
    a. Source-to-image distance (SID)
    b. Object-to-image distance (OID) (Air-Gap)
3. Quality Control (QC)
    a. Collimator accuracy/beam restriction
        i. Light field to radiation field alignment
    b. Beam alignment
        i. Central ray alignment
    c. Filtration
        i. Half-value layers (HVL)
    d. Recognition and reporting of malfunctions
    e. Digital imaging receptor systems

        i. Maintenance (e.g., detector calibration, plate reader calibration)
        ii. QC tests (e.g., erasure thoroughness (CR/PSP), plate uniformity, exposure linearity, spatial resolution)
        iii. Display monitor quality assurance (e.g., grayscale standard display function, luminance)
        iv. Shielding accessories (e.g., testing lead apron, gloves)
    f. Spatial resolution test tools
    g. kVp accuracy
    h. Timer accuracy
    i. SID indicator
    j. AEC
        i. Density control accuracy
4. Extending tube life
    a. Warm-up procedures
    b. Rotor considerations
    c. Anode thermal capacity and exposure limits
    d. Heat units and tube rating charts
5. Digital imaging characteristics
    a. Spatial resolution
        i. Pixel characteristics (e.g., size, pitch)
        ii. Detector element (DEL) (e.g., size, pitch, fill factor)
        iii. CCD, CMOS (e.g., size, pitch)
        iv. Sampling frequency (CR)
        v. Matrix size (Image receptor matrix vs. display matrix)
        vi. MTF
    b. Contrast resolution
        i. Bit depth
        ii. DQE
        iii. Grids
    c. Image signal
        i. Dynamic range
        ii. Quantum noise (quantum mottle)
        iii. SNR
6. Image identification
    a. Methods (e.g., radiographic, electronic)
    b. Legal considerations (e.g., patient data, examination data)
7. Criteria for image evaluation
    a. DQE
    b. MTF
        i. Line spread function (LSF)
        ii. Point spread function (PSF)
        iii. Edge spread function (ESF)
    c. SNR
        i. Quantum noise (quantum mottle)
        ii. Gross exposure error (e.g., loss of contrast, saturation)
    d. Contrast-to-noise ratio (CNR)
    e. Exposure indicator (e.g., EI/DI/S#)
    f. Spatial resolution
    g. Distortion (e.g., size, shape)
    h. Bit depth
    i. DEL
        i. Size
        ii. Fill factor
        iii. Pitch
    j. Identification markers (e.g., anatomical side, patient, date)
    k. Image artifacts
    l. Radiation fog (CR)
    m. Image receptors
8. Digital radiography (DR)/Flat panel detectors
    a. Direct conversion
    b. Indirect conversion

        i. TFT arrays
        ii. CCD
        iii. CMOS
    c. CR/PSP
        i. Image plate reader
        ii. ADC
        iii. Photomultiplier
        iv. Translation
            1. Slow speed
            2. Fast speed
    d. Laser interaction
        i. Spatial resolution
    e. Erasing
        i. Accumulated background radiation
        ii. Image retention (e.g., ghosting)
    f. Image processing and display
9. Raw data (pre-processing)
    a. ADC/data extraction
        i. Sampling frequency
        ii. Quantization
    b. Corrections (e.g., rescaling, flat fielding, dead pixel correction)
    c. Histogram formation
        i. Creation and analysis
        ii. VOI
        iii. Automatic rescaling
        iv. Look-up table (LUT) application
    d. Automatic electronic masking
10. Histogram analysis errors
    a. Incorrect anatomic menu selection
    b. Exposure field recognition
        i. Collimation border recognition
        ii. Exposure field distribution (segmentation error)
    c. Unexpected material in data set (e.g., metal)
    d. Over-exposure/saturation/gross exposure error/loss of contrast
    e. Underexposure/starvation
    f. Noise
        i. Random (e.g., quantum mottle, scatter)
        ii. Electronic (e.g., electronic interference, detector malfunction, software)
        iii. Quantum
        iv. System
        v. Background
11. Operator Processing (post-processing)
    a. Windowing
        i. Display brightness (window level (WL))
        ii. Display contrast (window width (WW))
    b. Spatial domain processing
        i. LUT reprocessing
        ii. Equalization
    c. Spatial frequency processing
        i. Low frequency (smoothing)
        ii. High frequency (edge enhancement)
    d. Image reformatting
        i. Electronic cropping or masking
        ii. Magnification/zoom/pan
        iii. Rotation
        iv. Image flip (inversion)
        v. ROI
        vi. Field of view (FOV)
        vii. Stitching

12. Display monitors
    a. Viewing conditions
        i. Ambient lighting (peripheral glare)
        ii. Viewing angle/on-axis viewing (viewing direction)
        iii. Veil glare
    b. Types
        i. Liquid crystal displays (LCD)
        ii. Light emitting diodes (LED)
        iii. Active-matrix arrays (e.g., AMOLED)
    c. Spatial resolution
        i. Matrix size
        ii. Pixel dimensions
        iii. Size
        iv. Pitch
    d. Contrast resolution
    e. Luminance
        i. Pixel intensity
        ii. Color
13. File size
    a. Imaging informatics and archiving
    b. System architecture
        i. Integrating the healthcare enterprise (IHE)
        ii. Health level seven standard (HL7)
        iii. Cloud-based computing
    c. Network connectivity
        i. Information management
            1. HIS
            2. RIS
            3. EMR/electronic health record (EHR)
    d. Data file
        i. Raw data
    e. Image data
        i. MIMPS (formerly PACS)
    f. System components and functions
        i. DICOM standards
        ii. Health Insurance Portability and Accountability Act of 1996 (HIPAA)
14. Medical image storage and communications devices
    a. Archive media and management
        i. Short-term digital memory (redundant array of independent discs [RAID])
        ii. Long-term
        iii. Optical discs
        iv. Tapes
    b. Teleradiology
    c. Downtime procedures

The Course Schedule is subject to change due to pedagogical needs, instructor discretion, parts of term, and unexpected events.

Resources for the Instructor

Carter, C., & Veale, B. (2023) *Digital radiography and PACS (4th ed.)*, Elsevier.

Carlton, R., Adler, A. & Frank, E. (2020) *Principles of radiographic imaging: An art and a science (6th ed.)*, Cengage.

Carroll, Q. B. (2018) *Radiography in the digital age: Physics, exposure, radiation biology (3rd. ed.)*, Thomas, Publisher, Ltd.

Carroll, Q. B. (2019) *Digital radiography in practice*, Charles C. Thomas, , Publisher, Ltd.

Fauber, T. L. (2017) *Radiographic imaging & exposure (6th ed.)*, Mosby.

Additional Resources for the Instructor

1. American Society of Radiologic Technologists. Radiography Curriculum. http://www.asrt.org (http://www.asrt.org/)
2. American Registry of Radiologic Technologists. Certification Handbook containing examination content specifications. http://www.arrt.org (http://www.arrt.org/)

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