

R T 52D: DIGITAL IMAGE ACQUISITION & DISPLAY

Foothill College Course Outline of Record

Heading	Value
Effective Term:	Summer 2023
Units:	3
Hours:	3 lecture per week (36 total per quarter)
Prerequisite:	R T 55B.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Non-GE
Transferable:	CSU
Grade Type:	Letter Grade Only
Repeatability:	Not Repeatable

Student Learning Outcomes

- Assess the application and components of a digital radiography system in order to maximize radiation protection of the patient in the clinical setting.
- Describe the components of both computed radiography and direct radiography equipment in conjunction with the process of image formation.

Description

Imparts an understanding of components, principles, and operation of digital imaging systems found in diagnostic radiology. Factors that impact image acquisition, display, archiving, and retrieval are discussed. Compare/contrast different types of digital systems. Principles of digital system quality assurance and maintenance. Intended for students in the Radiologic Technology Program; enrollment is limited to students accepted in the program.

Course Objectives

The student will be able to:

- Differentiate between pixel size, matrix size, and bit depth
- Compare and contrast the computed radiography digital system with the direct radiography digital system
- Examine the potential impact the properties of digital radiographic systems have on patient exposure and methods of practicing the As Low As Reasonably Achievable (ALARA) concept with digital systems
- Categorize data acquisition and image extraction during the pre-processing phase for both CR and DR digital systems
- Describe the methods of post-processing in both CR and DR digital systems
- Evaluate various image acquisition errors and how they affect image quality
- Differentiate between quality assurance (QA) and quality control (QC)
- Discuss the impact of viewing angle, luminance, ambient lighting, and pixel size on image display
- Describe medical image management and processing system (MIMPS) and its function

- Relate HIPAA and patient confidentiality issues that arise with digital imaging and electronic records
- Describe steps to take during system down-time due to power outage or other emergency situation

Course Content

- Digital image characteristics
 - Picture elements—pixels
 - Pixel size
 - Matrix size
 - Spatial resolution
 - Bit depth
 - Information content—megabytes/image
- Image acquisition
 - Detector types
 - Direct conversion and thin film transistor (TFT) arrays
 - Amorphous selenium
 - Indirect conversion and thin film transistor (TFT) arrays
 - Amorphous silicon
 - Scintillator
 - Charge-coupled device (CCD)
 - Complementary metal oxide semiconductor (CMOS) systems
 - Photostimulable phosphor (PSP) plate
 - Turbid phosphors
 - Columnar phosphors
- Detector properties
 - Evaluation of detector characteristics
 - Detective quantum efficiency (DQE)
 - Modulation transfer function (MTF)
 - Line spread function (LSF)
 - Point spread function (PSF)
 - Edge spread function (ESF)
 - Spatial resolution
 - Bit depth
 - Detector element (DEL)
 - Size
 - Fill factor
 - Pitch
 - Dynamic range
 - Raw data extraction
 - Data extraction
 - TFT
 - PSP
 - CCD
 - Analog to digital conversion
 - Sampling frequency
 - Quantization
 - Exposure field recognition
 - Region of interest (ROI)
 - Histogram analysis
 - Exposure index
 - Exposure indicators and deviation index
 - Air kerma (e.g., K indicator)
 - Deviation index (DI)
 - Exposure indicators

1. Centering and beam collimation
2. Optimal value ranges
4. Initial processing
 - a. Preprocessing
 - b. Image analysis
 - i. Segmentation
 - ii. Histogram creation
 - iii. Histogram analysis
 - c. Automatic rescaling
 - d. Values of interest (VOI)
 - e. Grayscale/look-up table (LUT)
 - f. Noise reduction
5. Post-processing
 - a. Windowing
 - i. Brightness adjustment (window level)
 - ii. Contrast adjustment (window width)
 - b. Spatial domain processing
 - i. Look-up table (LUT) reprocessing
 - ii. Equalization
 - c. Spatial frequency processing
 - i. Low-frequency (smoothing)
 - ii. High-frequency (edge enhancement)
 - d. Image reformatting
 - i. Electronic masking
 - ii. Magnification/zoom/pan
 - iii. Rotation
 - iv. Image flip (inversion)
 - v. Region of interest (ROI)
 - vi. Field of view (FOV)
6. Image acquisition errors
 - a. Histogram analysis
 - i. Incorrect anatomic menu selection
 - ii. Exposure field recognition
 1. Collimation border recognition
 2. Exposure field distribution
 - a. Multiple fields/plate
 - iii. Unexpected material in data set
 1. Metal
 - a. Prosthetics
 - b. Plates and screws
 2. Lead
 - iv. Overexposure/saturation
 - v. Underexposure/starvation
 - vi. Failure of automatic rescaling
 1. Dark image
 2. Light image
 - b. Low intensity radiation response
 - i. Impact of accumulated background radiation
 - ii. Image retention
 1. Ghosting
 - c. Scatter control
 - i. Beam restriction
 - ii. Grid use
 1. Kilovoltage peak (kVp)
 2. Grid cutoff
7. Quality management
 - a. Continuous quality improvement (CQI)
 - i. Standards for quality
 - ii. Communications
 - iii. Quality management manual
 - iv. Responsibility and administration
 - v. Test equipment, procedures, and training
 - vi. Record-keeping
 - vii. Test review
 - viii. Evaluation
 - ix. Continuing education
 - b. Quality assurance and maintenance
 - i. Image quality control
 1. Exposure indicator accuracy
 2. Image integrity
 - ii. Imaging receptor systems
 1. Receptor maintenance
 - a. Cleaning and inspection
 - b. Erasure
 2. Equipment calibration
 3. Uniformity
 4. Spatial resolution
 - iii. Reject analysis
 1. Causation rate
 2. Action plan
 - iv. Monitor patient exposure
 1. Part of quality assurance (QA) program
 2. Vendor-supplied software
 - v. Service engineer and/or medical physicist
 1. Notification process
 2. Preventive maintenance
 - vi. Involvement in quality control
 - c. Benefits
 - i. Patient safety
 - ii. Reduced radiation exposure
 - iii. Efficacy of patient care
 - iv. Departmental efficiency
 - v. Consistent image quality
 - vi. Cost-effectiveness
8. Image display
 - a. Monitor
 - i. Characteristics
 1. Aspect ratio
 2. Spatial resolution
 3. Contrast resolution
 4. Luminance
 - ii. Types
 1. Active matrix array size (e.g., AMOLED)
 2. Liquid crystal displays (LCD)
 3. Light emitting diodes (LED)
 - iii. Care and maintenance
 - iv. Quality control
 1. Grayscale standard display
 - a. SMPTE
 - b. AAPM

- 2. Luminance
- 3. Resolution
- b. Viewing conditions
 - i. Ambient lighting (peripheral glare)
 - ii. Viewing angle/on-axis viewing (viewing direction)
 - iii. Veil glare
- c. Hard copy (e.g., laser film)
- 9. Image informatics and archiving
 - a. System architecture
 - i. Enterprise imaging
 - ii. Image distribution and viewing
 - iii. Integrating the healthcare enterprise (IHE)
 - iv. Health level seven standard (HL7)
 - v. Cloud-based computing
 - vi. Database health monitoring
 - vii. Cybersecurity
 - b. Network connectivity
 - i. Information management
 - 1. Hospital/health information system (HIS)
 - 2. Radiology information system (RIS)
 - 3. Electronic medical record (EMR)/electronic health record (EHR)
 - ii. Network architecture
 - 1. Network protocols
 - 2. Transmission protocols
 - 3. Network components
 - 4. Network configuration
 - c. Data file
 - i. Raw data
 - ii. Image data
 - d. Medical image management and processing system (MIMPS)–formerly, picture archiving and communications system (PACS)
 - i. System components and functions
 - ii. Emergency contingency plan
 - iii. Digital imaging and communication in medicine (DICOM) standards
 - iv. Technologists responsibilities
 - 1. Accessing work order (worklist)
 - 2. Post-processing (e.g., image operation and manipulation)
 - 3. Annotation issues
 - 4. Image transmission
 - 5. HIPAA
 - 6. Workflow
 - 7. Metadata
 - e. Medical image storage and communications devices
 - i. Architectures
 - 1. Network attached storage (NAS)
 - 2. Storage area network (SAN)
 - 3. Direct attached storage (DAS)
 - ii. Archive media and management
 - 1. Short-term digital memory (redundant array of independent discs [RAID])
 - 2. Long-term
 - a. Optical discs
 - b. Tapes
 - iii. Vendor neutral archives (VNA)
 - iv. DICOM storage considerations
 - 1. Service object pair (SOP) digital image storage
 - a. Digital image compress types
 - b. Digital image compression ratios
 - 10. Privacy and confidentiality
 - a. Image transmission
 - b. HIPAA
 - c. Electronic medical record (EMR) or electronic health record (EHR)
 - d. DICOM header elements
 - e. Teleradiology
 - 11. System downtime procedures
 - a. Patient scheduling
 - b. Order creation
 - c. Image acquisition
 - d. Image processing
 - e. Image informatics and archiving
 - f. Post-downtime data entry
 - g. Review and quality control

Lab Content

Not applicable.

Special Facilities and/or Equipment

1. Multimedia classroom
2. Digital radiology laboratory to create images for students to review
3. Digital QC equipment
4. Large flat panel monitor
5. Internet access

Method(s) of Evaluation

Methods of Evaluation may include but are not limited to the following:

- Quizzes
- Midterm
- Comprehensive final exam
- Participation in class discussion
- Process reflection paper
- Repeat analysis project

Method(s) of Instruction

Methods of Instruction may include but are not limited to the following:

- Lecture
- Discussion
- Cooperative learning exercises
- Demonstration

Representative Text(s) and Other Materials

Fauber, Terri. Radiographic Imaging and Exposure. 2021.

Course syllabus, provided by instructor.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

1. Weekly 20-page reading assignments from text and outside white papers produced by the American Society of Radiologic Technology
2. Reflection paper, of a minimum of three pages, comparing and contrasting digital imaging systems. This includes a requirement to interview a technologist to increase the student's understanding of the radiographic equipment utilized by their assigned clinical affiliate
3. Group presentation related to digital imaging technique. Students will create images from lab or Shaderware to demonstrate how SID, tube angle, kV, mAs, collimation, OID affects patient exposure

Discipline(s)

Radiological Technology