CHAPTER 9

Digital and Advanced Imaging Equipment

**KEY TERMS**
- active matrix array
- amorphous
- analog-to-digital converter
- aspect ratio
- cinefluorography
- computed radiography
- detective quantum efficiency
- Digital Imaging and Communications in Medicine group
- digital fluoroscopy
- digital radiography
- digital subtraction angiography
- digital x-ray radiogrammetry
- direct-to-digital radiographic systems
- dual-energy x-ray absorptiometry
- F-center
- fill factor
- frame rate
- image contrast
- image enhancement
- image management and communication system
- image restoration
- interpolation
- liquid crystal display
- Nyquist frequency
- photostimulated luminescence
- picture archiving and communication system
- pre-processing
- post-processing
- refresh rate
- special procedures laboratory
- specular reflection
- teleradiology
- thin-film transistor
- window level
- window width

**OBJECTIVES**
At the completion of this chapter the reader should be able to do the following:
- Describe the basic methods of obtaining digital radiographs
- State the advantages and disadvantages of digital radiography versus conventional film/screen radiography
- Discuss the quality control procedures for evaluating digital radiographic systems
- Discuss the basic methods of obtaining digital fluoroscopic images
- Explain how digital subtraction angiography is performed
- Discuss the quality control procedures for evaluating digital fluoroscopy
- Describe the basic principle of image production from multiformat cameras, laser cameras, dry laser printers, cathode-ray tube cameras, videotape and videodisc recorders, and cinefluorographic equipment and discuss the quality control procedures for each
- Describe the various types of electronic display devices and discuss the applicable quality control procedures
- Explain the basic image archiving and management networks and discuss the applicable quality control procedures
- Describe the basic quality control process for special procedures equipment
- Explain the various methods for obtaining bone mineral density measurements

**OUTLINE**

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Disadvantages of Computed Radiography versus Conventional Radiography 138
In recent years, diagnostic imaging has undergone an explosion in technology with the advent of computerized imaging, magnetic resonance imaging (MRI), and digital archiving and retrieval systems. All of these technologies are now commonplace in diagnostic imaging departments and can be subject to variations with age and use; therefore, quality control protocols should be in place to monitor for these variations so that they can be kept to a minimum.

**DIGITAL RADIOGRAPHIC IMAGING SYSTEMS**

Virtually all diagnostic imaging systems can be considered to have three key components: image acquisition, image processing, and image display. Since the late 1890s, radiographic images were acquired by exposing a screen/film combination that required chemical processing and was displayed on a viewbox illuminator. In digital imaging, an image acquisition system obtains image data in the form of an electronic signal, which is processed electronically in a computer memory whereby the image exists as electronic values in a computer matrix (rather than as grains of silver on a sheet of polyester plastic), and displayed on an electronic display device (computer monitor). The computer matrix is made up of tiny squares called pixels (a contraction of the term *picture element*). The more pixels in a matrix, the smaller each pixel becomes, thereby increasing spatial resolution (Fig. 9-1). The production of digital radiographic images is rapidly replacing this method of film/screen radiography. Creating radiographic images in a digital format has many advantages over the analog format (film/screen images), including:

- the reduction of repeat images due to technique error (Most overexposures and slight underexposure can be corrected with software and not have to be repeated, but gross underexposure cannot.),
- simplification in the filing of images (They can be stored electronically rather than in hard copy.),
- reduction in the number of lost images (Digital images are stored electronically and can be retrieved as long as it has been correctly entered and saved in the computer system.),
- postprocessing of the image (Detail and contrast can be enhanced by the computer software.),
- and electronic transmission of images (This allows quick access to images by referring physicians and for consultation over large distances.).
Currently, digital images can be acquired by using one of three methods: secondary capture, computed radiography (CR), or digital radiography (DR).

**Secondary Capture**

This method of creating digital images involves the initial creation of an analog image (on film) and then its conversion into a digital format. One method of accomplishing this conversion would involve taking a photograph of a film radiograph with a digital camera. This method has been used for years by diagnostic imaging educators (like myself) to obtain digital images. However, there is considerable loss of resolution even with a large matrix (>3-megapixel) camera. Therefore, it may be acceptable for teaching files or professional meeting presentations but should never be used to make a diagnosis. More acceptable conversion of analog film images to digital format can be accomplished by a laser scanning digitizer or a charge-coupled device (CCD) scanner. Common uses of secondary capture devices include:

- Film radiographs are archived into a picture archiving and communication system (PACS).
- Computer-aided diagnosis is a software program whereby the computer can look for abnormalities in mammography and chest radiographs.
- Teleradiology is the process of sending digitized images to distant locations for interpretation and consultation.
- Duplicate Images allows the original film-based radiograph to remain at the original clinical site while an electronic copy made by the digitizer can be burned onto a CD or DVD and given to the patient.

**Laser Scanning Digitizer.** The laser scanning digitizer is used to convert an existing radiographic image that is recorded on film into a digital format that can be stored and transmitted electronically (Fig. 9-2). It is similar in function to a scanner that is used with a personal computer to scan photographic images into the computer data storage. The existing radiograph is placed in the digitizer, where it is scanned by a laser and then detected by photosensors on the other side. The signals sent by the photosensors are then sent through analog-to-digital converters (ADCs) and into the computer memory. The higher optical density areas of the film image attenuate a higher percentage of the laser light.