1.2 Digital radiography

Digital radiography (DR) is a type of X-ray imaging that uses a digital sensor to capture and translate X-ray radiation into a digital image:

DR has many advantages over traditional X-ray imaging, including:

- **Immediate access**

  Images are available immediately after the exam and can be viewed by multiple physicians simultaneously

- **Electronic access**

  Images can be accessed electronically through electronic health records (EHRs)

- **Portability**

  Patients can take their X-ray images on a compact disk to another hospital or physician

- **Filmless**
  DR can make a radiological facility filmless, eliminating the need for chemical film processing

There are two types of digital radiography:

- **Computed radiography (CR)**

  Uses an imaging plate (IP) to replace traditional film. CR is often the first step toward digital imaging technology because it's relatively inexpensive to install.

- **Digital detector array radiography (DDA)**
  Also known as digital radiography, DDA uses a digital detector array or flat panel detector to convert X-rays directly into a digital image. Flat panel detectors can provide high quality images with a better signal-to-noise ratio.

Some disadvantages of DR include:

- The cost of the detectors
- The need for high resolution monitors and high luminance to view the images
- The need for a picture archiving and communication system (PACS) with high bandwidth to store and archive the images

Discrete digital detectors

Discrete digital detectors are used in digital radiography (DR) to capture and store X-ray images using digital values. This is in contrast to conventional film radiography, which uses analog values.

Digital detectors can be categorized as direct or indirect:

- **Direct detectors**: Convert X-rays directly into electrons that are measured
- **Indirect detectors**: Convert X-rays into visible light first, and then into electrons that are measured

Digital detectors are used in a variety of applications, including:

- Aerospace product examination
- Detecting corrosion under insulation (CUI) in the oil and gas, petrochemical, and power generation industries
- Detecting flow accelerated corrosion

Digital detectors can be used in place of film or computed radiography (CR) systems. CR systems use imaging plates that contain a flexible phosphor plate that stores a latent image. The computerized system scans the plate into a digital format for image processing, archiving, and presentation.

Storage phosphors, also known as photostimulable phosphors (PSPs), are used in computed radiography (CR) to produce digital images:

- **How it works**

  X-rays are absorbed by the storage phosphor plate, which excites electrons to higher energy levels. This creates a latent image. When the plate is read out, the energy is released as blue photons.

- **Benefits**

  CR offers many advantages over traditional X-ray film, including:

  - **Less radiation**: Digital imaging sensors are more sensitive than film, so less radiation is needed to produce an image.
  - **Improved image quality**: Digital X-rays can better reveal small areas of decay, gum disease, abscesses, and more.
  - **Faster results**: Digital X-rays require little processing time, so results can be viewed almost immediately.
  - **Electronic records**: Digital images can be easily stored in electronic patient files and transferred to other specialists and insurance companies.
  - **More environmentally friendly**: Digital X-rays don't require lead foil, chemical processing, or the disposal of hazardous wastes.

  Other types of digital radiography include direct digital radiography and direct conversion.

Film processing in radiography is a procedure that converts a latent image on a film into a visible radiograph. The process involves four main steps:

- **Development**

The film is exposed to a developer solution, such as hydroquinone or phenidone, for a specified time. The developer solution reduces silver ions into silver atoms, which precipitates metallic silver in the emulsion layer.

- **Stop bath**

  The film is immersed in a stop bath solution, usually a dilute solution of acetic acid or citric acid, to stop the action of the developer.

- **Fixing**

  The film is washed in a chemical solution called a fixer, which dissolves unexposed silver halide crystals and leaves behind metallic silver. The fixer also hardens the film.

- **Drying**

  The film is dried.

Radiographic film is made of a layer of emulsion coated on one or both sides of a transparent polyester plastic base.