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Q1: Describe the parts of a digital fluoroscopy imaging system and explain their functions.

Ans: **Parts of digital fluoroscopy imaging system:-**

The key components include an X-ray tube, spectral shaping filters, a field restriction device (collimator).

- An anti-scatter grid
- An image receptor
- An image processing computer.
- A display device

Ancillary but necessary components includes a high voltage generator, A patient-support device (table or couch) and Hardware to allow positioning of X-ray source assembly and the image receptor assembly relative to the patient.

Digital Fluoroscopy System:-

The main components of a digital fluoroscopy system are:-
(1) Flat screen monitors
(2) CCD (Charge couple device)
(3) Flat panel image receptor
(4) Computer and Operating console.

Advantages of Digital fluoroscopy over conventional fluoroscopy include the speed of image acquisition and post processing to enhance image contrast.
Digital fluoroscopy is currently most commonly configured as a conventional fluoroscopy system.

The Analog video signal is converted to a digital format with an analog-to-digital converter (ADC).
The computer has been added as have multiple monitors and a more complex operating console.

• Charge-coupled device -

A major change from conventional fluoroscopy to DF is the use of a charge coupled device (CCD) instead of a TV camera tube.
The sensitive component of a CCD is a layer of crystalline silicon.

→ The CCD is mounted on the output phosphor of the image-intensifier tube and is coupled through the fiber optics.

The CCD has greater sensitivity to light a lower level of electronic noise than a television camera tube.

The response of the CCD to light is very stable. Warmup of the CCD is not required.

"DF with CCD results in wider dynamic range and better contrast resolution than conventional fluoroscopy"

- **Flat Panel Image Receptor:-**

The further improvement of DF imaging is developing the flat panel image recepter (FPIR).

Such as image receptor is much smaller and lighter and is manipulated more easily than an image intensifier.

Flat panel detectors are more Sensitive and Faster than Film.

- **Flat Panel image display:-** Flat panel display technology is rapidly replacing the cathode ray tube (CRT) in all applications. They are easier to view and easier to manipulate, they provide better images.

Q2:- Explain the four prime exposure factors?

Ans:- The four prime exposure factors are:-

1. Kilovolt peak (kVp)
2. Current (mA)
3. Exposure time (s)
4. Source to image receptor distance (SID).

(b) Secondary factors:-

1. Focal spot size
2. Distance
3. Filtrations

• Four Prime Exposure:-

1. Kilovolt Peak (kVp):-

kVp controls screen-film radiographic contrast & beam penetrability.

→ The kVp has more effect than any other factor on image receptor exposure.

→ kVp increases, less differential absorption occurs. Therefore, high kVp result in reduced image contrast.

2. **Milliamperes:-**

The mA selected determines the numbers of x-rays produced and therefore the radiation quality.

As more electrons flow through the x-ray tube more x-rays are produced. With a constant exposure time, mA controls the x-ray quality and therefore the patient radiation dose.

→ X-ray quality remains fixed with a change in mA.

3. **Exposure time:-**

Radiographic exposure times usually are kept as short as possible.

→ The purpose is not to minimize patient radiation dose but rather to minimize motion blur that occur because of patient motion.

→ Short exposure time reduces motion blur.

4. Distance:-

Distance has no effect on radiation quality.

→ (1) Distance (SID) affect (OD).

Q3. Identify four image-quality factors and explain how they influence the characteristics of a radiograph.

Ans:- **Image-Quality Factors:-**

Image-quality factors refers to characteristics of the radiographic image; these includes:-

1) OD.
2) Contrast
(3) Image detail
(4) Distortion.

Image-quality factors are considered the 'language' of radiography.

- Characteristics of a radiograph:-

1. Optical Density:-

Optical density is the degree of blackening of the finished radiograph.

→ In medical imaging, many problems involve an "image being "too dark" or "too light".

A radiograph that is too dark has a high OD caused by exposure.

This situation results when too much x-radiation reaches the image receptor

→ Opitical density can be controlled in radiography by two major factors:- mAs and SID.

2. **Contrast:-**

The function of contrast in the image is to make anatomy more visible.

→ Contrast is the difference in OD between adjacent anatomical structures, or the variation in OD on a radiograph.

→ Contrast therefore is perhaps the most important factor in radiographic quality.

→ KVp is the major factor used in controlling radiograph contrast.

3. **Detail:-**

Detail describes the sharpness of appearance of small structure on the radiograph. With adequate detail, even the smallest parts of the anatomy are visible, and the radiologist can more readily detect tissue abnormalities.

Sharpness of image detail is best measured by spatial resolution.

4. Distortion:-

It is reduced by positioning the anatomi- part of interest in a plane parallel to that of the image receptor.

→ The misrepresentation of object size and shape on the radiograph. Because of the position of x-ray tube, the anatomical part, the image receptor, the final image may misrepresent the object.

Q4:- Describe the components of an image intensifier.

• Image Intensifier Components:-

An image intensifier consists of the following major components:-

(1) An input window;
(2) An input phosphor
(3) Photocathode
(4) Several electrostatic focusing lenses
(5) An accelerating anode
(6) An output phosphor screen
(7) A protective vacuum case.

• Glass envelope:-

Surrounds all of the components and provides mechanical support of internal components has a vacuum tube.

2. Input phosphor:-
Receives incident x-rays from the x-ray tube and converts them into light. Composed of cesium iodide.

- Photocathode:-
Attached to the input phosphor by an adhesive layer, converts light from input phosphor to electrons by photo-emission negative portion of the tube.

- Anode:-
Positive portion of the tube. A circular plate with a hole in it in which electrons are focused to which goes to the output phosphor.

- Electrostatic Focusing Lenses:-
Focuses electron path form photocathode to anode by means of

of repulsion.

- **Output phosphor:-** Converts electrons from anode to light.

Q5:- Enumerate the advantages of using a flat panel image receptor.

Ans5- The further improvement of DF imaging is developing the flat panel image receptor (FPIR).

→ Such as image receptor is composed of cesium iodide (CsI)/amorphous silicon (a-Si) pixels. The FPIR is much smaller and lighter and is manipulated more easily than an image intensifier.

→ Flat-panel detectors are more sensitive and faster than film.

Their sensitivity allows a lower dose of radiation for a given picture quality than film.

→ As tubes were replaced by CCD now CCD will be by FPIRS which is smaller, lighter and manipulated more easily.

→ It provides easy manipulation of patient, radiologist, radiographer.

→ No cassette is required.

(b) Describe the properties and use of a charge-coupled device.

- **Properties of CCD:-**

The principal advantage of CCDs in most applications, such as a digital camera, is their small size and ruggedness.

→ The spatial resolution of a CCD is determined by its physical size and pixel count.

→ The CCD has greater sensitivity to light (Detective quantum efficiency) DQE and a lower level of electronic noise than a television camera tube.

→ The results are higher signal to noise ratio (SNR) and better contrast.

Advantages of charge-coupled devices for Medical Imaging:-

(i) High Spatial resolution
- High SNR
- High DQE
- No warm up required
- No lag or blooming
- No spatial distortion
- No maintenance
- Unlimited life
- Linear Response
- Lower patient dose
- Unaffected by magnetic fields.

- **Use of Charge-coupled device:-**

Charge-coupled device (CCD) is a device for the movement of electrical charge, usually from within the device to an area where the charge can be manipulated for example conversion into a digital value.