

PA Fluoroscopy

Digital Fluoroscopy

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Terminology

- Matrix – grid made of pixels
- Pixel – picture element
- SNR / CNR
- CCD – Charge coupled device
- PACS – Picture Archival and Communication System
- HIS / RIS
- HIPAA

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Terminology

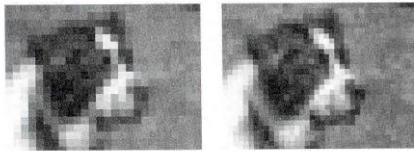
- Flat panel detector
- Contrast resolution / Dynamic range
- DICOM gray-scale function
- WW/WL function
- DSA
- Sampling frequency
- DEL (detector element size)

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Matrix

- Every image is made of small squares called pixels (picture element)
- Within a specified field size, an increased matrix will equate to a more detailed image
 - Let's say we have a 9" square field
 - If the field has a matrix of 16 x 16, the pixels are large
 - If the same field has a matrix of 512 x 512, the pixels are considerably smaller

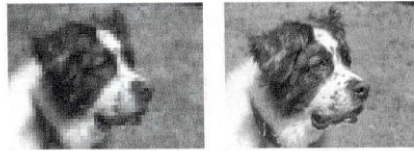
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1

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<http://www.picturemosaics.com/gallery/zoom.php?i=30&rows=4&page=2&term=>



3

4

Charge Coupled Device

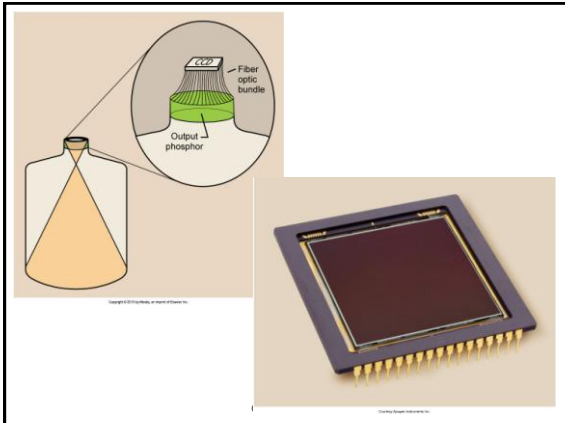
- Would be used instead of a TV camera at the output phosphor
- Mounted on the output phosphor, the light is transferred through fiberoptics
- The sensitive layer of the CCD is composed of crystalline silicon

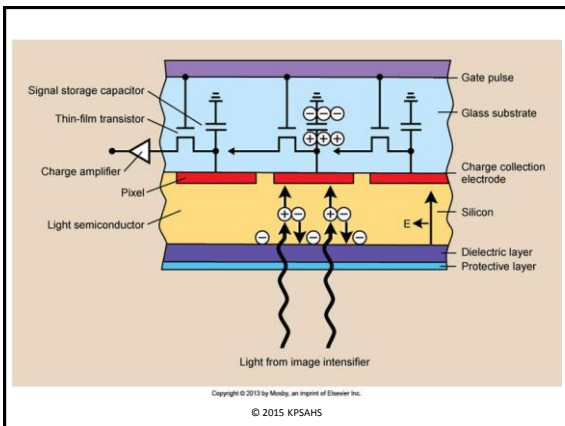
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Charge Coupled Device (cont)

- When the silicon is illuminated, an electrical charge is generated
- Electrical charge is put through the ADC (analog-to-digital converter) then sent to the computer

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Charge Coupled Device (cont)

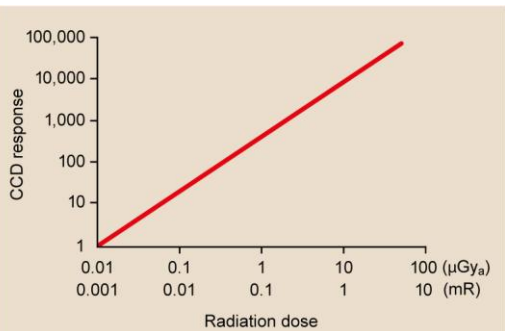
- The CCD contains pixels arranged in a matrix
- Each pixel is sampled and manipulated to produce a digital image
- No lag or blooming
- No spatial distortion (pincushion)

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Charge Coupled Device (cont)

- No warm up time
- Lower patient dose
- Image quality depends on the matrix of the CCD

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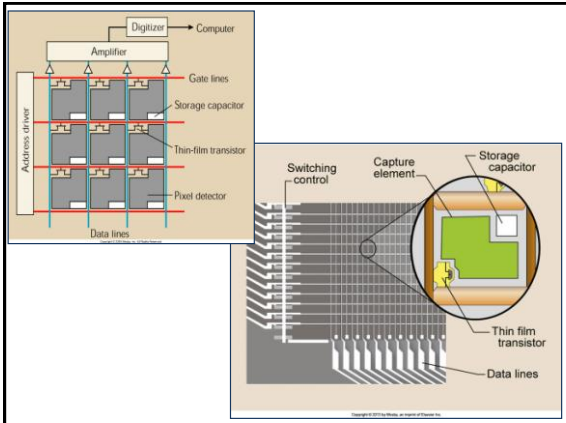
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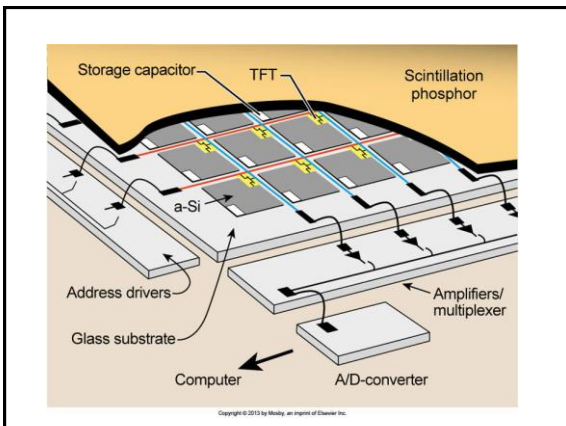
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Flat Panel Detector

- Flat Panel Image Receptor (FPIR)
- Used in place of an image intensifier
- Composed of CsI / a-Si detector elements (DEL)
 - Each DEL represents a pixel
 - Size of the pixel will help determine spatial resolution
- Pixel size = FOV divided by matrix

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FPIR

- Digital fluoroscopy operates in radiographic mode
 - Tube current measured in hundreds of mA instead of 1 to 5 mA
- Images are obtained in a manner called pulse-progressive fluoroscopy
- Imaging rates between 1 and 10 frames per second

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FPIR (cont)

- Exposures can be continuously varied for dose reduction
- Each time the flat panel is exposed, it is read immediately and the image is projected until the next image is acquired
- X-ray generator must be capable of switching on and off very rapidly

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FPIR (cont)

- Interrogation time is the time required for the x-ray tube to be switched on and reach selected levels of kVp and mA
- The time required for the x-ray tube to be switched off is the extinction time
- HF generators are used to keep interrogation and extinction times (total on/off cycle) to less than 1 ms

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FPIR (cont)

- The fraction of time the tube is energized is the duty cycle
- The next graphic shows the x-ray tube is energized for 100 ms every second
- This represents a 10% duty cycle
- Can result in significant dose reduction

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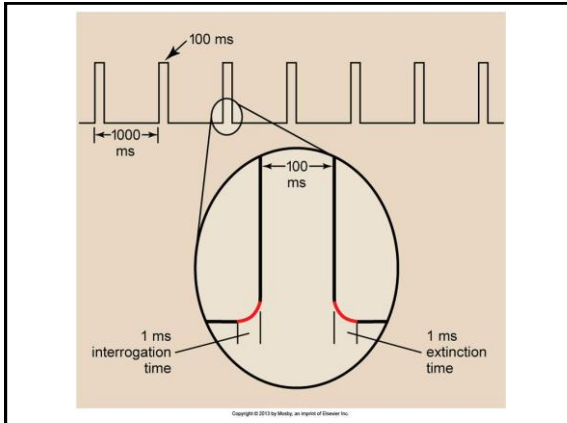


Image Gently: Enhancing Radiation Protection During Pediatric Fluoroscopy

FPIR Quality

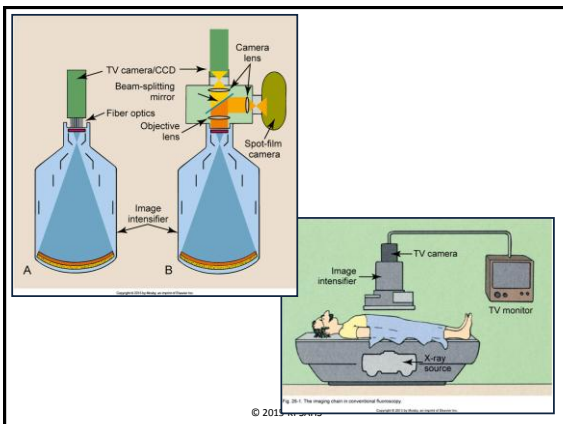
- Higher DQE than CCD
- Distortion-free images
- Improved contrast resolution
 - The ability to distinguish many shades of gray from black to white
 - Grayscale (dynamic range)
- A rectangular image area can be matched with a rectangular display

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Conventional vs. Digital

- Typical imaging chain in conventional fluoroscopy
- X-ray tube is below table
- Light from x-ray photons are “intensified” through the image intensifier
- Light at the output phosphor is split between a TV monitor and a recording device

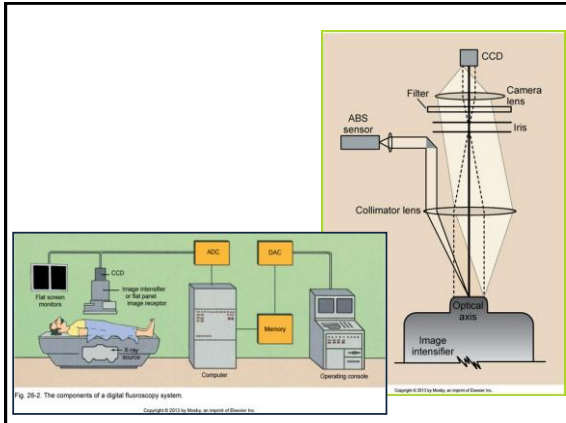
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Conventional vs. Digital

- Typical components of a digital system
- Instead of a TV camera attached to the output phosphor, a CCD or flat panel is used
- A computer is used to allow manipulation of images
- Brightness of the image is based on the pixel values

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SNR / CNR

- SNR – Signal to Noise Ratio
 - Signal from the unit scaled against inherent noise of the system
 - 1000:1 is needed in DF

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SNR / CNR (cont)

- CNR – Contrast to Noise Ratio
 - Relationship of signal intensity differences between two regions scaled to image noise
 - Increased CNR increases perception of distinct differences between two areas
 - Both pertain to video display

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Video Display

- Typical display monitors (CRT) with interlaced mode (525 lines per frame consisting of two fields of 262.5 lines each)
- Interlacing action of a display degrades the image
- Television cameras are noisy
- SNR is about 200:1

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Video Display (cont)

- DF TV camera tubes reads in progressive mode
 - Video signal sweeps from top to bottom in 33 ms
- There may not be a TV camera if the signal goes to the computer first
- No flickering
- Sharper image

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Video Display (cont)

- Many systems use flat panel displays
- Easier to view and easier to manipulate
- Better image quality
- Lightweight and easy to see
- Can be suspended from the ceiling
- Digital imaging allows image manipulation

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Window and Level

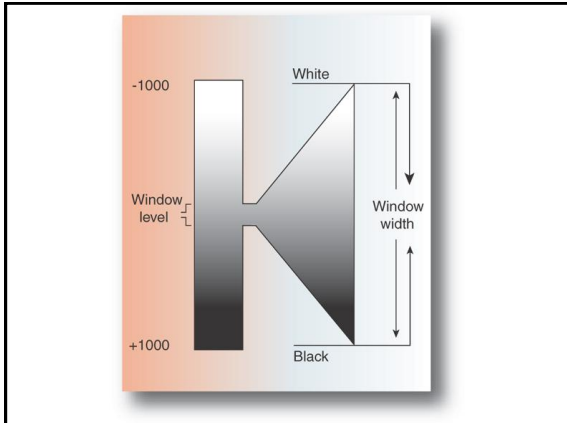
- Most common method of image manipulation
- Dependent on bit depth of the system
 - Bit processing will determine how many shades of gray can be manipulated
 - For instance, an 8-bit system would have 256 shades available while a 10-bit system would have 1024

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Window and Level (cont)

- Contrast in different regions of interest can be enhanced as long as the computer system has a sufficient dynamic range
- With digital, we can alter the display window and level
 - Window is the number of gray shades (controls image contrast)
 - Level (center) is where that window is centered along the gray scale (controls image brightness)

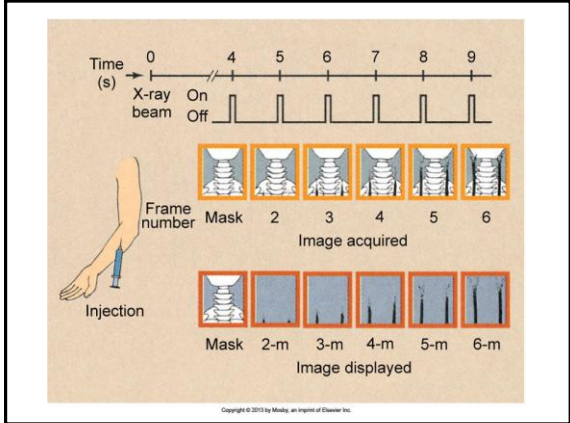
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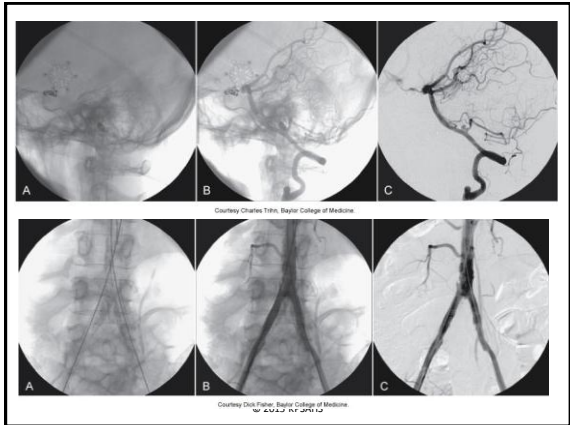


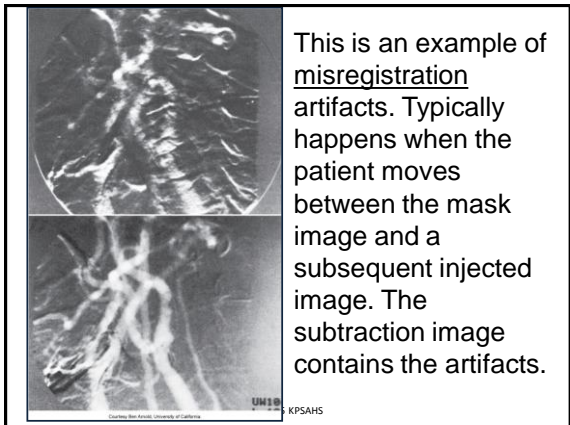
DSA

- Digital Subtraction Angiography
- Helps enhance image contrast through post-processing
- Steps involved include creating a mask, applying an image with IV contrast, and subtracting out the information that is not needed

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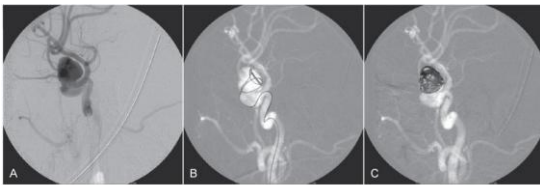


Roadmapping

- A special application of DSA
- The mask image is stored, contrast is injected, and subtracted images are acquired
- As the catheter is advanced, another mask is obtained showing the catheter in the vessel

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Roadmapping



Courtesy Michael Maxwell, Baylor College of Medicine

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PACS

- Picture Archival & Communication System
- Allows acquisition, interpretation, and storage of images
- Four components: acquisition, display, network, and storage
- Separate from any other network in the facility

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DICOM

- PACS can accept any image in a DICOM format
- Digital Imaging and Communications in Medicine
- DICOM is a standard
- Prior to that, each vendor had its own way of storing images with no need to share

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DICOM (cont)

- Each manufacturer has its own proprietary image file which needs to be converted into DICOM
- Within the image file, there are other pieces of information like patient and image information
- DICOM is an object-oriented standard
 - Two classes of information

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DICOM (cont)

- Object class
 - Contains information about the study and the patient
 - Includes normalized and composite information
- Service class
 - Describes what to do with the object
 - Includes image storage, image query, image retrieval, image print, storage resource, and composite information

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HIS / RIS / EMR

- HIS: Hospital Information System
 - Holds a patient's full medical record (billing, inpatient ordering)
- RIS: Radiology Information System
 - Holds radiology-specific patient data (patient scheduling, reports)
- EMR: Electronic Medical Record
- EHR: Electronic Health Record

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HL 7 Standard

- HL 7: Health Level 7
- Oversees most clinical and administrative data
 - Demographics, reports, claims, orders (text based information)
 - A standard generally used to communicate between the HIS and RIS

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HIPAA

- Stands for the Health Insurance Portability and Accountability Act of 1996
- Mandated governing the provision of health benefits, delivery and payment for healthcare services, and security / privacy of protected health information (PHI) in written, electronic or oral formats

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