Syrian Private University
Faculty of Dentistry
Department of Oral Medicine

Digital imaging

Lecture 7

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Digital radiography

- A digital image consists of a large collection of individual pixels organized in a matrix of rows and columns.

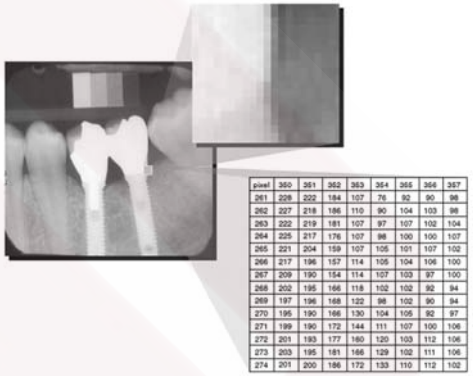


Image formation

- At each pixel of an electronic detector, the absorption of x rays generates a small voltage.
- More x rays generate a higher voltage and vice versa.

Differences between digital and film-based radiography

- Exposure time is reduced.
- The physics of the interaction of x rays with matter and the effects of the projection geometry on the appearance of the radiographic image are unaltered in digital radiography.

Advantages of digital radiography

- Digital imaging eliminates chemical processing.
- Hazardous wastes in the form of processing chemicals and lead foil are eliminated with digital systems.
- Images can be electronically transferred to other health care providers without any alteration of the original image quality.

Advantages of digital radiography

- Digital intraoral receptors require less radiation than film, thus reducing patient exposure.
- Digital imaging allows enhancements, measurements, and corrections not available with film.

Disadvantages of digital radiography

- The initial expense of setting up a digital imaging system is relatively high.
- Certain components, such as the electronic x-ray receptor used in some intraoral systems, are susceptible to rough handling and are costly to replace.

Disadvantages of digital radiography

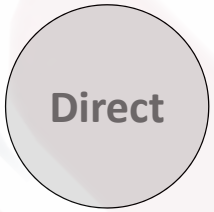
- The excellent image quality and comparatively low cost of a properly exposed and processed film keeps film-based radiography competitive with digital alternatives.

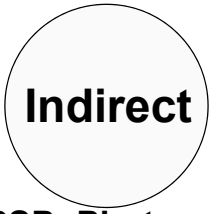
Digital X-ray receptors

1- Solid state detectors (CCD/ CMOS/ Flat panel).

2- Photostimulable phosphor technology (PSPP) [It will be covered in RAD-2 in-sha'a Allah].

Digital X-ray receptors





CCD **CMOS**

PSP: Photo-stimulable Phosphor

Digital X-ray receptors

In some references, making a digital version of the radiograph by a scanner or digital camera is called indirect digitalization.

- The benefit is that digital enhancement can be performed.

Digital X-ray receptors

1- Solid state detectors.

- It is often called sensors in dentistry.
- Consist of solid semiconducting material.
- The radiograph is available rapidly after the exposure.
- The internal components are enclosed within a plastic housing to protect them from the oral environment.

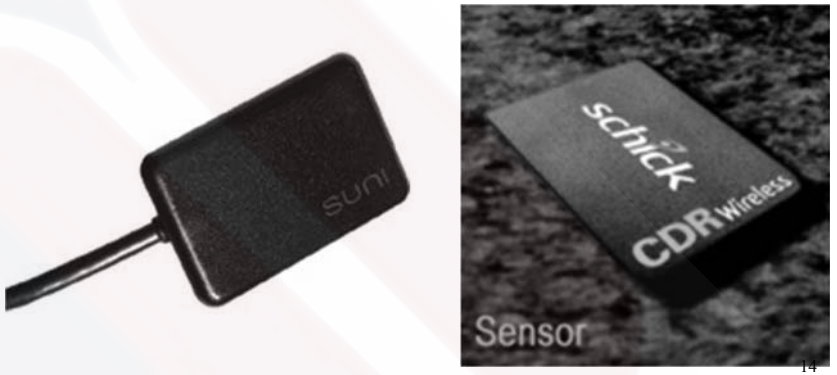
Digital X-ray receptors

1- Solid state detectors.

- Disadvantages include sensors bulk, and the presence of a cable attached to the sensor.
- Sensors that does not include a cable (wireless sensors) have increased the overall bulk of the sensor.

Digital X-ray receptors

1- Solid state detectors.

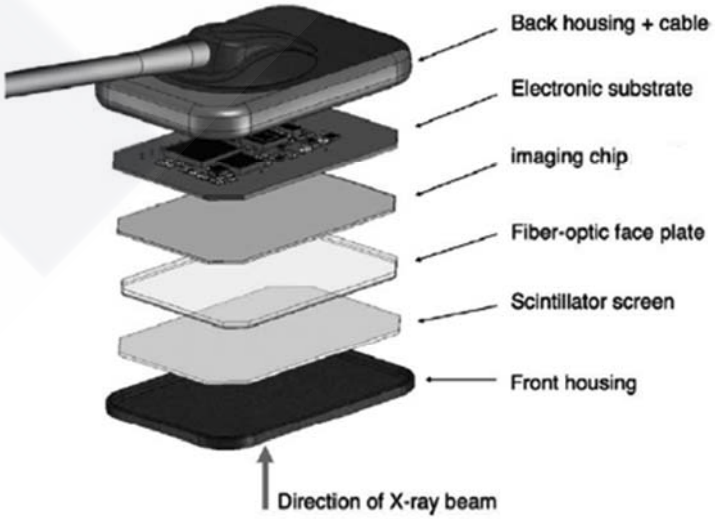


Digital X-ray receptors

1- Solid state detectors.

- Pixel sizes ranges from 20 to 70 µm (sensors are made of 1.5 to 2.50 Mega-pixel).
- The smaller the size of the pixel, the higher the resolution.

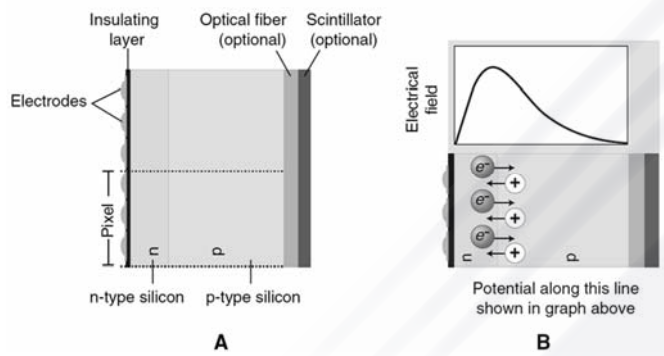
Digital X-ray receptors



Digital X-ray receptors

I. Charge-coupled device (CCD)

- It uses a thin wafer of silicon.



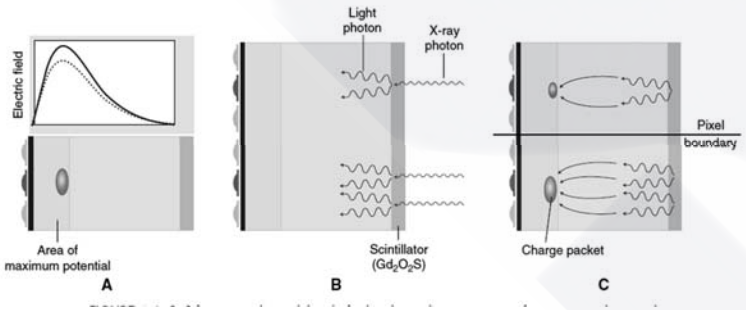
Digital X-ray receptors

I. Charge-coupled device (CCD)

- When exposed to radiation, the covalent bonds between silicon atoms are broken, producing electron-hole pairs.
- The number of electron-hole pairs that are formed is proportional to the amount of exposure that an area receives.
- CCD is the basis for digital cameras.

Digital X-ray receptors

I. Charge-coupled device (CCD)



Digital X-ray receptors

II. Complementary Metal Oxide Semiconductors (CMOS)

- It is a silicon-based semiconductors.
- It is the basis for typical digital cameras.
- Less expensive that CCD.

Digital Radiography equipment

X-ray machine

Sensor

Computer

X-ray machine

- DC machines are preferable as they offer low exposure time (as low as 0.02 s).
- Thus, DC machines prolong the life-time of the sensor.

Computer monitors

- Current digital detectors record the images with 256 to 65536 different shades of grey.
- Computer monitors are capable of displaying a gray scale of only 256 shades.
- Human eyes can capable of distinguishing about 30 shades under the typical viewing environment in the dental operatory.

Imaging techniques considerations

- **All intraoral techniques are applicable (paralleling, bisecting angle or bitewing technique). Paralleling and bitewing techniques are the recommended.**
- **Projection geometric properties are the same for digital receptors and film.**
- **Parallel device is different for sensors.**

Imaging techniques considerations

Digital radiograph enhancement

- The nature of the digital radiograph allows for adjusting the resultant radiograph.
- This can be accomplished by increasing contrast, optimizing brightness, and reducing unsharpness and noise and other tasks.
- Improving the diagnosis by these procedures is still a controversial issue.

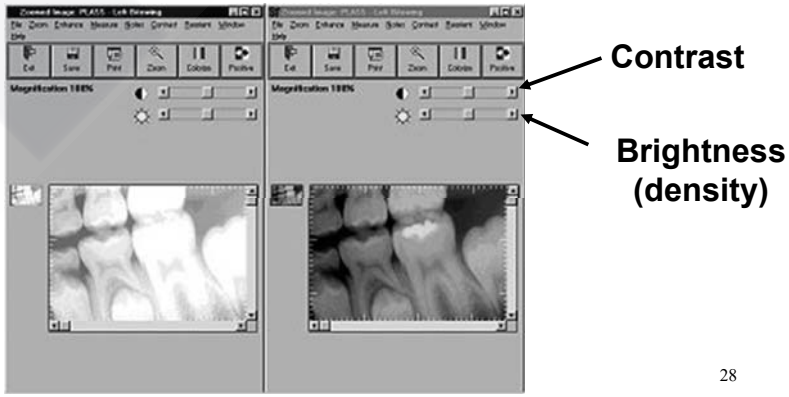
Digital radiograph enhancement

I. Adjusting the density and the contrast.

- Some studies show substantial benefits of contrast enhancement operations, whereas others have found only limited value or no improvement at all.
- If the subject contrast was not captured, it cannot be enhanced.

Digital radiograph enhancement

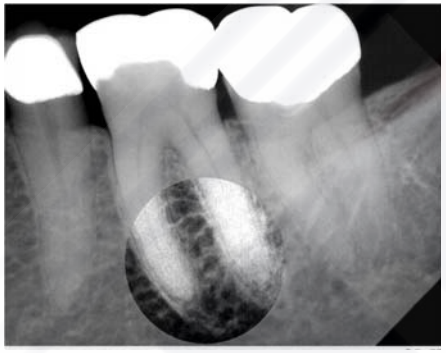
I. Adjusting the density and the contrast



Digital radiograph enhancement

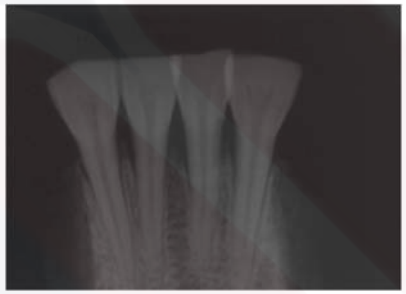
II. Equalization

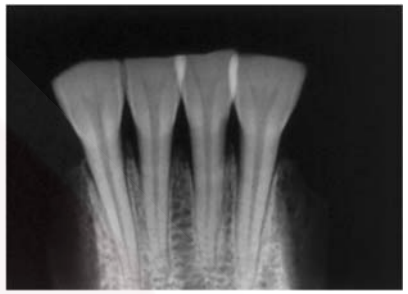
- Reducing the number of the gray shades within the radiograph.



Digital radiograph enhancement

II. Equalization





Digital radiograph enhancement

II. Equalization

- No reports mentioned the usefulness of this procedure.

Digital radiograph enhancement

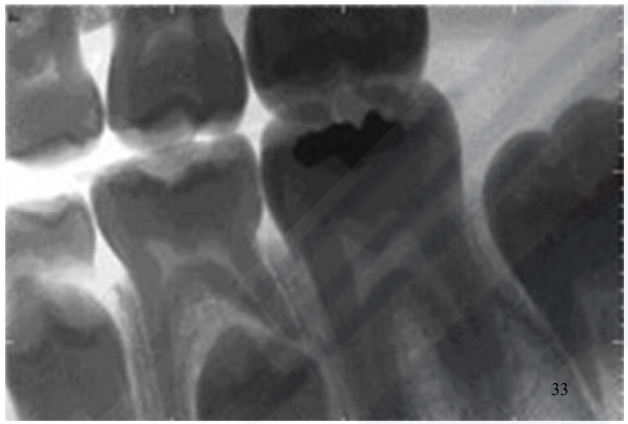
III. Contrast inversion

- Changing a radiographic positive image into a radiographic negative image.

- No usefulness was reported for this procedure.

Digital radiograph enhancement

III. Contrast inversion



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Digital radiograph enhancement

IV. Colorization

- Humans can distinguish many more colors than shades of gray.
- BE CAREFUL, in most cases, the changes distract the observer from seeing the real content of the image and result in degraded image interpretation.

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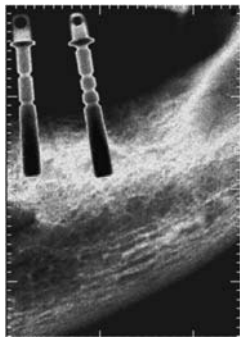
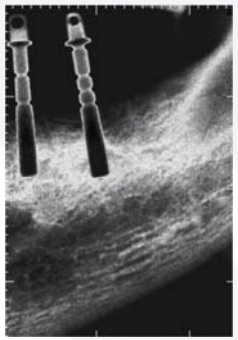
Digital radiograph enhancement

IV. Colorization





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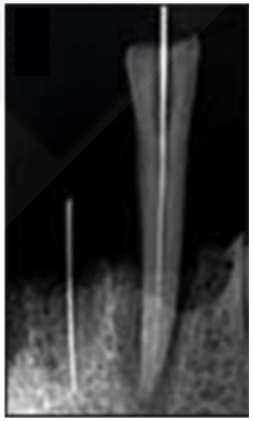
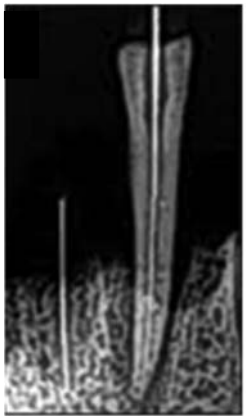
Digital radiograph enhancement

V. Sharpening (edge enhancement)





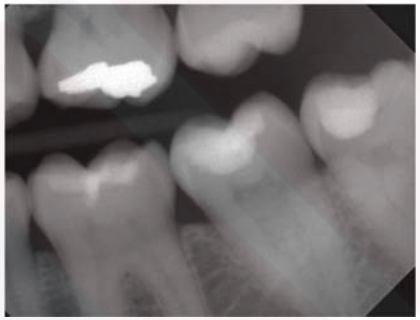
Digital radiograph enhancement

V. Sharpening (edge enhancement)

- It may be useful for endodontic files appearance on radiographs.
- Improper use of sharpening may produce radiolucencies at restoration edges simulating recurrent caries.

Digital radiograph enhancement

V. Sharpening (edge enhancement)



Digital radiograph enhancement

VI. Subtraction radiography

- Two images of the same object (2 different times) may be subtracted to better detect changes.
- It reveals small changes that may be undetectable by naked eye.

Digital radiograph enhancement

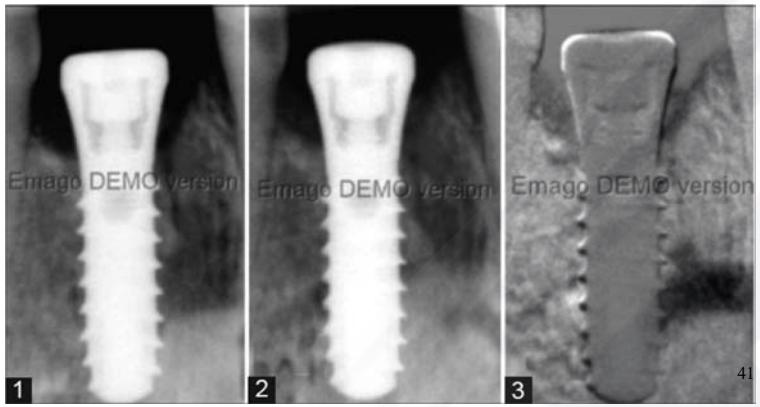
VI. Subtraction radiography

- Software may correct the little difference between the two original images.

After **Before**

Digital radiograph enhancement

VI. Subtraction radiography



Digital radiograph enhancement

VI. Subtraction radiography

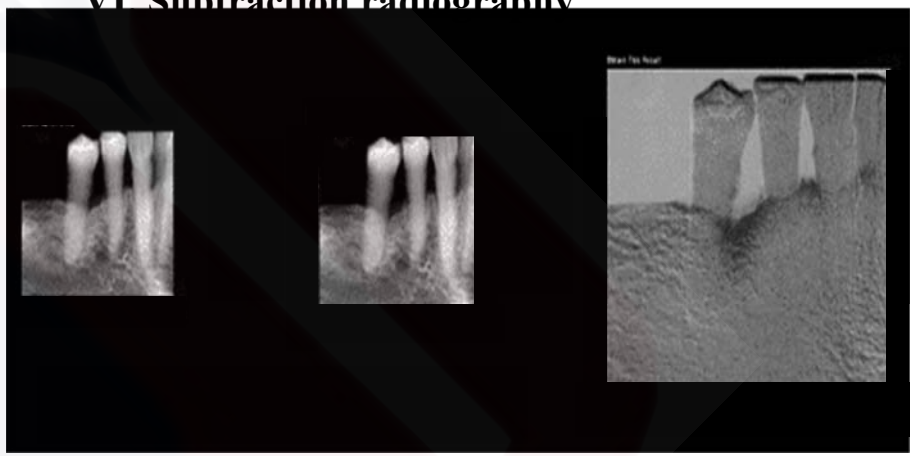
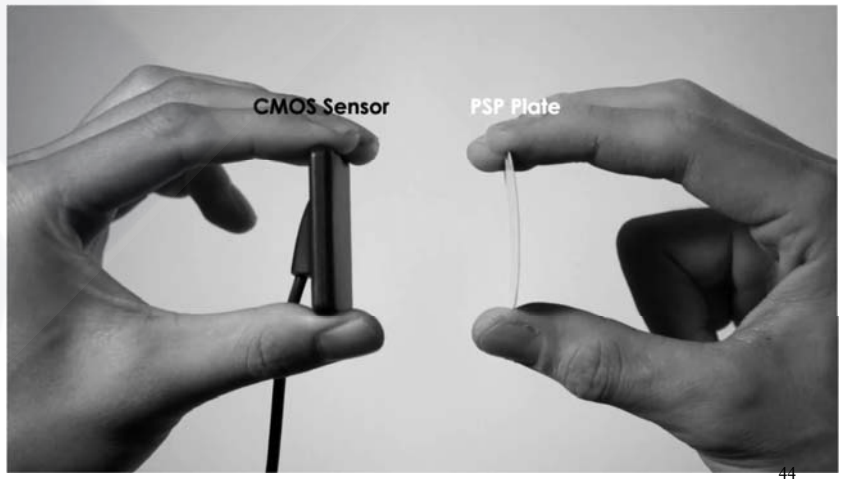


Image storage

- Intraoral radiograph image size is about 200 KB.
- All currently available programs save the image as a DICOM file format. Other format such as JPEG is also available.
- (DICOM) format has larger size than conventional image formats.

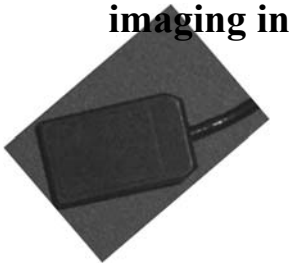
DICOM= digital imaging and communication in medicine.

Digital or film ?



Digital or film ?

- **From a diagnostic standpoint, most studies suggest that digital performance is not clinically different from film for typical diagnostic tasks, such as caries diagnosis.**
- **It is believed that shifting toward digital imaging in dentistry is certain.**



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