Digital Imaging

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Main Components of Digital Imaging System

- The x-ray source
- The detector: it measures the photon intensity of the x-ray beam and convert it into electrical signal (analog signal)
- Analog-digital converter (ADC) or digitizer: is used to change the analog signal to a numeric representation based on the binary number system recognizable by the computer.
- Image display: which are conventional computer monitors, thin film transistor used in laptop or flat panel computer displays, hard copies (like film printer or paper printer)

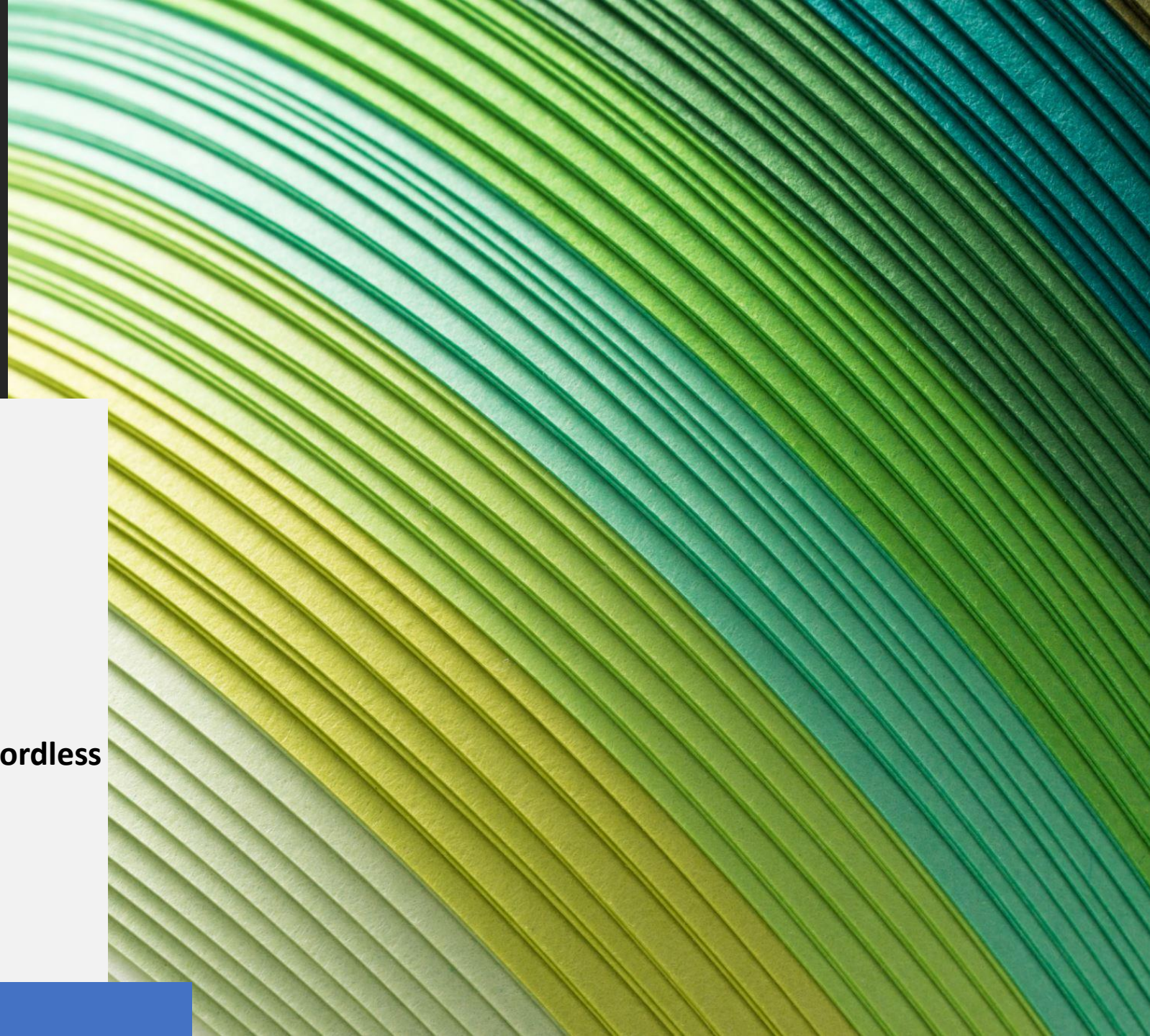
Digital imaging produces a dynamic image in which the visual characteristics of density and contrast can be manipulated to meet specific diagnosis or to correct errors in exposure techniques.

Methods of Acquiring a Digital Image

Digital images are acquired either:

- **Directly**: using a sensor or imaging plate replacing conventional film.
- **Indirectly**: by scanning and digitizing a film-captured image.

Direct digital imaging systems are divided into two types



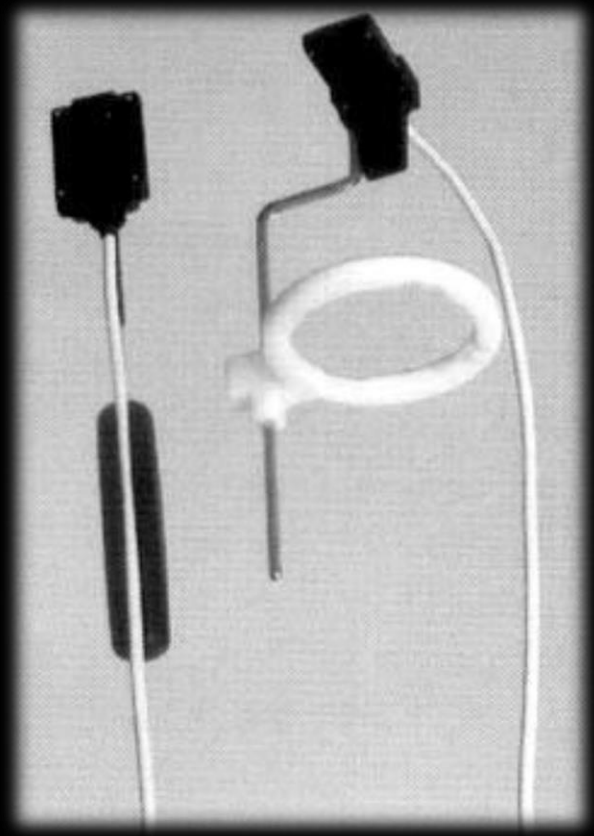
1. **Real time or corded**
2. **Photostimulable phosphor storage plate or cordless**

Real time or corded

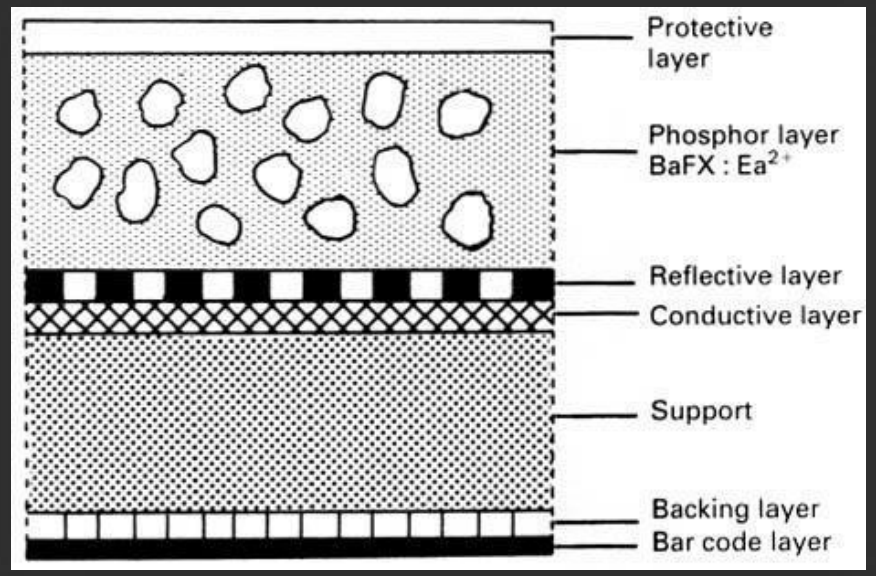
This system use conventional x-ray machine but conventional film is replaced by either a CCD (charge coupled device) or a CMOS (complementary metal oxide semiconductor) sensor which is connected to the computer via a cable (or cord).

The X-ray photons that reach the sensor are converted to light, and picked by the CCD/CMOS and converted into an electrical charge which, once produces a digital image on the monitor of the computer (so called real time).

Specially designed intraoral sensor holders similar to those used for conventional film, have been developed, when used clinically, the sensors need to be covered with a protective plastic barrier envelope for infection control purposes.



Photostimulable phosphor storage plate or cordless



Cross-section of a typical phosphor imaging plate

In This system the conventional film is replaced by photostimulable phosphor imaging plates (PSPP) .

The phosphor layer absorbs and stores the X-ray energy. The image plate is then placed in a reader where it is scanned by a laser beam. The stored X-ray energy in the phosphor layer is released as light, the information is displayed as a digital image on the monitor The time taken to read the plate depends on the system being used, and the size of the plate, but usually varies (1 – 5) minutes. The intraoral plates are inserted into protective barrier envelopes and can then be used in conventional film holders.

Theory

As computers deal with numbers and not pictures, a radiographic image within a computer is represented as a sequence of numbers. This image may be considered as a grid or matrix of tiny boxes or pixels. Each pixel has an x and y axis. Each number, and hence each pixel has an appropriate shade of grey.

The range of numbers is normally from (0 - 256) with 0 representing black, 256 representing white and all others are shades of grey.

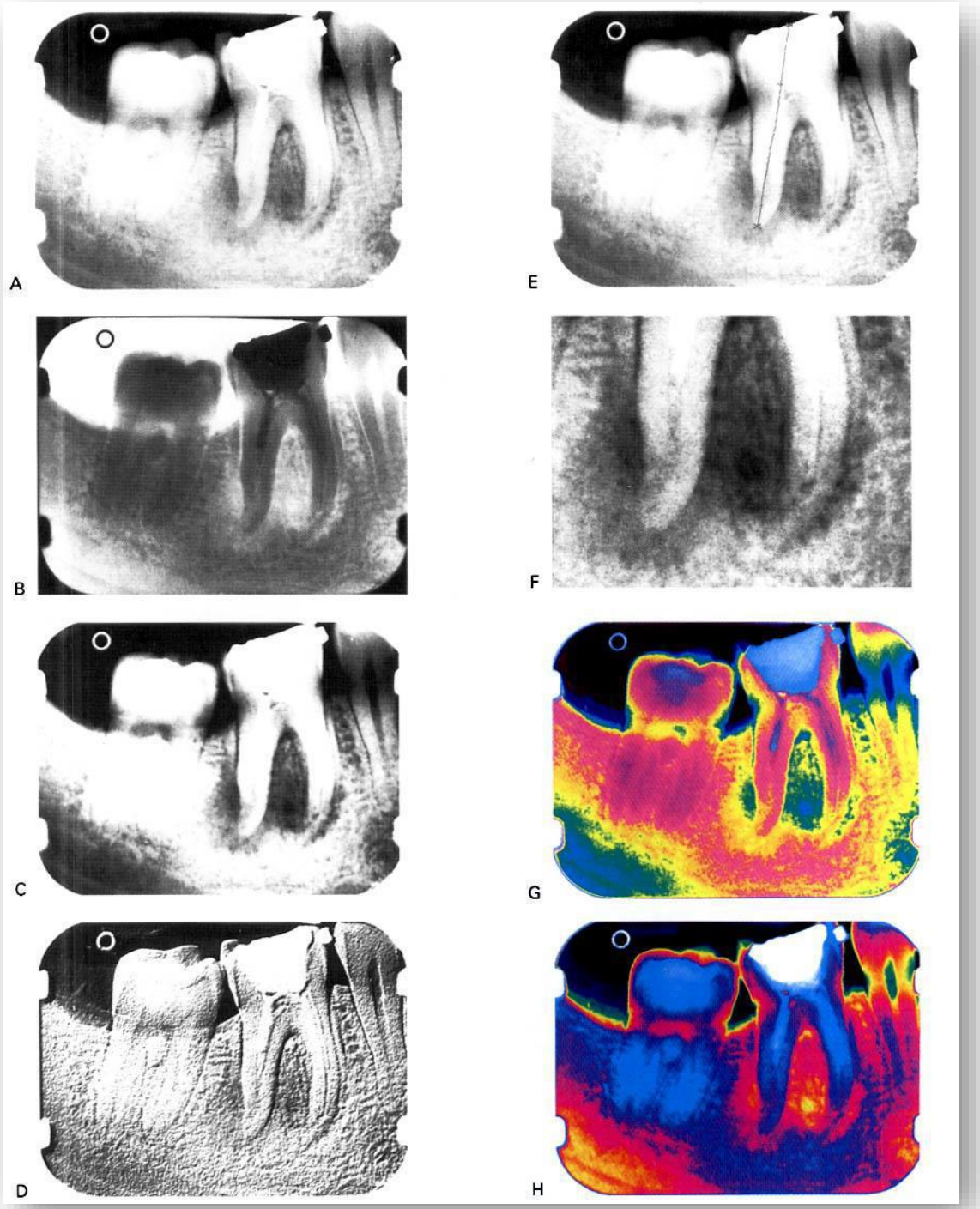
The pictures can be changed by giving the pixels different numbers. The coordinates of pixels may be changed also, and the shades of grey may be altered or using different colures. These variables are the basis for what is called (image processing or image manipulation).

Despite being able to alter the final image, the computer cannot provide any additional real information to the original image. It should be remembered that although enhancement may make images look aesthetically more pleasing, it may also cause clinical information to be lost and diagnoses compromised.

Advantages of Digital Imaging over Conventional Film-Based Radiography

1. Lower dose of radiation required as both types of digital image receptors are much more efficient at recording photon energy than conventional films.
2. No need for conventional processing, thus avoiding all processing film faults and the hazards associated with handling the chemical solutions.
3. Easy storage and archiving of patient information
4. Easy transfer of images electronically (teleradiology).
5. Image enhancement and processing which include: (Inversion (reversal), Alteration in contrast, embossing or pseudo 3-D, Magnification, Automated measurement, image subtraction).

A Original image.
B Inverted/reversed.
C Altered contrast.
D Embossed or pseudo 3-D.
E Automated measurement.
F Magnified
G and **H** Pseudo-colored.



Digital Image Subtraction

When two images of the same object are registered and the image intensities of corresponding pixels are subtracted, a new difference image is produced.

This is useful in the diagnosis of (periodontal diseases, carious lesions, evaluation of small changes in the condylar position and assessment of dental implant).

Disadvantages of Digital Imaging

1. Expensive, especially panoramic systems
2. Long-term storage of the images although this should be solved by saving them on CD-ROM
3. Digital image security and the need to back up data
4. The connecting cable (or cord) can make intraoral placement of these system's sensor difficult.
5. Loss of image quality and resolution on the hard copy-out when using thermal, laser or ink-jet printers
6. Image manipulation can be time-consuming and misleading to the inexperienced
7. While manufacturers provide safeguards to any tampering with original images within their own software, it is relatively easy to access these images using cheap software and to change them.


Thank You