Radiology

Digital Imaging

The term digital imaging refers to the numeric format of the image Content. unlike conventional dental radiographic techniques; there is no film or processing solutions used instead.

Components of a Digital Radiographic System

- **Source of radiation** most of the systems use a conventional X-ray unit
- **Image receptor** it measures the photon intensity of the x-ray beam and convert it into electrical signal (analog signal) using Analog-digital converter (ADC) or digitizer that based on the binary number system recognizable by the computer.
- **Data processing unit** is consisting of computer and output device as computer monitor, laptop or flat panel, printer.

Methods of Acquiring a Digital Image

Digital images are acquired either **Directly** or **Indirectly using**:

- **Solid-state technology:(Real time or corded system)**
  This technology have the ability to generate a digital image directly in the computer without any other external device uses conventional x-ray machine but conventional film is replaced by solid-state detector (often called sensor) which is of two types either a **CCD (charge coupled device)** or **CMOS (complementary metal oxide semiconductor)**

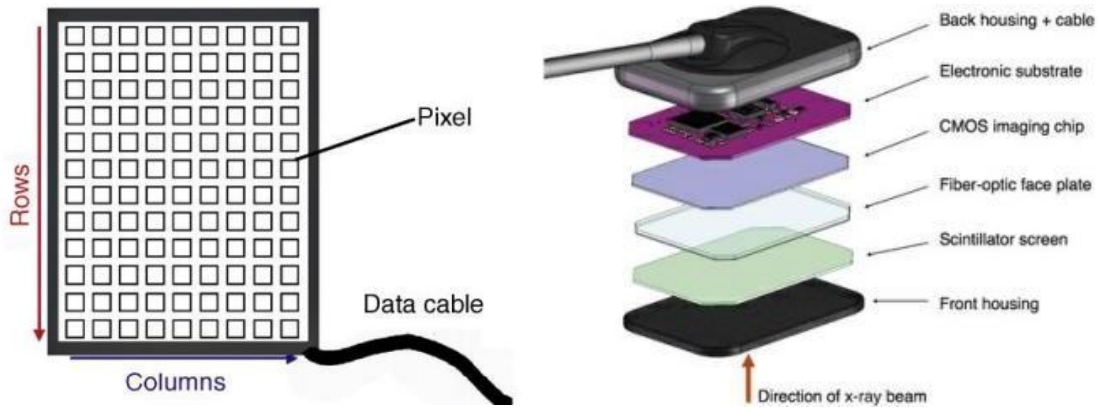
The sensor consists of silicon crystals arranged in a network pattern forming a pixel matrix and it converts the X-ray photons that reach the sensor to light,

Then picked by CCD/CMOS and converted into an (electrical charge) which once relayed to the computer produced a digital image on the monitor immediately (that why it named **real time**). The sensor is connected to the computer via a cable or cord (so called **corded** system).

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 for infection control purposes. Different sized intraoral receptor (adult size and small size sensor for children) and larger extraoral receptors for both panoramic and cephalometric radiographs are required.

Advantages of CCD and COMS:

- The image appears on the monitor instantaneously.
- Infection control is easier and quicker.



- Photostimulable phosphor technology (image plate, cordless system):

This technology consists of a phosphor-coated plate in which a latent image is formed after x-ray exposure. The latent image is converted indirectly to a digital image by a scanning device through stimulation by laser light. the conventional film is replaced by **photostimulable phosphor storage plate (PSPP)** which is flexible and re-usable.

The phosphor layer plates contain a layer of barium fluorohalide phosphor it 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 (phosphorescence) which is detected by a photomultiplier, so the information is indirectly scanned and then displayed 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. A range of intraoral plate sizes are available identical in size to the conventional periapical and occlusal film packet. The intraoral plates are inserted into protective barrier envelopes and can then be used in conventional film holders. The essential components of the indirect system are a CCD camera so the signal amplified and transferred to the computer.

Advantages of PSPP:

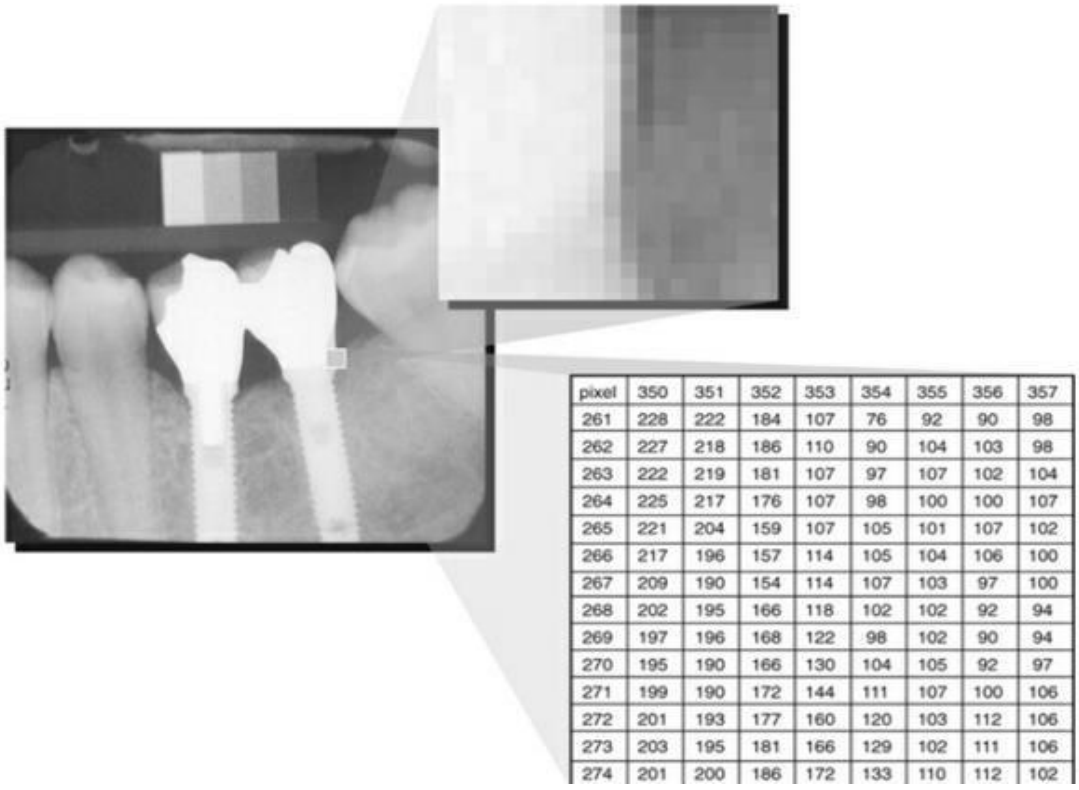
• Detectors are thin and flexible, more comfortable for the patient, and easier for operator to use.
• Cheaper and reusable.

Digital Image theory

Digital images are numeric (because computers deal with numbers and not pictures). A digital image consists of a large collection of individual pixels organized in a (matrix of rows and columns), at each pixel of an electronic detector, the absorption of x-rays generates a small voltage.

As a radiographic image within a computer is represented as a sequence of numbers. Each pixel has an x and y axis. Each number, and hence each pixel has an appropriate shade of grey. Most current dental system operates with 8-bit images 2^8 shades of grey ranging (0 - 256), 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.



pixel	350	351	352	353	354	355	356	357
261	228	222	184	107	76	92	90	98
262	227	218	186	110	90	104	103	98
263	222	219	181	107	97	107	102	104
264	225	217	176	107	98	100	100	107
265	221	204	159	107	105	101	107	102
266	217	196	157	114	105	104	106	100
267	209	190	154	114	107	103	97	100
268	202	195	166	118	102	102	92	94
269	197	196	168	122	98	102	90	94
270	195	190	166	130	104	105	92	97
271	199	190	172	144	111	107	100	106
272	201	193	177	160	120	103	112	106
273	203	195	181	166	129	102	111	106
274	201	200	186	172	133	110	112	102

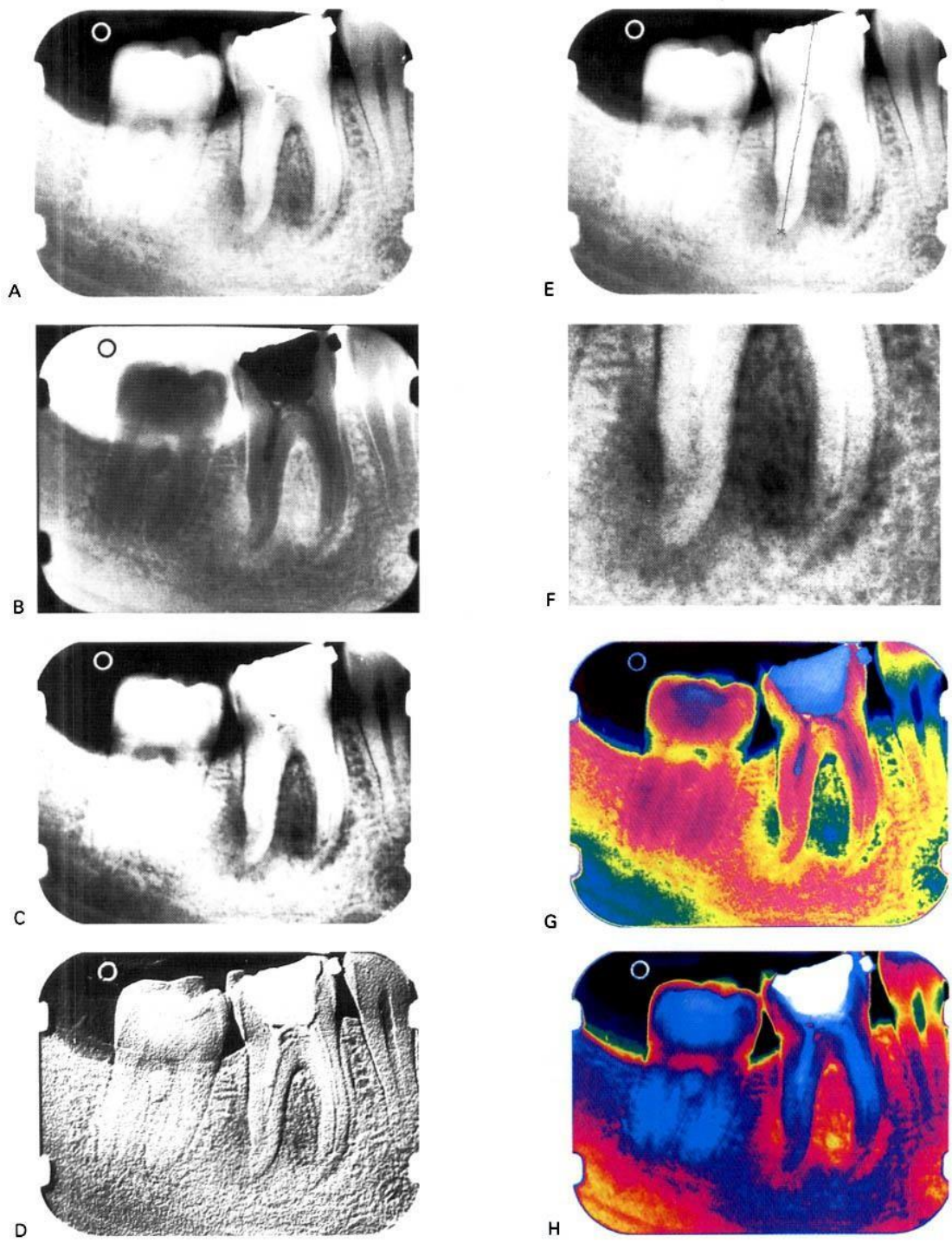
Advantages of Digital Imaging Over Conventional Film-Based Radiography:

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, brightness, sharpness, and colors (Pseudo-color)
    - embossing or pseudo 3-D,
    - Magnification,
    - Automated measurement,
    - image subtraction.

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 technique requires two identical images exposed at different times then subtract one image from another, leaving only the changes that occur over time between the two intact.

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



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.

Disadvantages of Digital Imaging:

1- Expensive, especially panoramic systems
2- Long-term storage of the large images required more storage space 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- Although manufacturers provide safeguards to the original images within their own software, but it is relatively easy to access these images using cheap software and to change them.

Indications:

1- Carious lesion detection: it measures lesion depth more accurately
2- Detection of structural changes: detection of morphological changes (periapical lesions, carious lesions) in the tissues
3- Growth and development: useful in cephalometric analysis and growth prediction of the facial structures
4- Research purpose and documentation: useful for a variety of scientific research approaches giving pure mathematical information applied for scientific purposes.