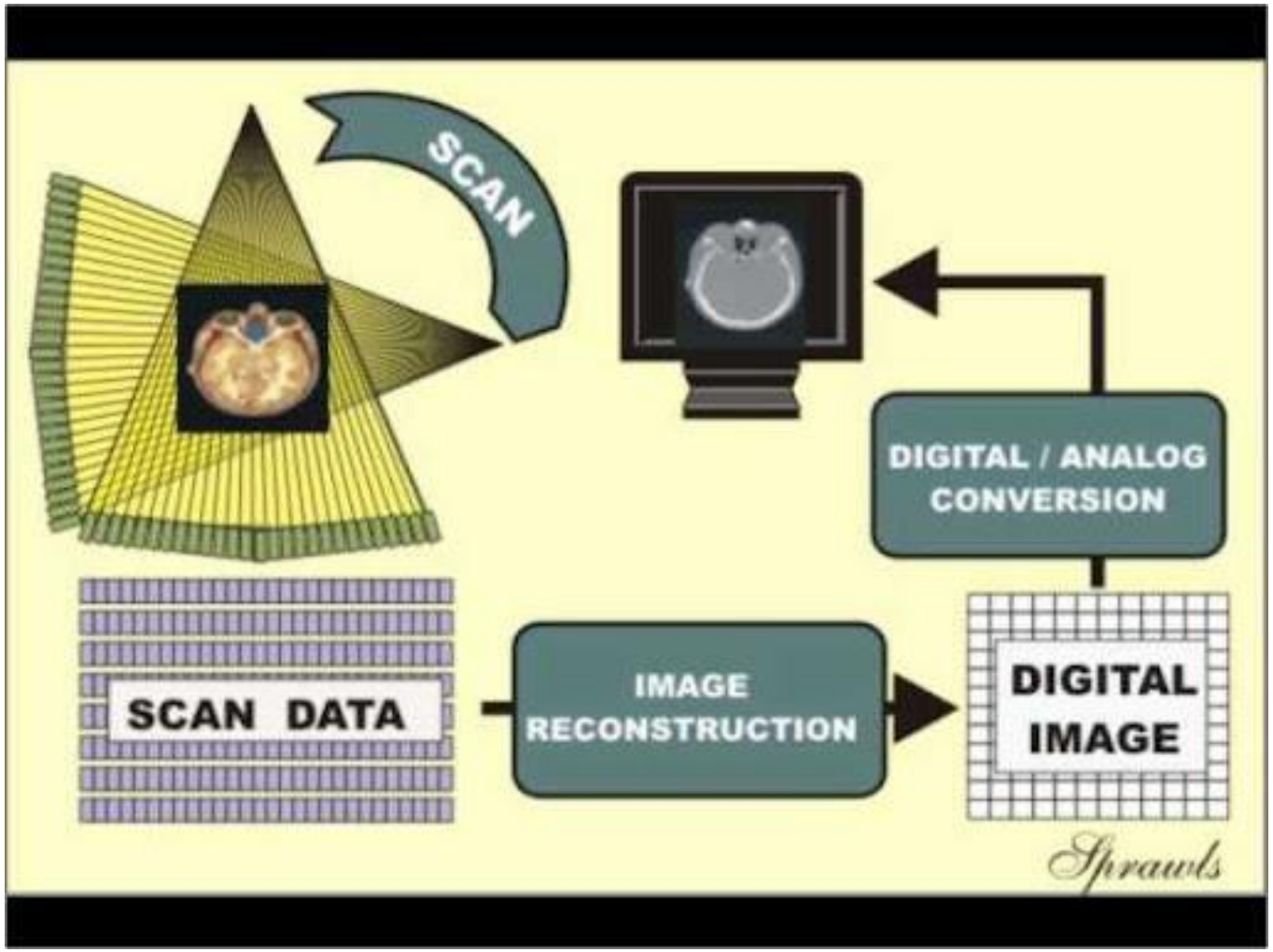
Digital Imaging - Image Formation - 4



What is Digital Imaging

Digital imaging or **Digital Image Acquisition**

- Is the creation of a representation of the visual characteristics of an object, such as a physical scene or the interior structure of an object.

- A key advantage of a digital image, versus an analog image is the ability to digitally make copies and copies of copies indefinitely

  without any loss of image quality.

- Digital imaging can be classified by the type of electromagnetic radiation or other waves whose variable attenuation, as they pass through or reflect off objects, conveys the information that constitutes the image.

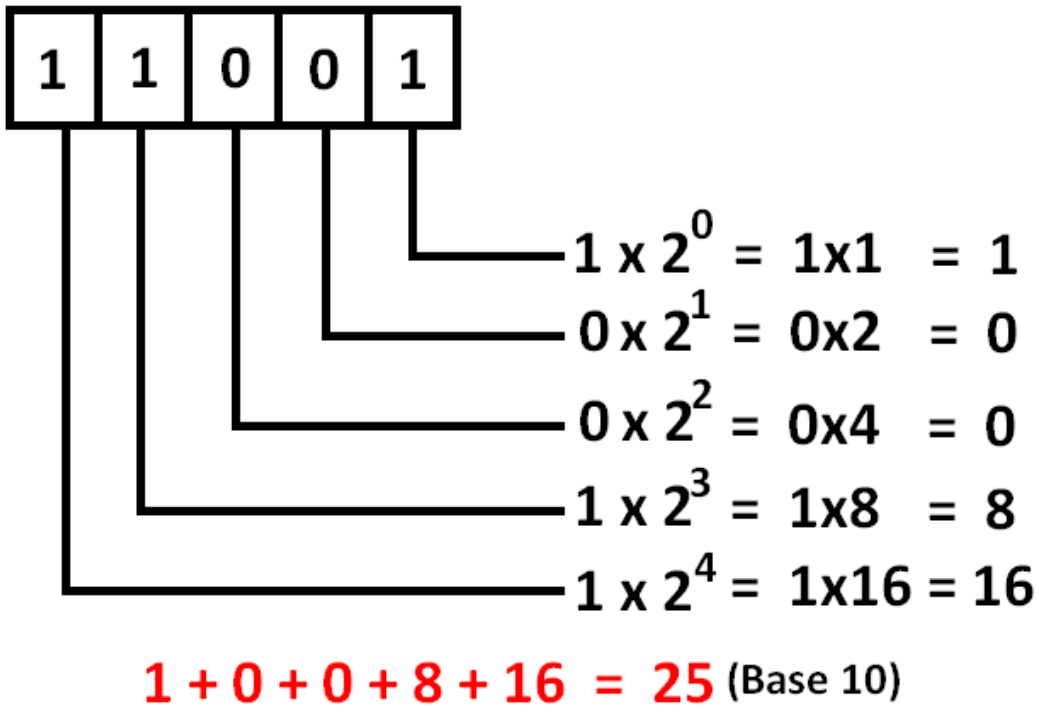
- In all classes of digital imaging, the information is converted by image sensors into digital signals that are processed by a computer and made output as a visible-light image.

- For example - X-rays allow digital X-ray imaging (digital radiography, fluoroscopy, and CT), and gamma rays allow digital gamma ray imaging (digital scintigraphy, SPECT, and PET).

- Digital imaging lends itself well to image analysis by software, as well as to image editing (including image manipulation).

Binary Numbers

- A **binary number** is number expressed in the **base-2 numerical system** or **binary numeral system**
- A method of mathematical expression which uses only two symbols: "0" (zero) and "1" (one).
- The computer uses the Binary number system.
- Conversion of base 10 to base 2 is beyond the scope of this class



Analog to Digital Conversion

The conversion of analog signals to digital information is accomplished by the ADC

- Two main characteristics are:
  - Accuracy – Poor accuracy can result in Aliasing Artifacts
  - Speed – The time it takes to convert the signal
  - These two measurements are inversely proportional

- ADC samples the analog signals at various points to measure the transmitted beam strength.

- The more points sampled – the better the representation of the signal.

Digital Image Characteristics

- **Matrix**
  - Digital images are made of up of a two dimensional array of numbers called a Matrix
  - Consists of rows and columns of pixels
  - Technologist selects the Matrix size

Pixel
- Pixels are each square in the Matrix that contain an individual number
- Each different number represents the corresponding tissue density.

Voxel
- Describes the thickness or depth of the pixels
- Example would be the different slice thickness of the scan

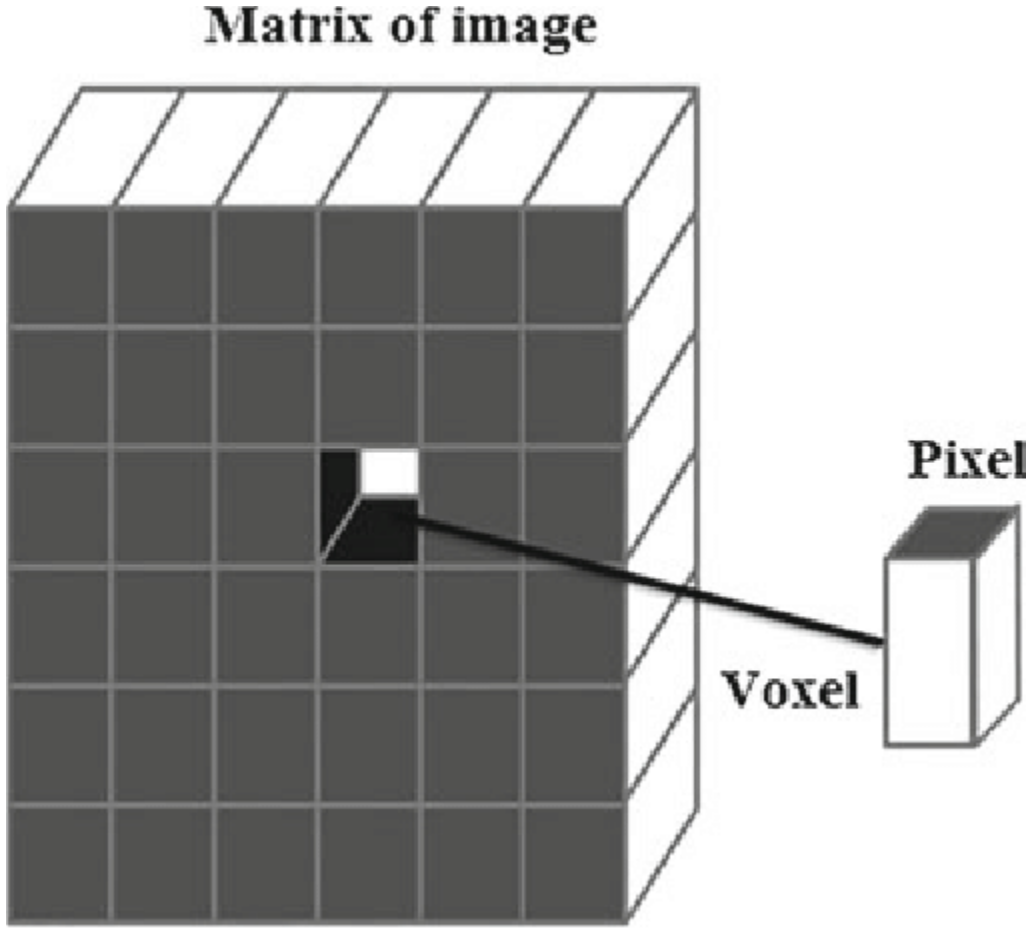


Image Digitization

- Objective of digitization is to convert an analog image into numerical data for processing by a computer.
- 3 Steps
  - Scanning
  - Sampling
  - Quantization

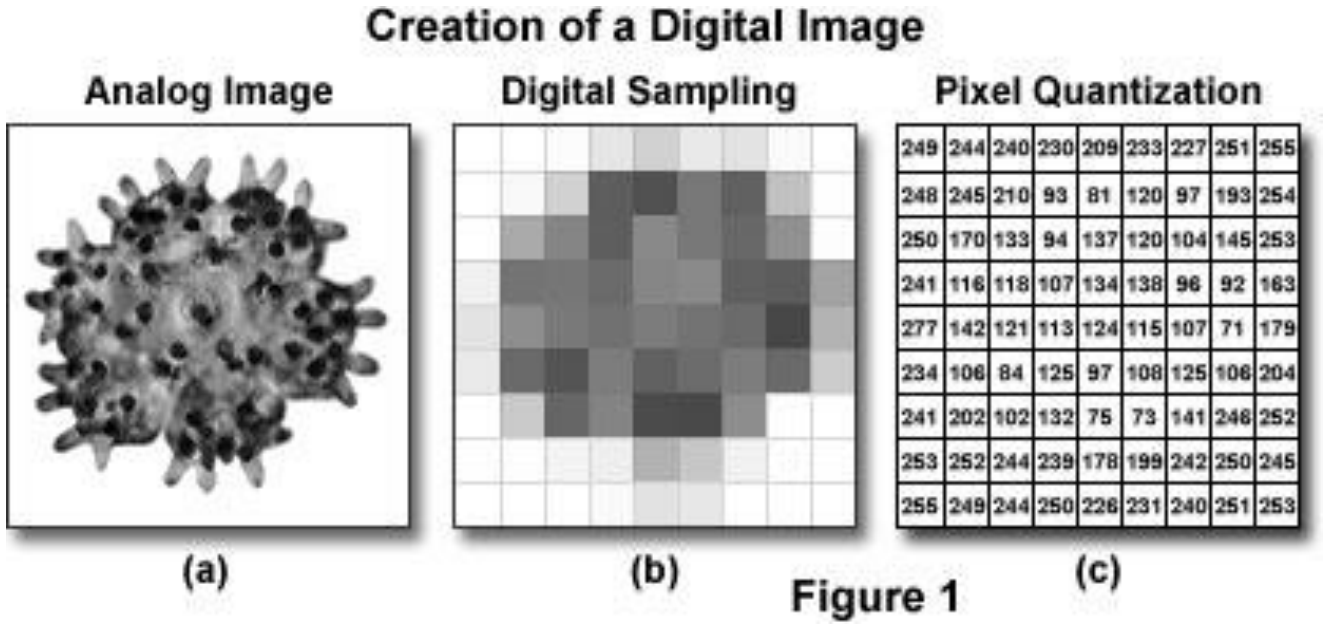
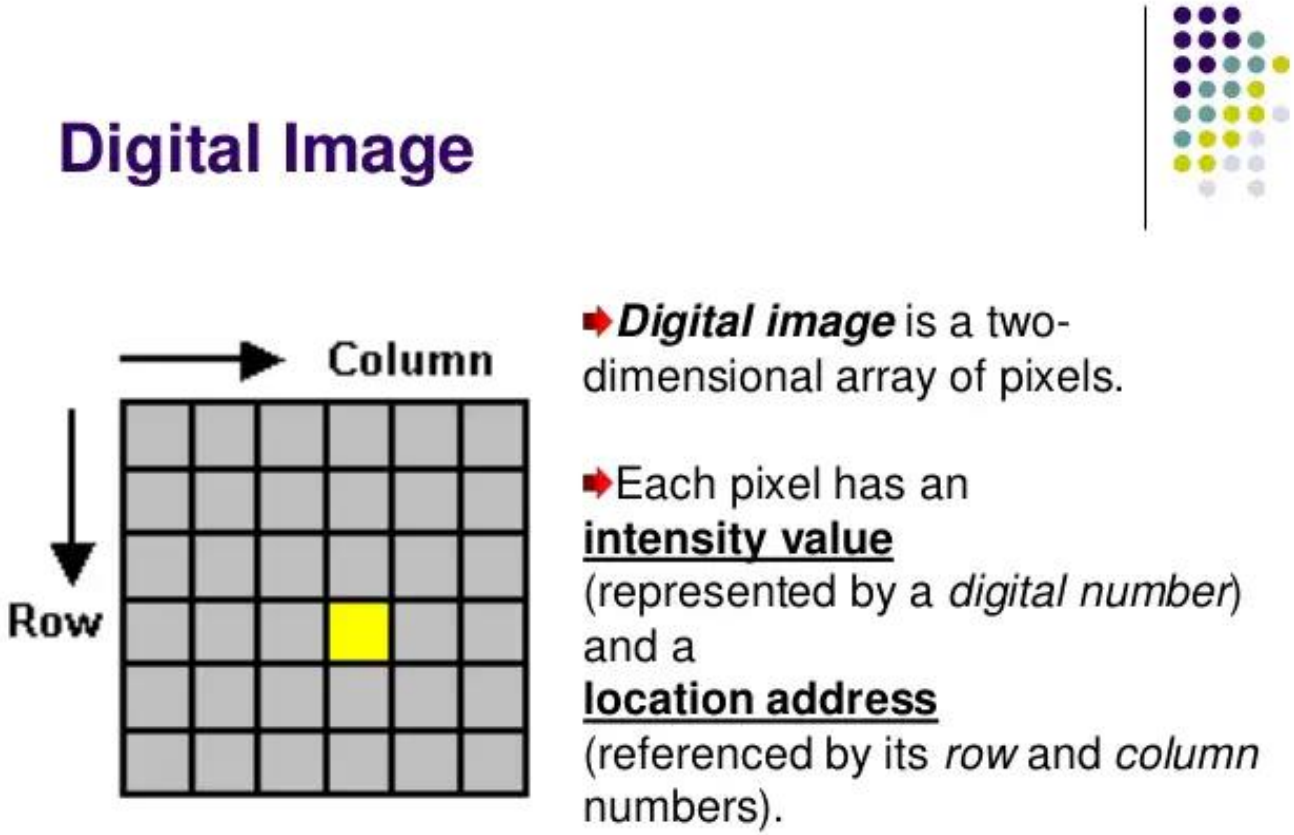


Figure 1

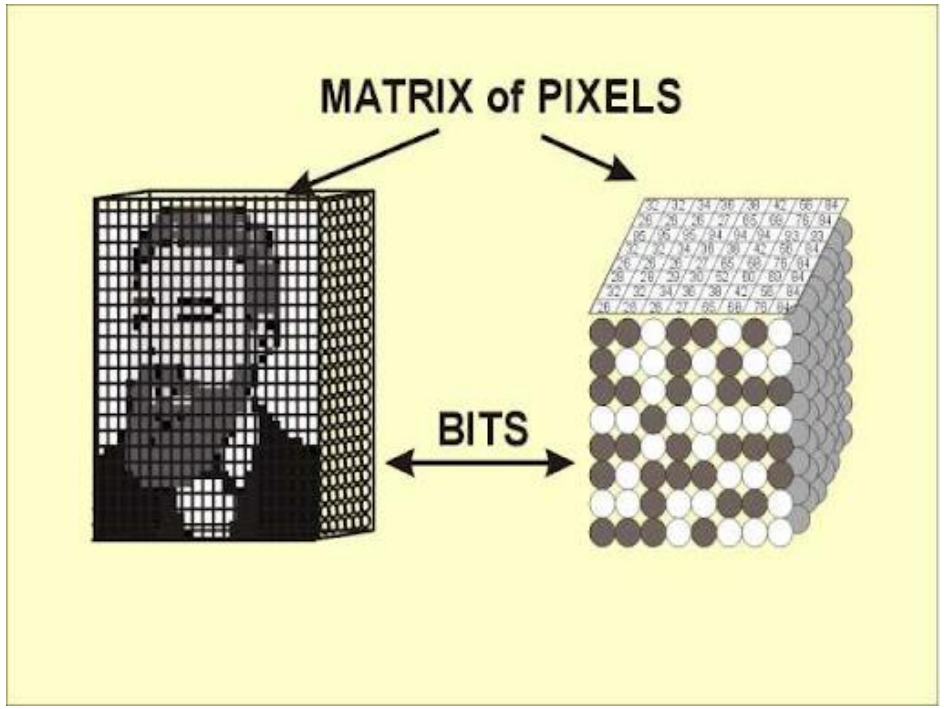
Scanning

- Step one is division of the image into small regions
- Pixels are small picture elements.
- Pixels are formed into a grid called a Matrix
- Each Pixel represents a particular space in the grid

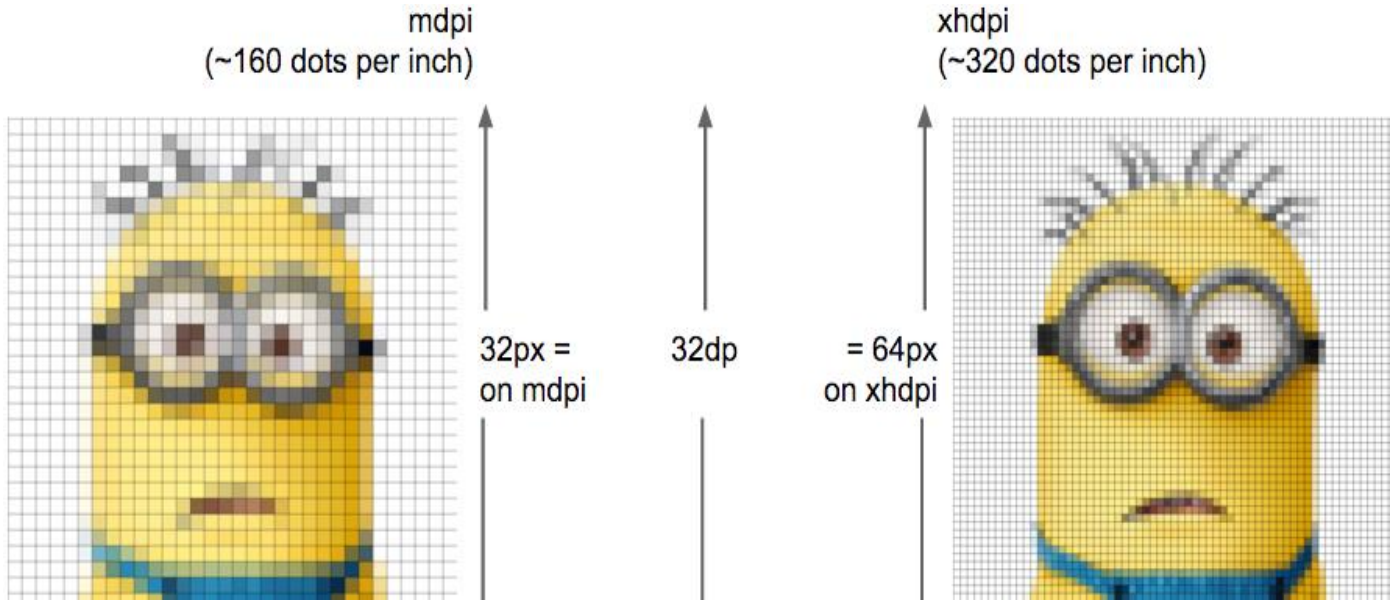


Examples of Pixels

Pixels and Matrix

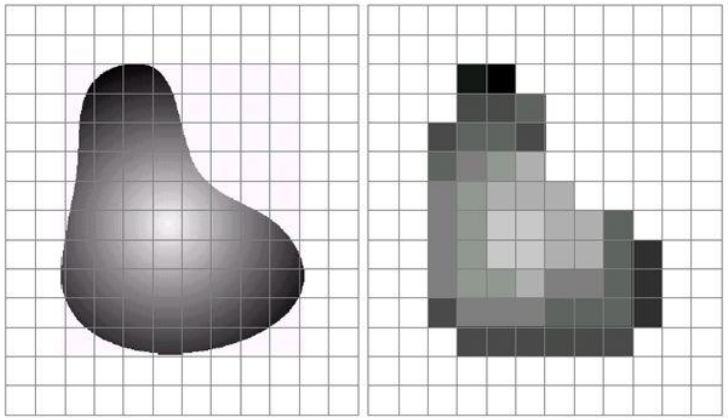


Smaller Pixels = More Detail



Sampling

- Sampling measures the brightness of each pixel
- Small light is projected thru the pixels and detected by a photomultiplier tube.
- The output of the photomultiplier tube is an electrical (analog) signal



a b

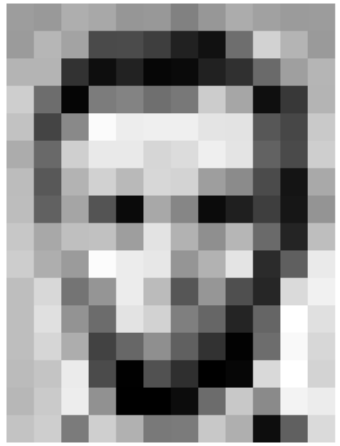
(a) Continuous image projected onto a sensor array. (b) Result of image sampling and quantization.

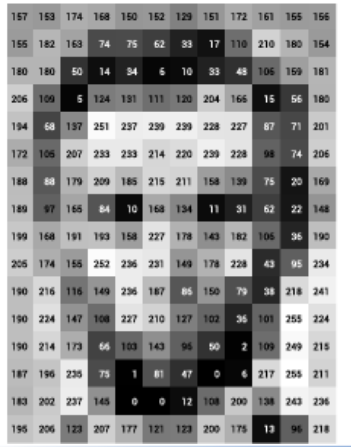
Quantization

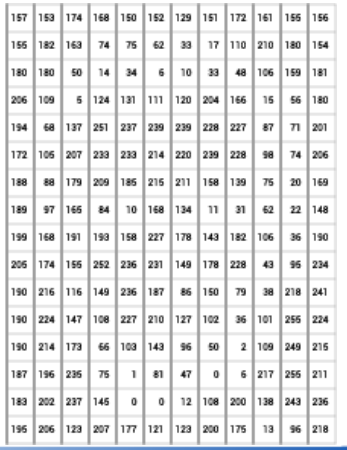
- Quantization is the final step in which each pixel is assigned an interger (o, positive or negative number) based on the strength of the signal
- The result is a digital image with a array of numbers
- This array of numbers is sent to the computer for more processing
- Each number is assigned a shade of gray.

Quantization Table

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

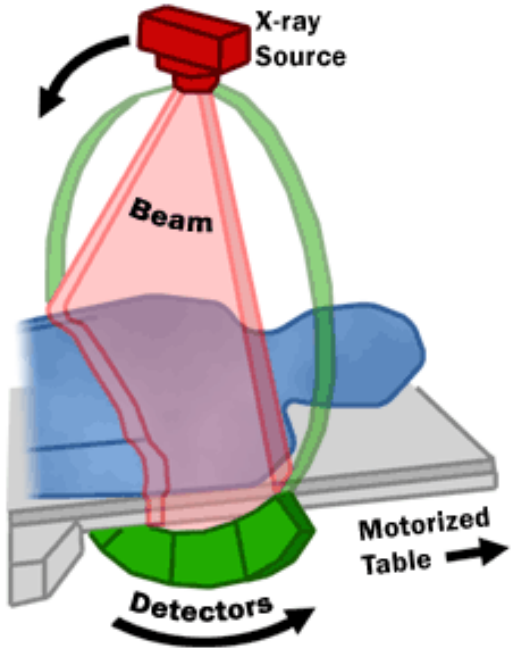


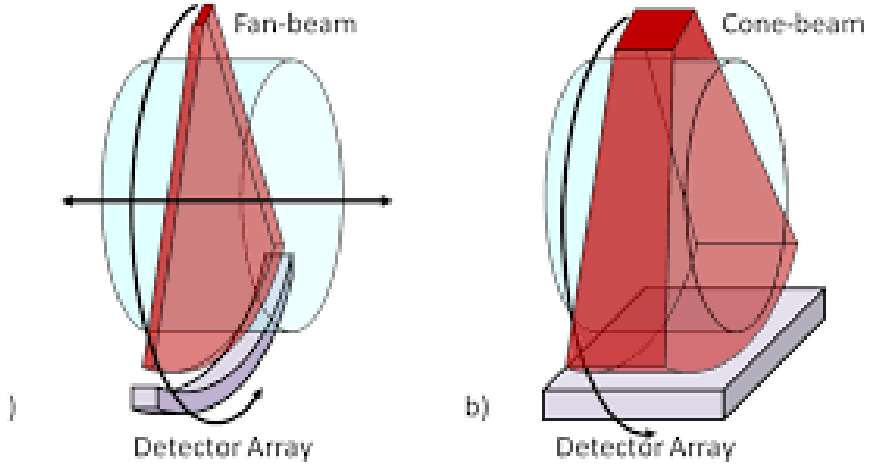




Beam Geometry

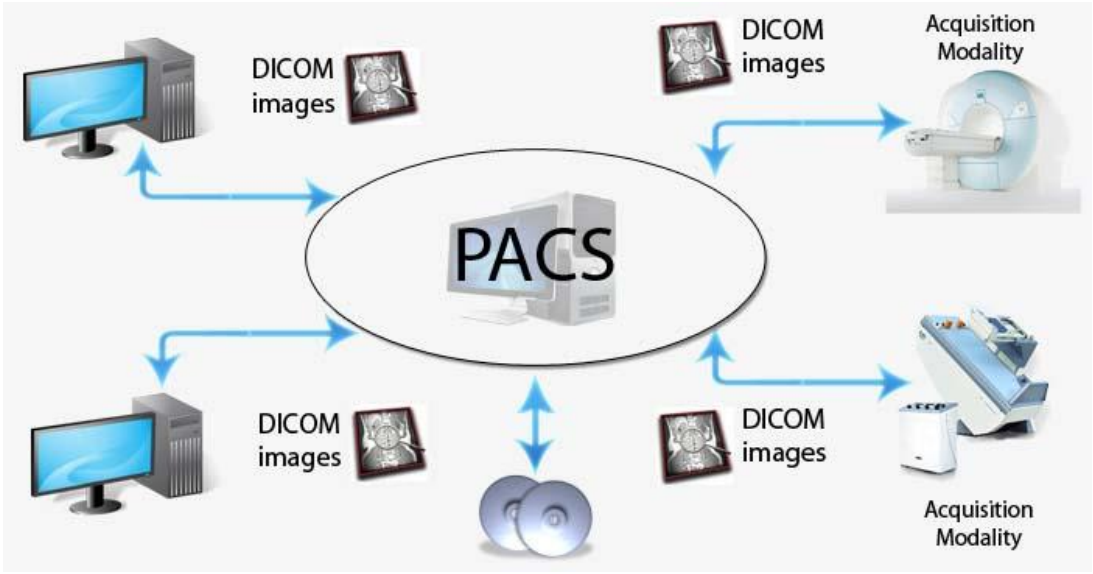
- Beam Geometry refers to the size and shape of the x-ray beam from the x-ray tube and passing thru the patient to reach the detector





PACS –Picture Archiving Communication System

- PACS is a medical imaging technology used primarily in healthcare organizations to securely store and digitally transmit electronic images and clinically-relevant reports.
- The use of PACS eliminates the need to manually file and store, retrieve and send sensitive information, films and reports.
- Instead, medical documentation and images can be securely housed in off-site servers and safely accessed essentially from anywhere in the world using PACS software, workstations and mobile devices.



DICOM SYSTEM

- There is a program called Digital Imaging in Communications and Medicine (DICOM)

- It is changing the medical world as we know it. DICOM is not only a system for taking high quality images, but also is helpful in processing those images.

- It is a universal system that incorporates image processing, sharing, and analyzing for the convenience of patient, physician and institution.

DICOM SYSTEM