Physics of Computed Tomography

Second Semester

Weeks 10-11-12: Image data

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Image data: **Pixel values calculated from the scan data that are used to display and analyze images. Also called reconstructed data.**

A display: is a computer monitor that shows the processed data from the scanned area. Displays can be black-and-white or color, small or large depending upon the model and price of the machine.

Image Matrix

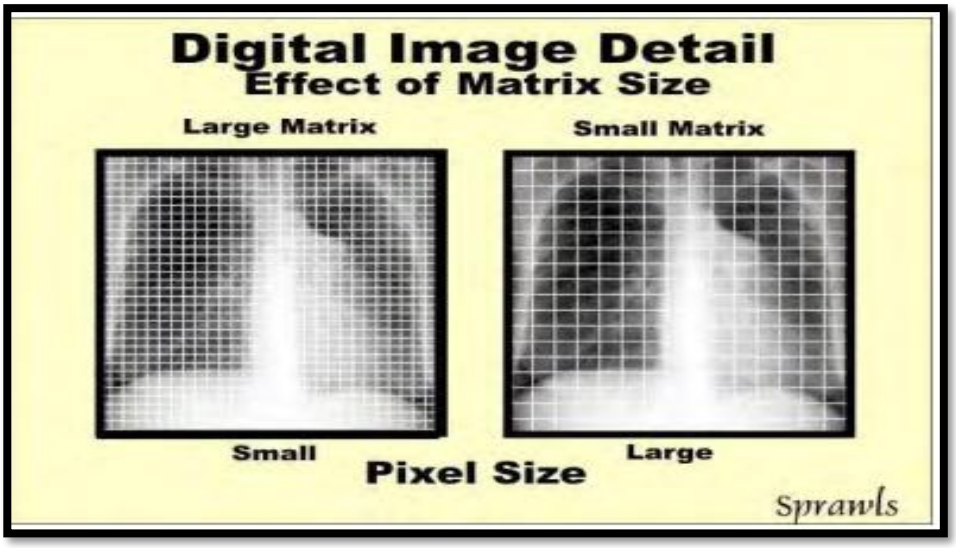
The image matrix is comprised of thousands of pixels divided into very small regions in varying shades of gray and represents the number of pixel elements from which the final image is created.

The matrix size is determined by multiplying the number of pixels in the length by the breadth of the image grid. Most images are displayed on a 512x512 matrix for a total of 262,144 pixels.

Matrix size generally represents a compromise between spatial resolution and noise, which is a blotchy or spotty image.

A small matrix is comprised of larger pixels, which decreases noise but also decreases resolution. Conversely, a larger matrix increases the resolution of the CT image by using smaller pixels, but the amount of noise is also increased (Figure1). When using a larger matrix to increase resolution, adjustments to other parameters

such as increasing tube current and patient radiation dose — must be made to counter the increase in noise



(Figure**1**). (Left) Larger matrix shows higher resolution with increased noise. (Right) Smaller matrix shows lower resolution with less noise

A pixel is a picture element (pix, abbreviation of pictures + element). Tomographic images are composed of several pixels; the pixel size is determined by the used field of view and the number of elements in the display image matrix. The corresponding size of the pixel may be smaller than the actual spatial resolution.

- **Pixels do not have a fixed size**

. Calculating pixel size

Pixel size is determined by converting the display field of view (DFOV) size from centimeters (cm)

to millimeters (mm) and then dividing by the matrix size.

DFOV: Display field of view-- determines how much of the scan field of view is reconstructed into an image. DFOV can be less than or equal to the SFOV but cannot be more than the SFOV.

SFOV: Scan field of view--the parameter that determines how much anatomy is scanned.

The SFOV should exceed the dimensions of the anatomy

$$\text{pixel size } (mm^2) = \frac{(DVOF)\ (mm^2)}{\text{matrix size}}$$

Example

Calculate pixel size using a 40 cm DFOV and a matrix size of 512x512

Answer:

pixel size (mm^2) = 400/512

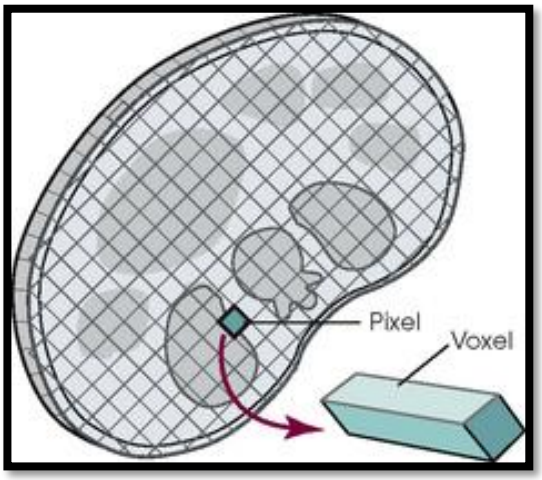
=0.781 mm^2

H.W Calculate pixel size using a 10cm DFOV and a matrix size of 512x512

H.W Calculate pixel size using a 25cm DFOV and a matrix size of 512x512

Voxel

A voxel or —volume element‖ is a three dimensional representation of the tissue volume. The tissue volume is represented by a given pixel and the slice thickness.



Fg. (2)

Calculating voxel size A voxel is determined by multiplying the pixel size by the scan slice thickness

$$\text{voxel size } (mm^2) = \frac{(DVOF)\ (mm^2)\ (\text{slice thickness mm})}{\text{matrix size}}$$

Calculate voxel size using a 40 cm DFOV, a slice thickness of 3 mm, and a matrix size of 512x512

Answer:

voxel size (mm^2) = (400mm) (3mm)/ 512

= 2.34mm^2

H.W

1-Calculate voxel size using a 30 cm DFOV, a slice thickness of 3 mm, and a matrix size of 512x512

2- Calculate voxel size using a 50 cm DFOV, a slice thickness of 3 mm, and a matrix size of 512x512

The Image Quality Depends On:

1-Resolution

2-Matrix

3-Field of view (FOV)

4-Slice thickness

5-Signal-to-Noise Ratio (SNR)

6-Contrast

7-Artefacts

<u>The resolution</u> is the size of the individual pixel (2D) or voxel (3D). The smaller the pixel or voxel the greater the resolution. It is intimately related to the field of view, the matrix size and the slice thickness as shown in the equation below.