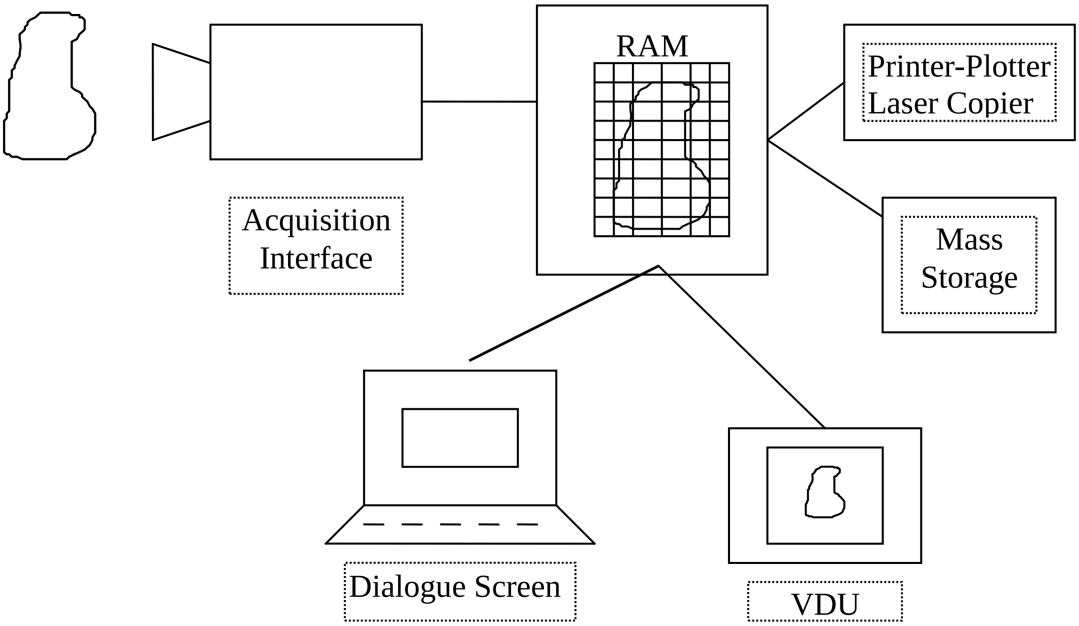
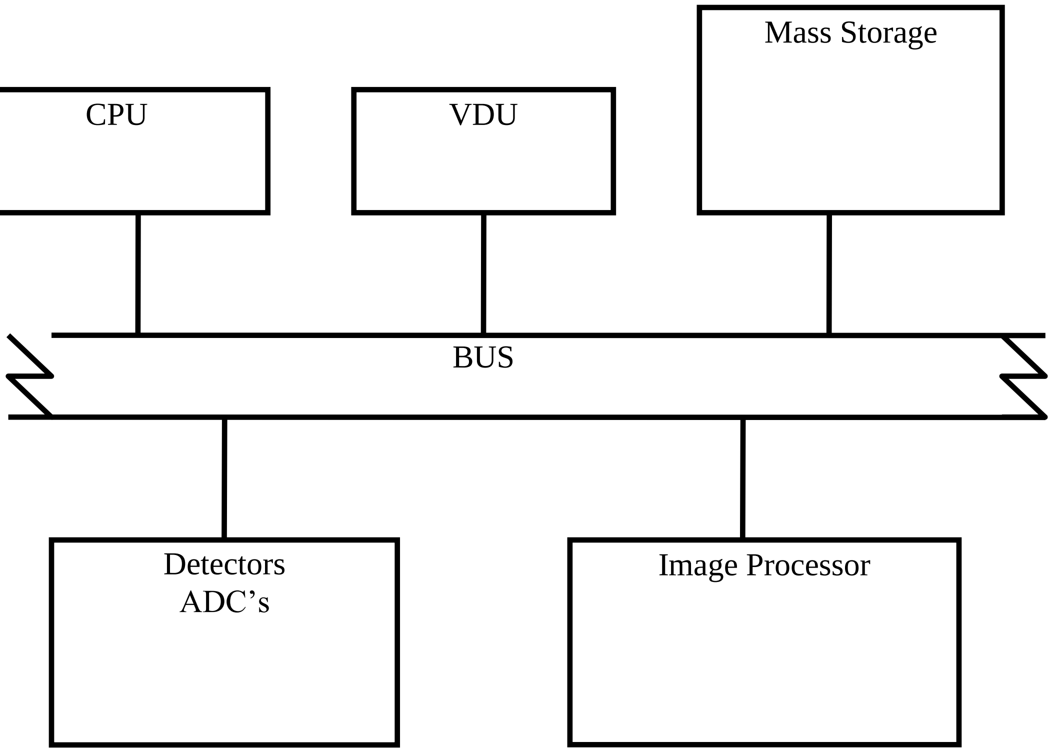
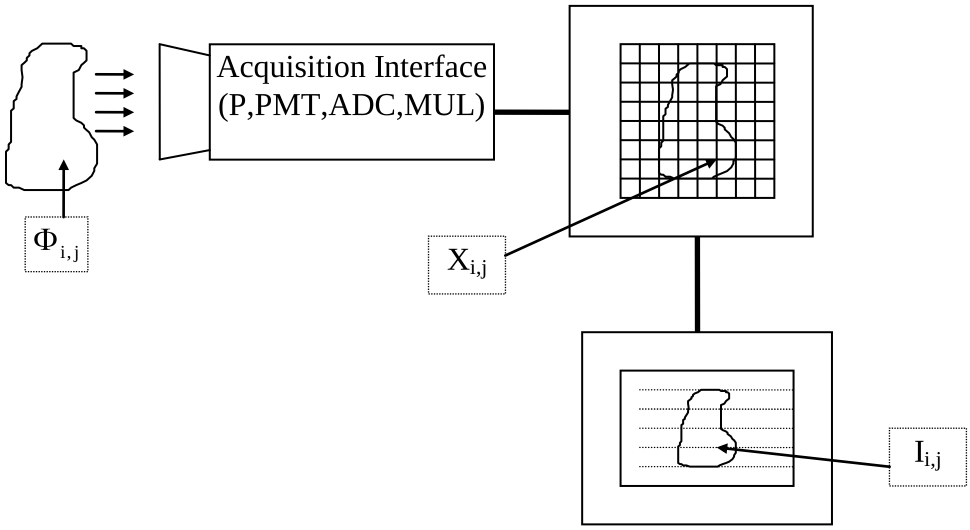

RAM
Printer-Plotter
Laser Copier
Acquisition
Interface
Mass
Storage
Dialogue Screen
VDU


Mass Storage
CPU
VDU
BUS
Detectors
ADC's
Image Processor


Acquisition Interface
(P,PMT,ADC,MUL)
Φ i, j
X i,j
I i,j

DIGITAL IMAGE: Stored in RAM as a 2-D array:

gamma-camera : 32x32, 64x64, 128x128, 256x256

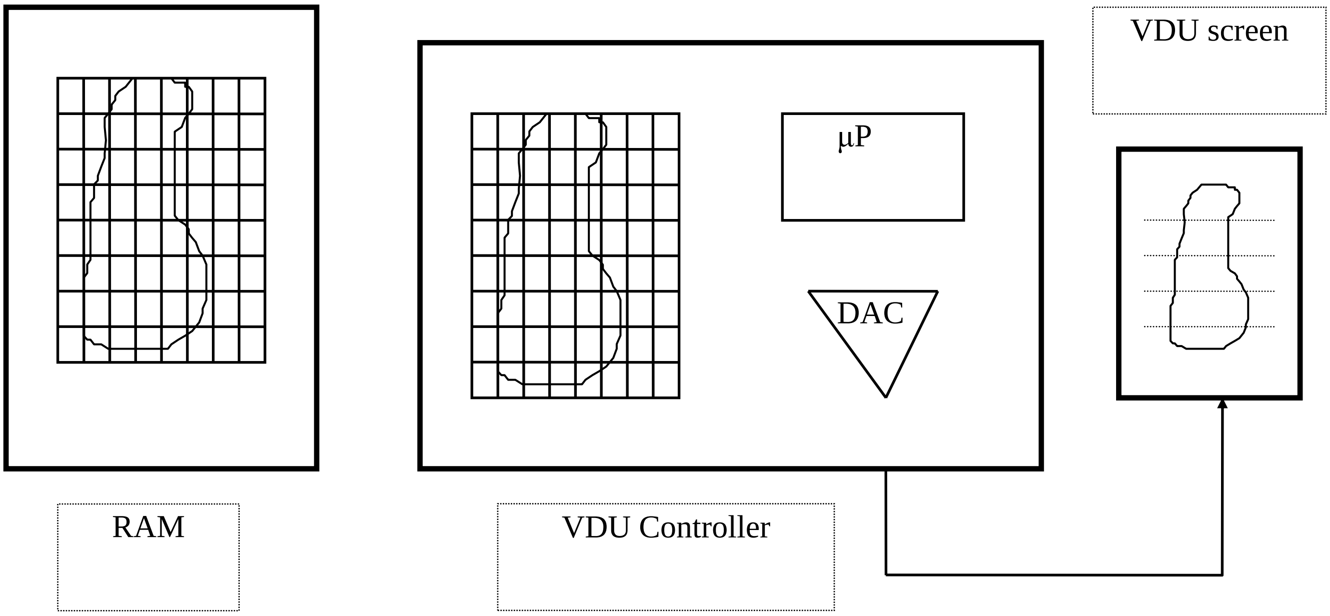
CT, MRI, US: 256x256, 512x512

DSA: 512x512, … , 2048x2048.

<u>Image depth:</u>

- Number of quantization levels,
- It's the 3^{rd} dimension, e.g. 512x512x8, where 8 is the number of bits, or 2^8.

IMAGE DISPLAY (1)



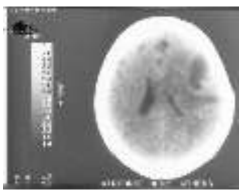


IMAGE DISPLAY(2)

VDU-CONTROLLER:

- **µP reads byte**
- **Transfers byte to level**

  e.g. for 16 greytones (0-15)

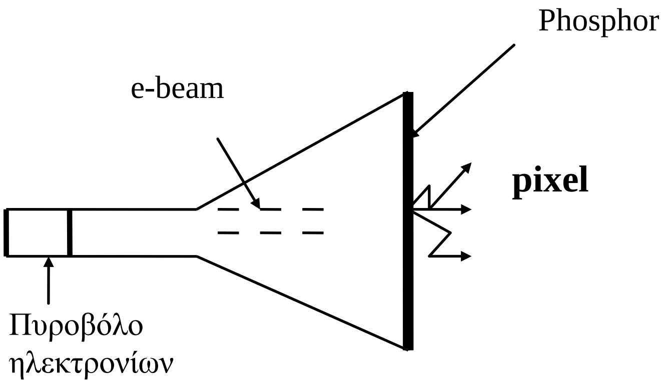
15	150	240
39	80	62
0	33	230

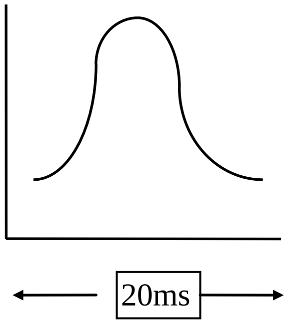
$$\xrightarrow{\mathbf{:16}}$$

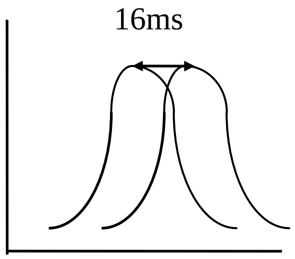
0	9	15
2	5	4
0	2	14

- **Calculates level (e.g. 5 x 8 µV D.A.C.)**
- **Applies dc Voltage to VDU's electron gun**

IMAGE DISPLAY (3)

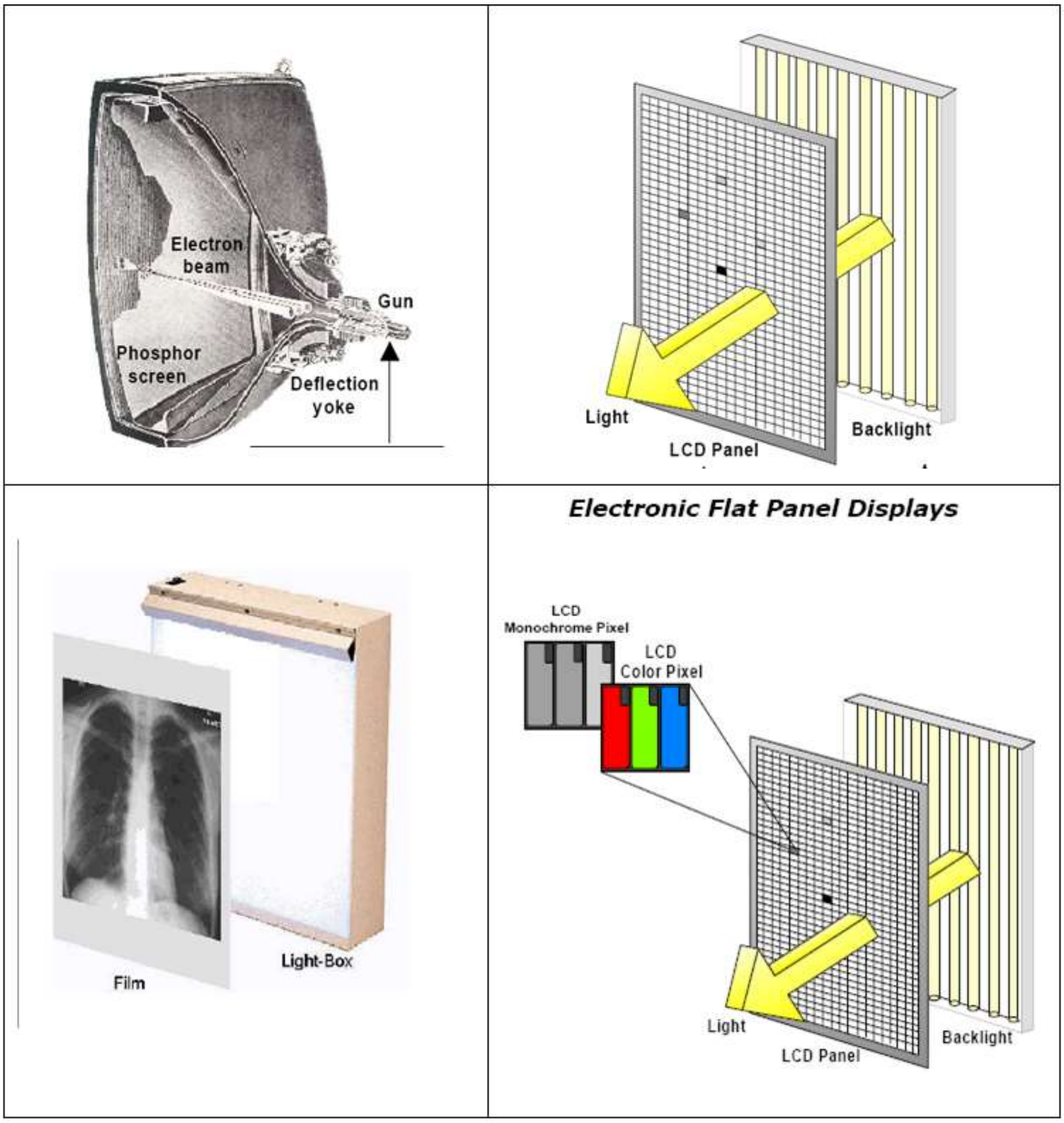






- **Screen is scanned every 16 ms**
- **Each pixel receives e-beam of kinetic energy $\propto$ the byte value every16 ms.**
- **Frequency of screen scanning = 50Hz (1/16 ms)**
- **16 greytones**

Active Matrix LCD display screens consist of a matrix of thin film transistors (TFT), one TFT per pixel. TFTs are micro-switching transistors (and associated capacitors) that are arranged in a matrix on a glass substrate to control each picture element (or pixel). Switching on one of the TFTs will activate the associated pixel. By adjusting the voltage applied on the TFT, in small increments, e.g. 1/256 or 1/1024 increments, it is possible to create the gray-scale effect. For colour display, 3 sub-pixels of RGB colors are combined to form a color pixel (*http://www.practical-home-theater-guide.com/lcd-display.html*).



Creation of microarray images

cDNA microarrays consist of thousands (e.g. 6000) of individual cDNA sequences printed in a high-density array on a glass microscope slide using a robotic arrayer
(see http://www.bio.davidson.edu/courses/genomics/chip/chipQ.html).

For two mRNA samples (extracted from 2 classes such as normal-abnormal cases), the two samples or targets are reverse-transcribed into cDNA, are labeled using different fluorescent dyes (e.g., the red-fluorescent dye Cy5 and the green-fluorescent dye Cy3), and are then mixed and hybridized with the arrayed cDNA sequences on the slide.
After this hybridization, the slides are imaged using a scanner which makes fluorescence measurements for each dye (red and green). Microarray images (16-bit) can be acquired using a number of devices, including a laser scanning confocal microscope, or scanner, and a charge coupled device (CCD) camera.

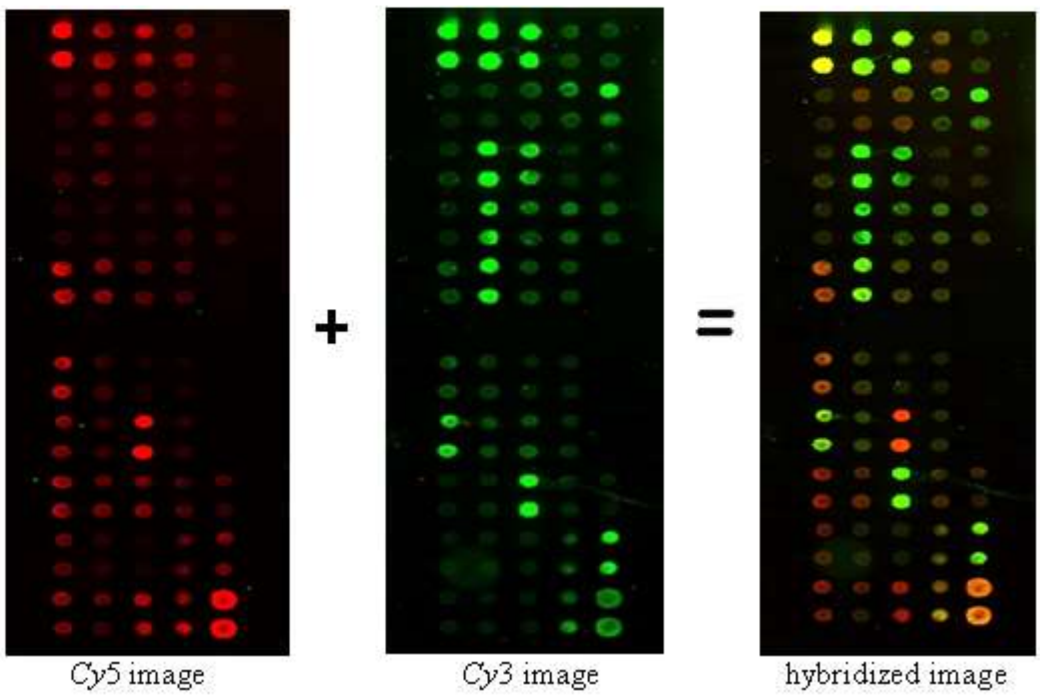


IMAGE QUALITY

Image quality (1)

- **Medical Image, it's related to the clarity of the specific information sought for in the image by the observing physician.**
- **objective image quality features for assessing image quality:**

Sharpness- Contrast - Noise

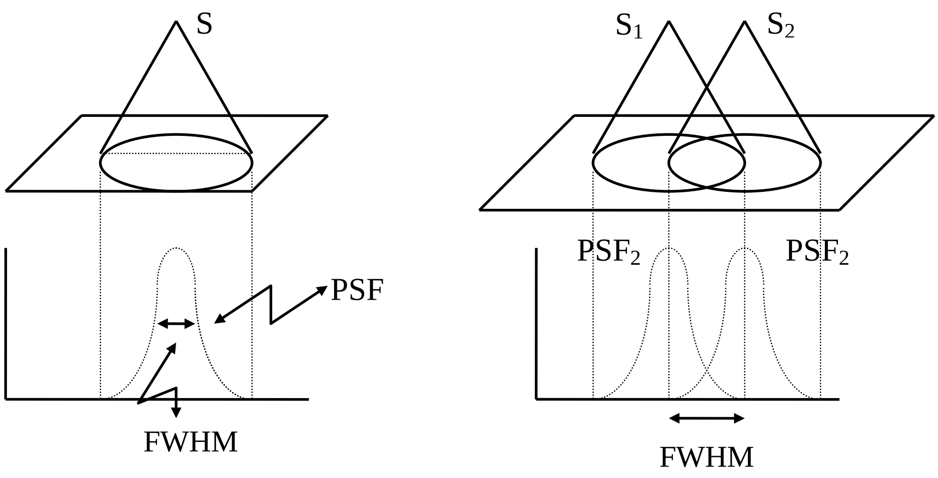
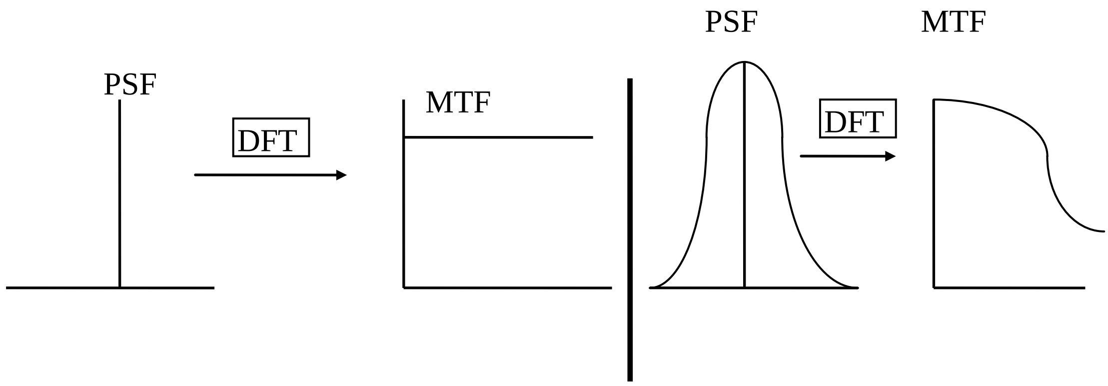
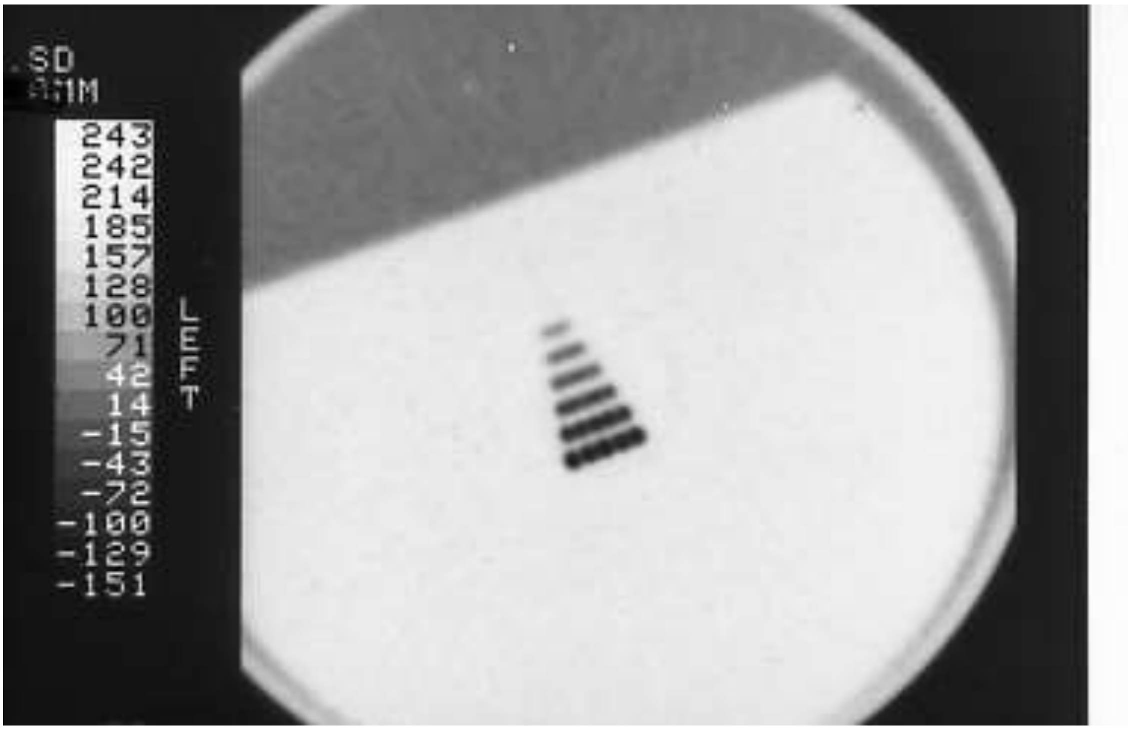


Image quality (2)

Image Sharpness: concerns mainly the ability to distinguish image detail. Image sharpness is assessed by the image spatial resolution, i.e. the ability of the imaging system to distinguish (i.e. clearly display) two small high contrast dots close to each other.

Quantitatively, the spatial resolution is determined by the smallest distance between two distinguishable high contrast dots or by the magnitude of the FWHM (Full Width at Half Maximum) or by the LSF (the number of distinguishable lines per cm) or by the MTF (Modulation Transfer Function).




SD
243
242
214
185
157
128
100
71
42
14
-15
-43
-72
-100
-129
-151
LEFT

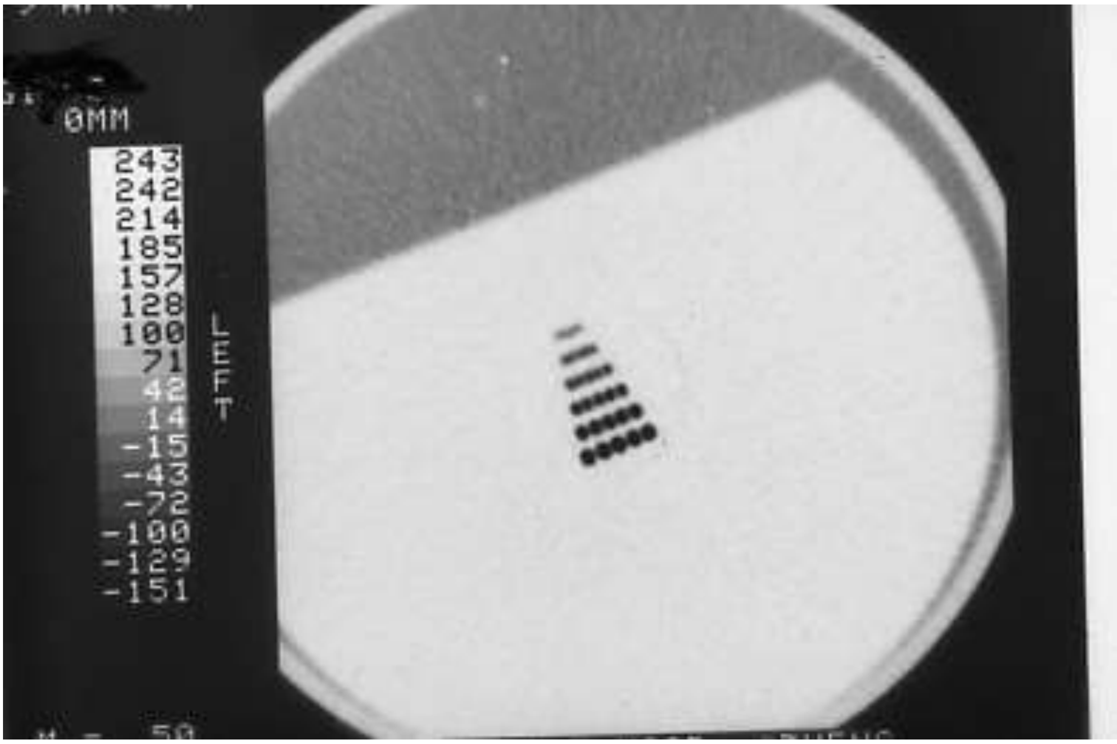
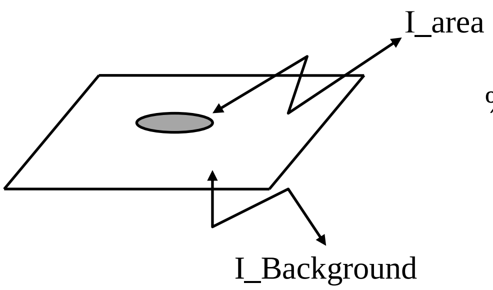

0MM
243
242
214
185
157
128
100
71
42
14
-15
-43
-72
-100
-129
-151
LEFT

Image quality (3)

Image contrast, **concerns the ability to distinguish image detail of low contrast with its surrounding background.**



$$\%\text{Contrast} = \frac{I\_area - I\_background}{I\_background} x100$$

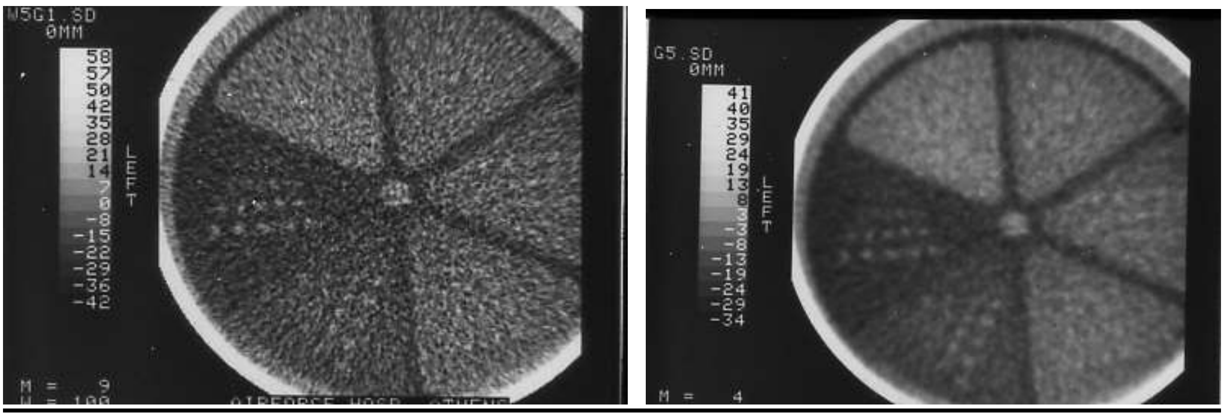
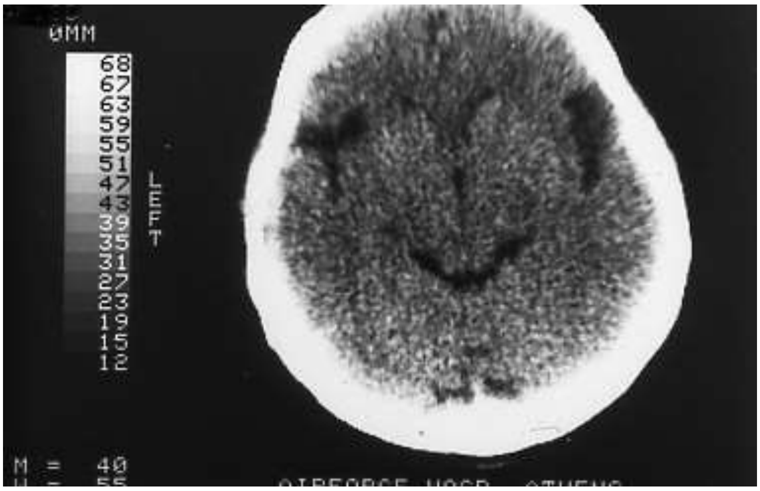
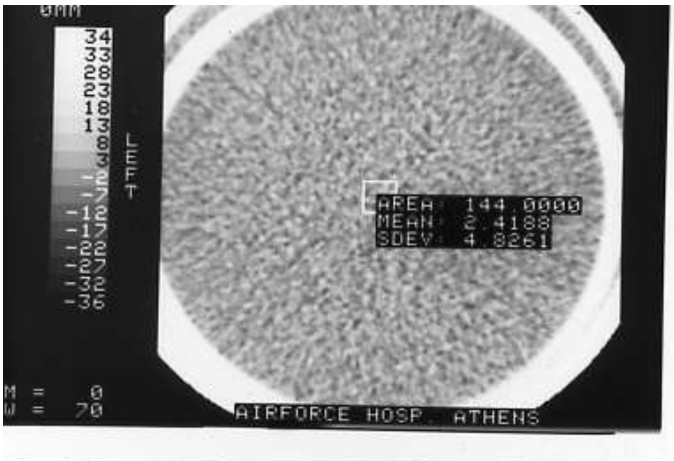
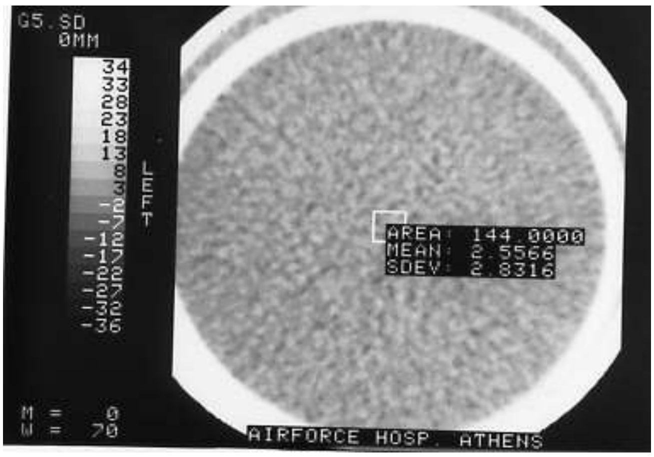


Image noise, is of statistical nature and signal dependent but, without great loss of accuracy, it can be considered additive and white. The noise contribution to each pixel of the medical image is not known but an assessment of the overall noise contribution to the image can be obtained from:

$$\text{Noise} = \sqrt{\frac{\sum_{i=1}^{N}\left(x_i - \overline{\mu}\right)^2}{N}}$$







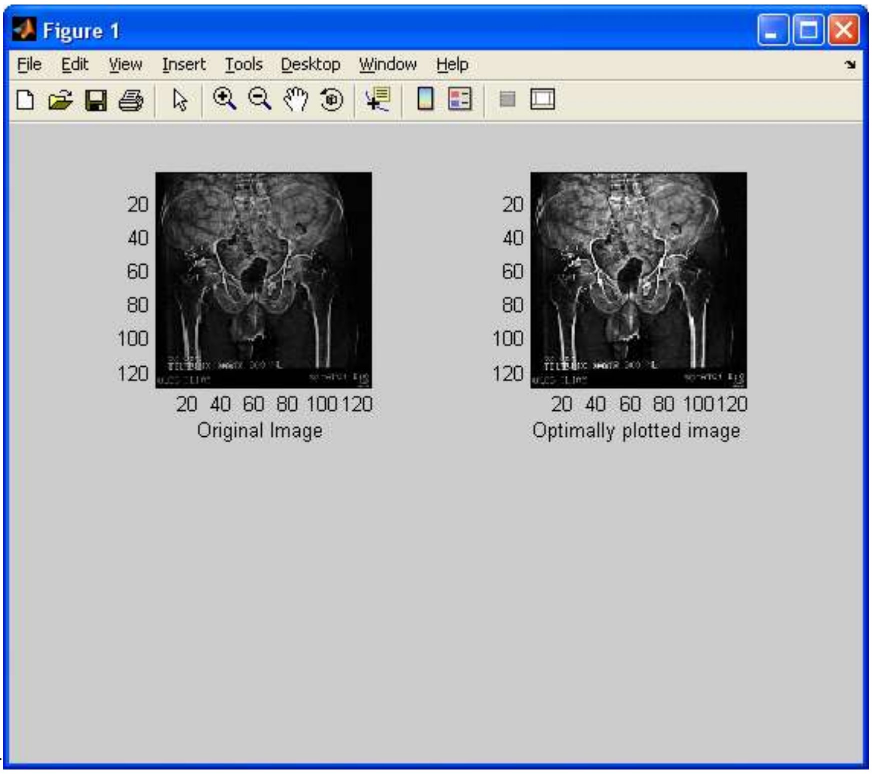
Overall image quality may be approximately evaluated by:

$$\text{Image\_Quality} = K\frac{(\text{Sharpness})^2(\text{contrast})^2}{\text{Noise\_Power\_Spectrum}}$$

```
%Program_0
% Read & plot image

function []=Program_1();
clc;echo off;close all;
A=[ 30,31,12, 9,
    17,12,25,10,
    12, 8,17, 9,
    31,12,26,22];
A=double(A);B=A;
disp('original image matrix');disp(A);

image_depth=31;tones=8;
x=size(A,1);y=size(A,2);

disp('plotted image matrix');
for i=1:x
    for j=1:y
        ival=A(i,j);
            tone_ival=(tones-1)*(double(ival)-0)/(31-0);
        B(i,j)=tone_ival;
    end;
end;
disp(round(B));
close all;
clear A; clear B;


%--------------------------------------------------------------
A=imread('C:\Program Files\MATLAB\R2006b\work\Images\Pelvis.BMP');
% A=imread('C:\Program
Files\MATLAB\R2006b\work\Images\01254520_256X256.bmp');%01254520_256X
256.bmp, AA1a.BMP
A=double(A);
x=size(A,1);y=size(A,2);
sprintf('x= %f  y=%f',x,y);

%expand image to 0-255
max_A=max(max(A));min_A=min(min(A));
for i=1:x
    for j=1:y
        val=A(i,j);
            tone_ival=(val-min_A)*(255/(max_A-min_A));
        B(i,j)=tone_ival;
    end;
end;
max_B=max(max(B));min_B=min(min(B));
[min_A max_A min_B max_B]
% %========= PLOT IMAGES ====================
colormap('gray');

subplot(2,2,1);imagesc(A, [0 255] );xlabel('Original Image');
axis equal;axis([1 size(A,2) 1 size(A,1)]);

subplot(2,2,2);imagesc(B, [0 255]);xlabel('Optimally plotted image');
axis equal;axis([1 size(B,2) 1 size(B,1)]);
```

```
%==================================================================
=======
```

```
Output
original image matrix
    30    31    12     9
    17    12    25    10
    12     8    17     9
    31    12    26    22
plotted image matrix
     7     7     3     2
     4     3     6     2
     3     2     4     2
     7     3     6     5

ans =

    1.0000  186.0000         0  255.0000
```



\>>

```
%Labwork:
% 1) construct your own routine for scalling an image to any
% interval between 0 and 255
% 2)construct a 20x20 pixels ROI at the center of an image
% and calculate the mean value and standard deviation by using
% your own basic code and by verifying results with matlab's respective
%functions
% 3)Plot histograms of the original and a modified (scaled) image.
Histogram is a graph of the number of pixels (y-axis) per gray-value (x-
axis)
```

UoA_2013