Image processing

„object”　　image　　perception, processing

Where?

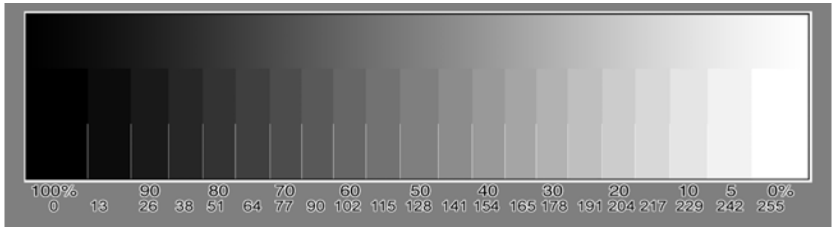
eg. radiology, patology, endoscopy ….. and in the normal life.

Image

	analogue	digital
pixel size	random	uniform
pixel distance	random	uniform

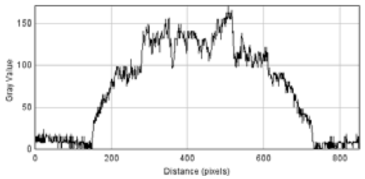
grayscale (8-bit):
- „0”: black
- „255”: white

Color image: **R (red), G (green) and B (blue) channels** additive combination 2^{24}, about 16 million colors.

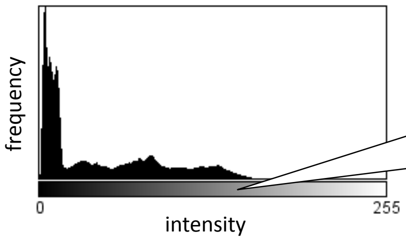


Intensity-histogram

The different colors (intensities) may be plotted as functions:



<u>Histogram:</u> The frequency of the colors ordered to the pixels in the whole image or in its selected part:



The dark tone is dominant in the image on the base of the intensity distribution. The whole intensity range is not used!

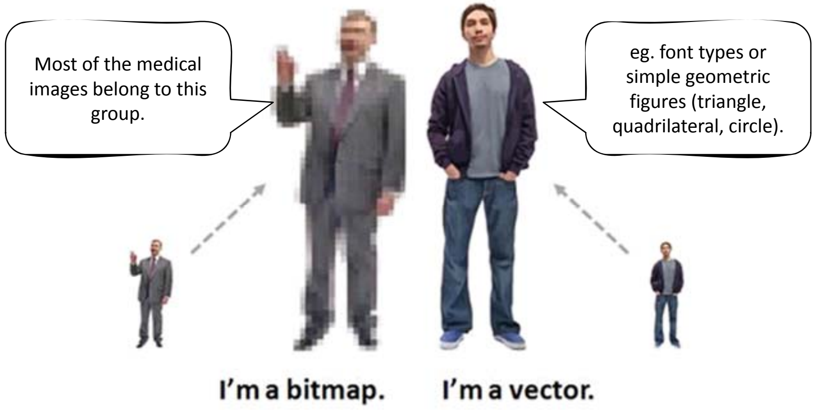
Resolution

The reciprok of the resolution limit
- PPI (pixels per inch - display)
- DPI (dots per inch - printer)
- line pair / cm

Decreasing resolution: **loss of information**, subsequent increase of resolution: **no more information!**

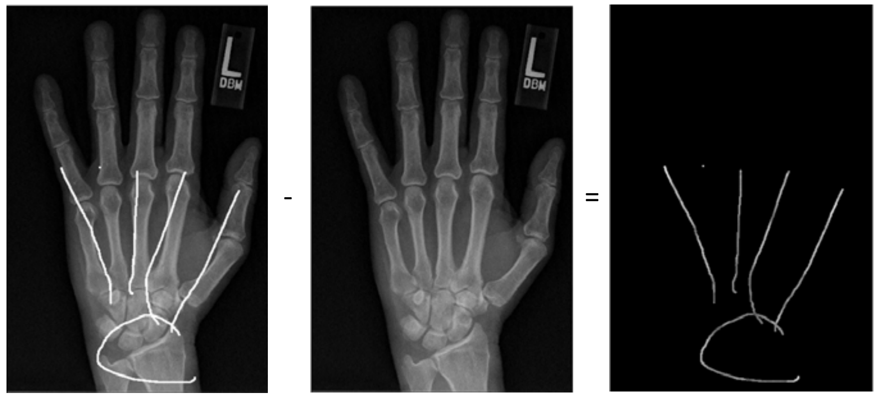
Zoom

Increasing pixel size.
Bitmap : Zoom is convenient to the processing, but there is no more information.
Vector graphics: unlimited zoom, but must be described as curves.



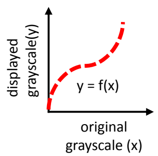
Addition / Subtraction

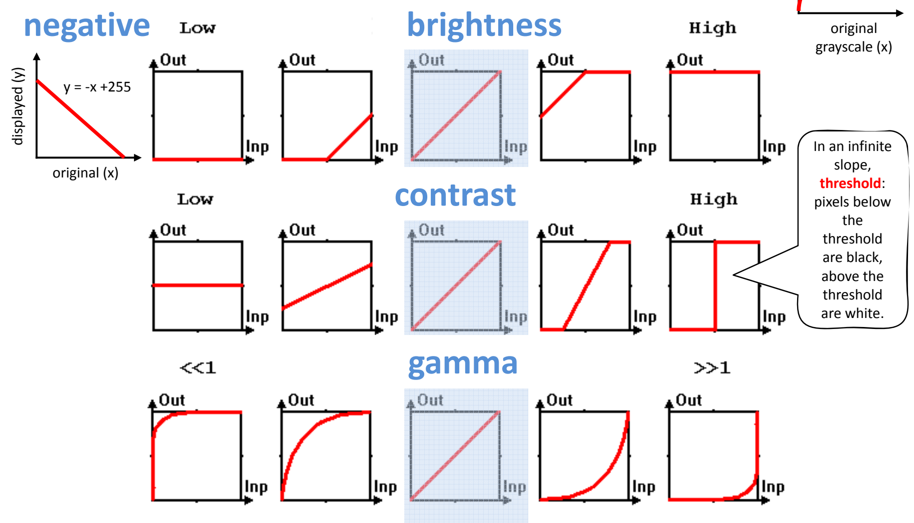
DSA = Digital Subtraction Angiography



(The subtraction of the grayscale values in the case of each pixels in the whole image)

Transfer-functions

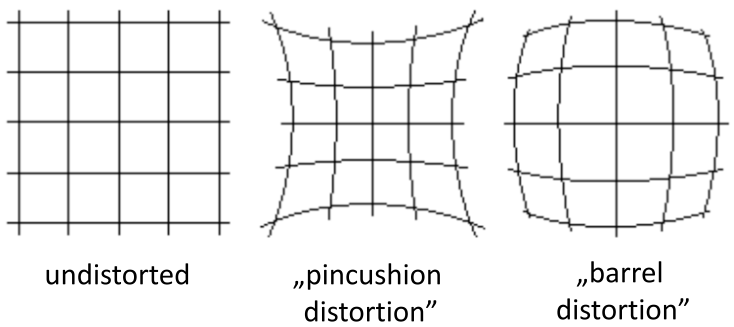




if there is no any change: „input = output"

Distortion

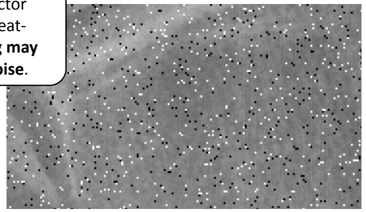
It appiers if a 3D structure (eg. organ) is diplayed in 2D.



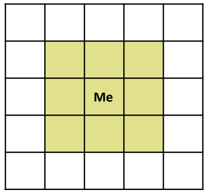
Noise:

- most common source: detector
- pepper and salt noise (random black and white pixels)

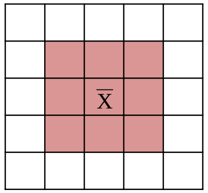
The semiconductor detectors are heat-sensitive: **cooling may decrease the noise.**

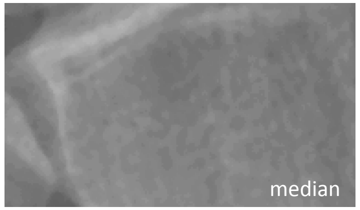


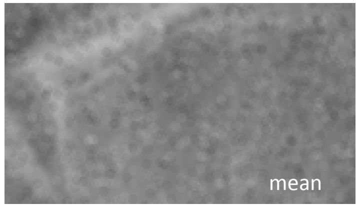
Filtering:



Effective in the case of pepper and salt noise.







Fourier-principle

Every periodic signal may be generated as the sum of sinusoidal functions.

time function

$$y(t)=\sum_k a_k \sin(k\cdot\omega_0\cdot t+\Phi_k)$$

FT ↓ ↑ **inverz-FT**

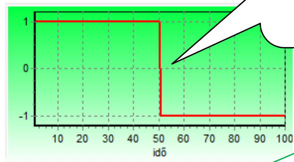
frequency function

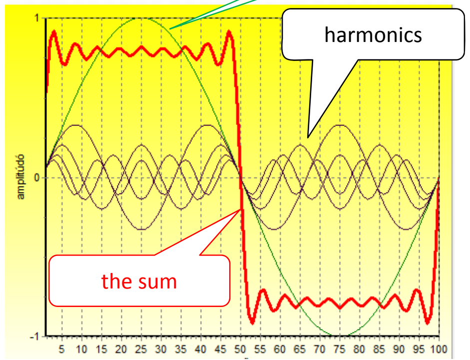
1D: f(x) -- F(u) spatial frequency

2D: f(x,y) -- F(u,v) 2D spatial frequency

image is a 2D…

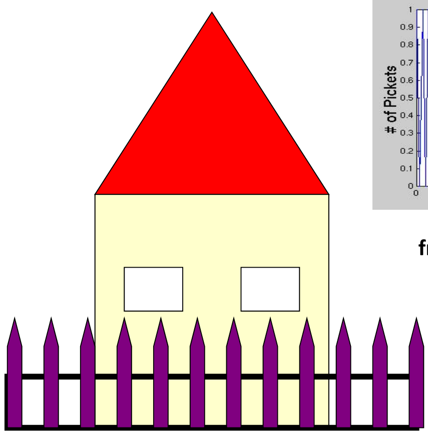
Square pulse: base frequency + adequate harmonics (right frequency and amplitude).

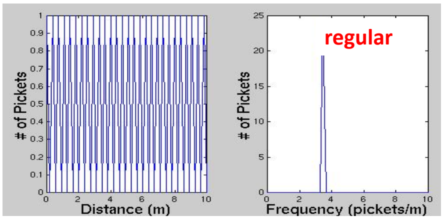




Fourier transformation (FT)

(spatial domain → frequency domain)



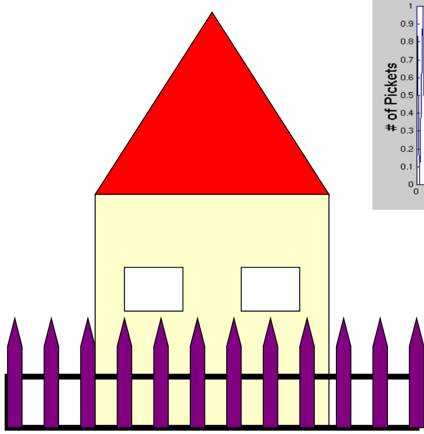


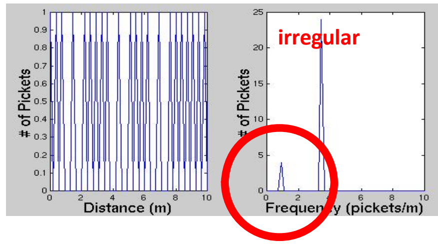
frequency domain (repeating fences)

spatial domain (house and fences)

Fourier transformation (FT)

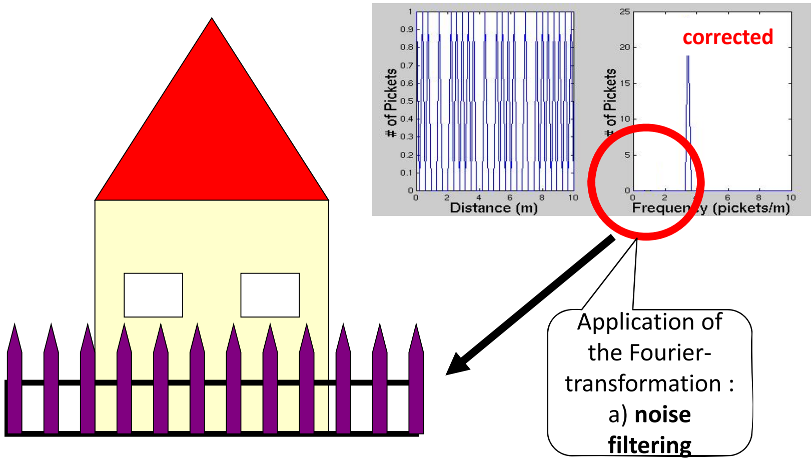
(spatial domain → frequency domain)

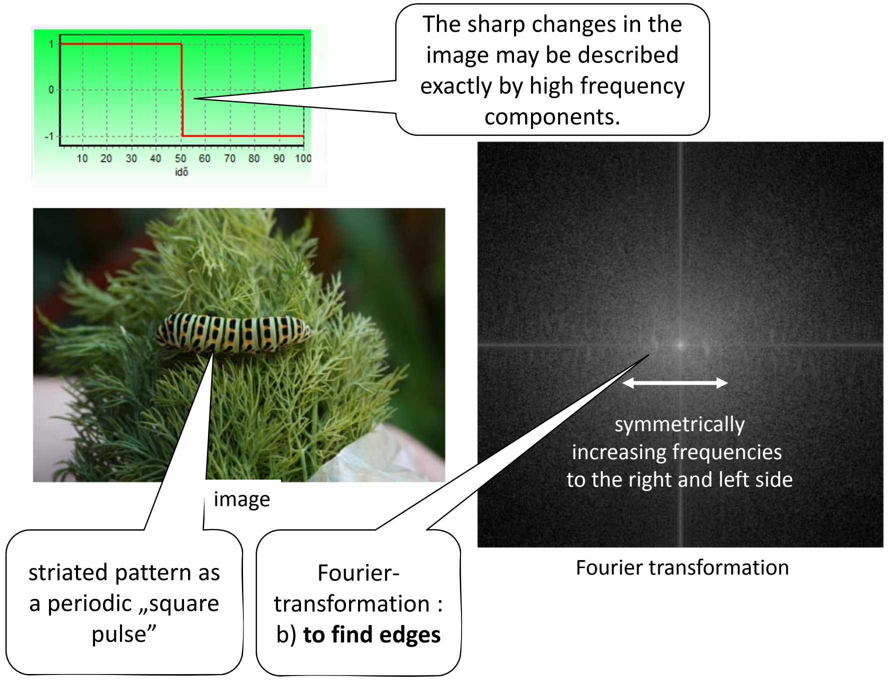




Fourier reconstruction

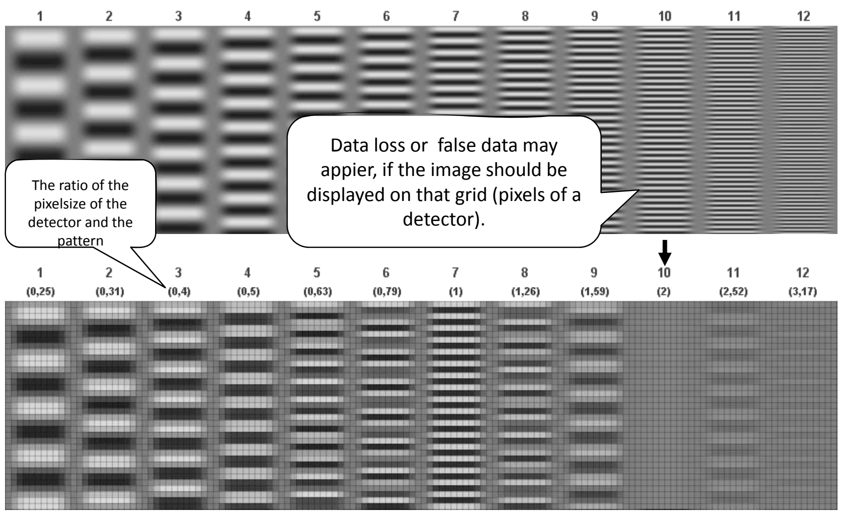
(frequency domain → spatial domain)





Aliasing (sampling problem)

The sampling frequency must be the double of the signal frequency at least!



Moiré

overexposed

underexposed

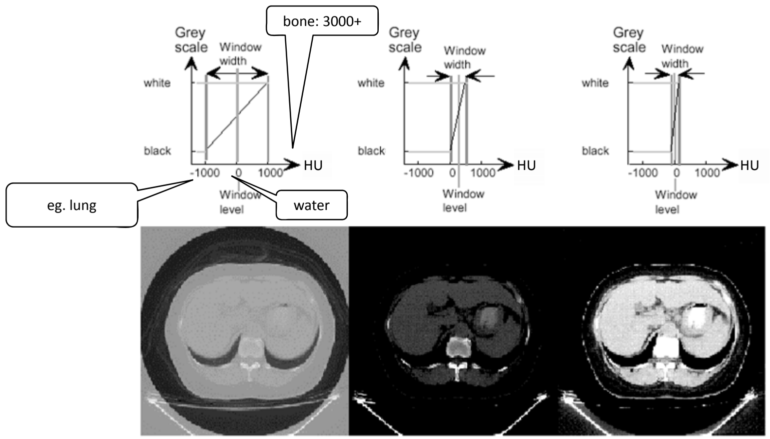
left side mastectomy

nipples

Windowing

as a transfer function

$$HU = \frac{\mu_x - \mu_{water}}{\mu_{water}} \cdot 1000$$ μ: linear attenuation coefficient



File types

- **uncompressed**, eg. BMP (bitmap)
- **compressed**
  - **Lossless**, eg. TIFF, GIF
  - **Lossy**, eg. JPG
- **DICOM**
  - image (or series of images)
  - patient data
  - Data on imaging mode / settings of the equipment, windowing, radiation dose in the case of CT, etc.

small storage requirements, but a part of the information content looses

„Digital Imaging Communications in Medicine”
(uniform file type + network communication protocol)