Image Processing

By: Mahnaz EtehadTavakol

What is an image

We can think of an **image** as a function, *f*, from R^2 to R:

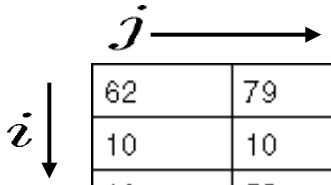
$f(x, y)$ gives the **intensity** at position (x, y)

A color image is just three functions pasted together.

$$f(x,y) = \begin{bmatrix} r(x,y) \\ g(x,y) \\ b(x,y) \end{bmatrix}$$

What is a digital image?

The image can be represented as a matrix of integer values



62	79	23	119	120	105	4	0
10	10	9	62	12	78	34	0
10	58	197	46	46	0	0	48
176	135	5	188	191	68	0	49
2	1	1	29	26	37	0	77
0	89	144	147	187	102	62	208
255	252	0	166	123	62	0	31
166	63	127	17	1	0	99	30

image processing

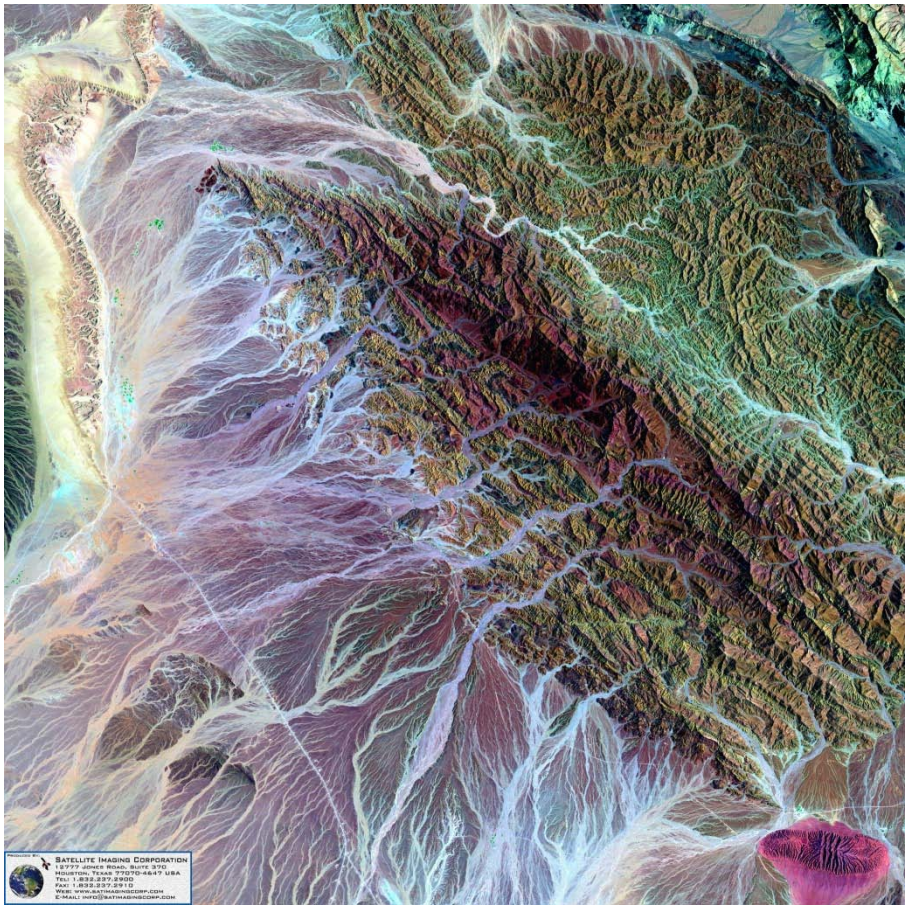
input

output

Image
- Photograph
- Video frame

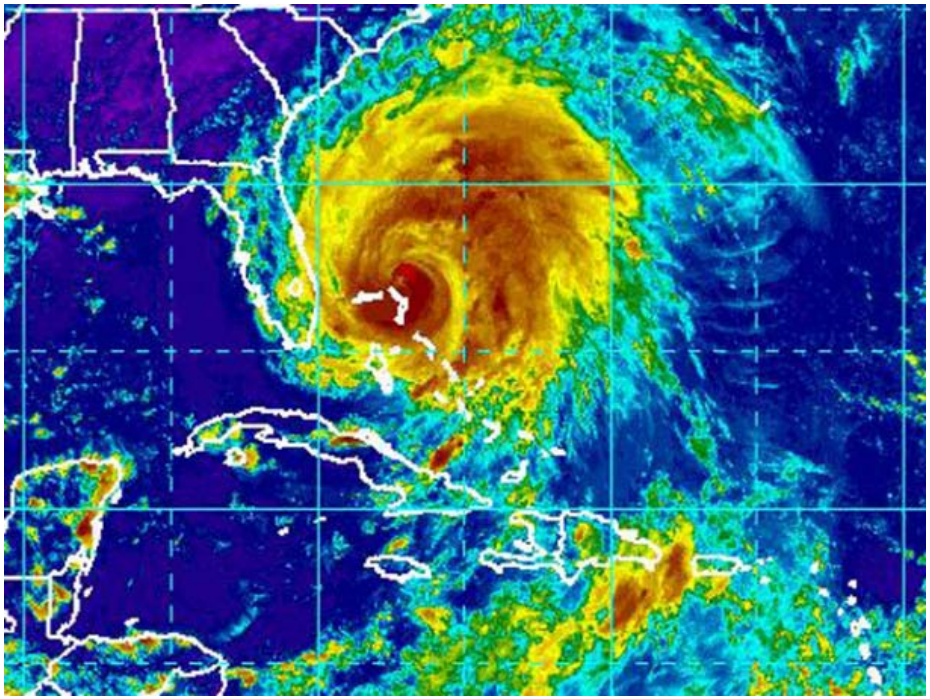
- Image
- A set of parameters related to image

Satellite images



Geological application

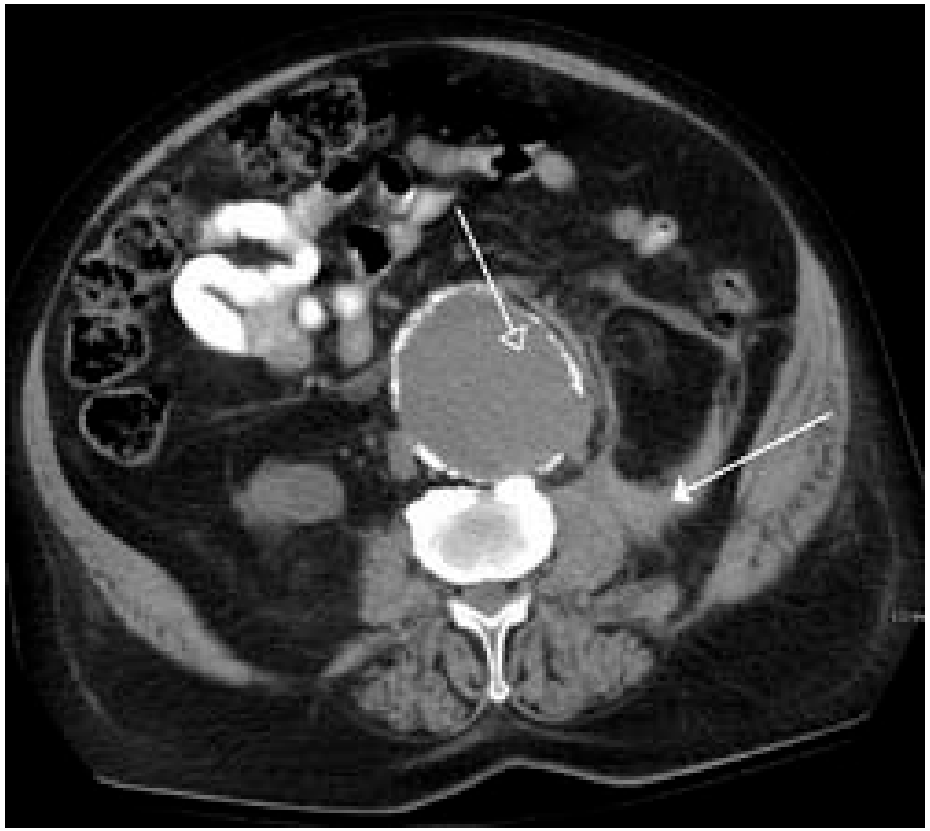
Agricultural application



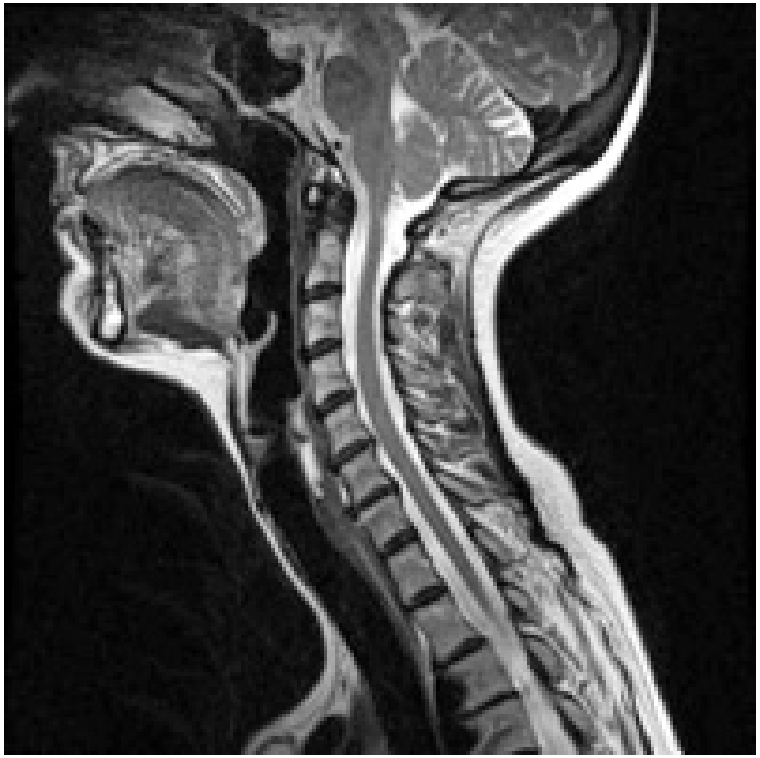
satellite images of hurricane irene

Military application

Medical images

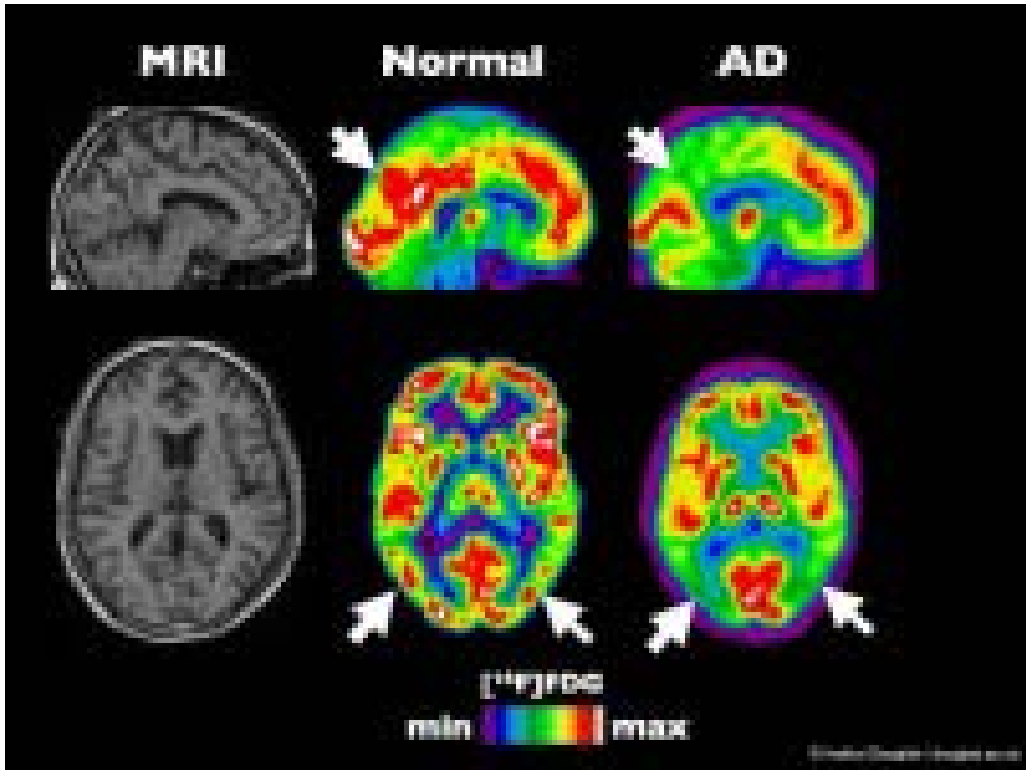


A CT scan image showing a ruptured abdominal aortic aneurysm



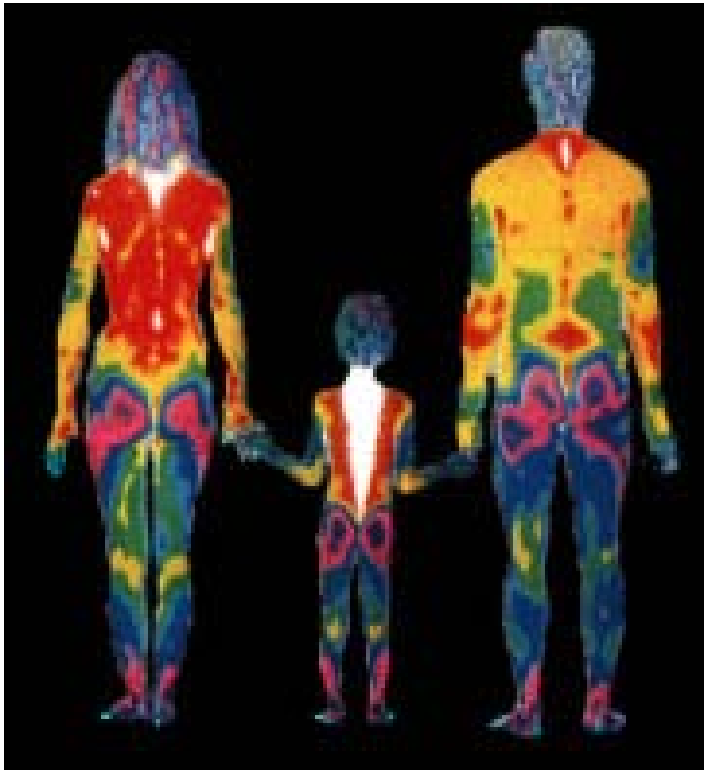
A MRI cervical spine

An Ultrasound of a kidney



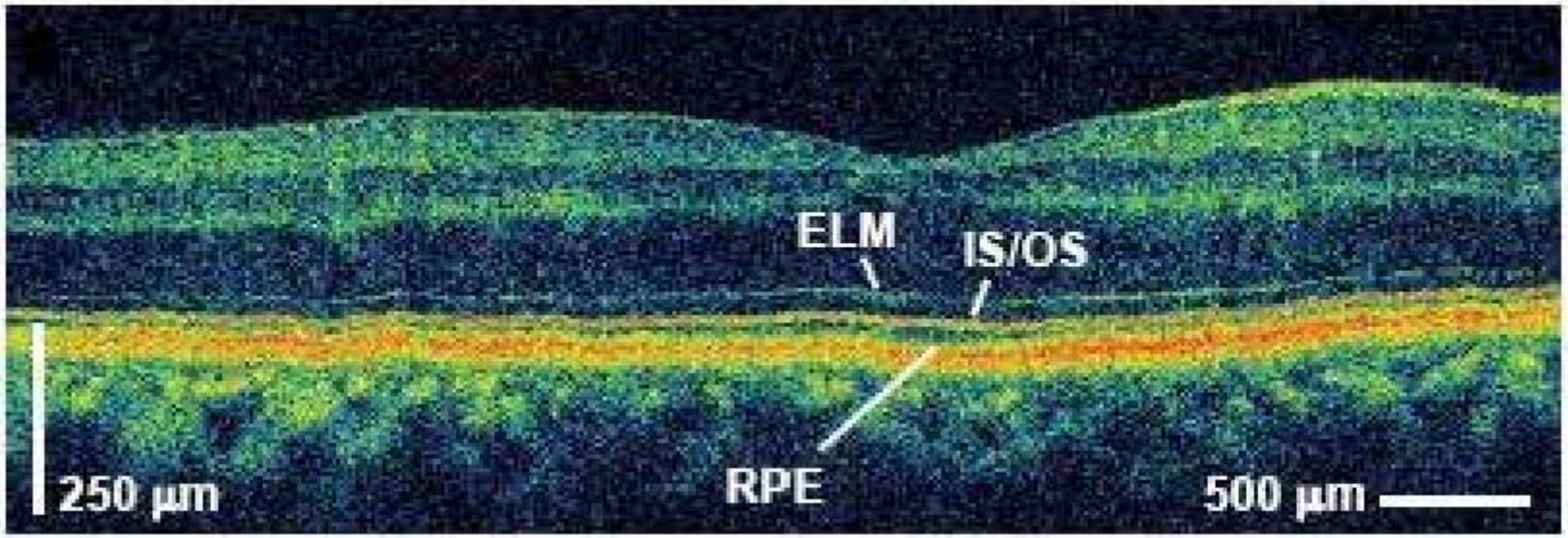
PET(**Positron emission tomography)**
A scan of an healthy brain compared to a brain at an early stage of Alzheimer's disease

Multiple sclerosis



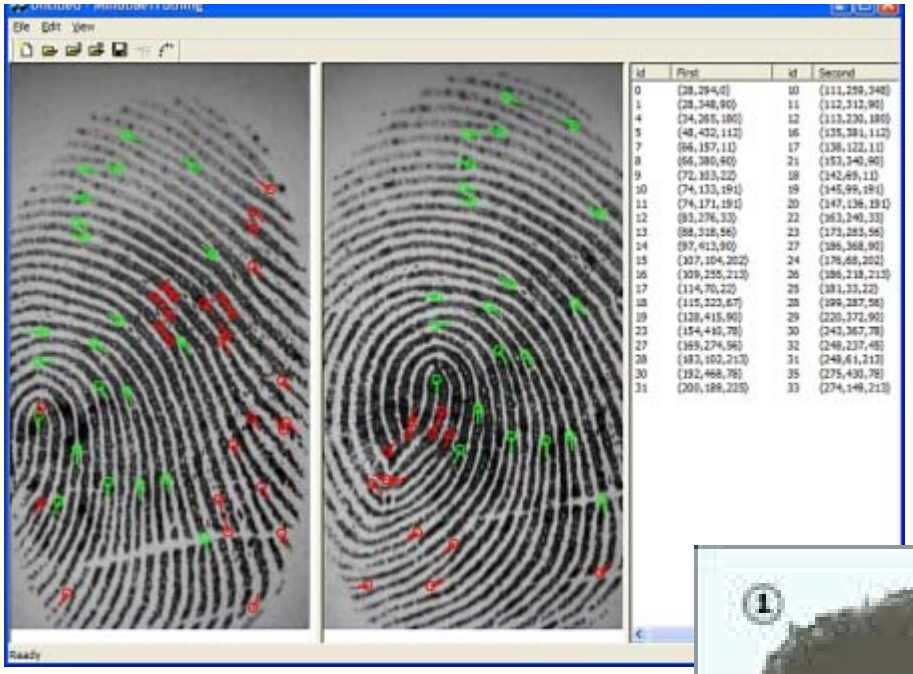
Whole body

Optical coherence tomography (OCT)

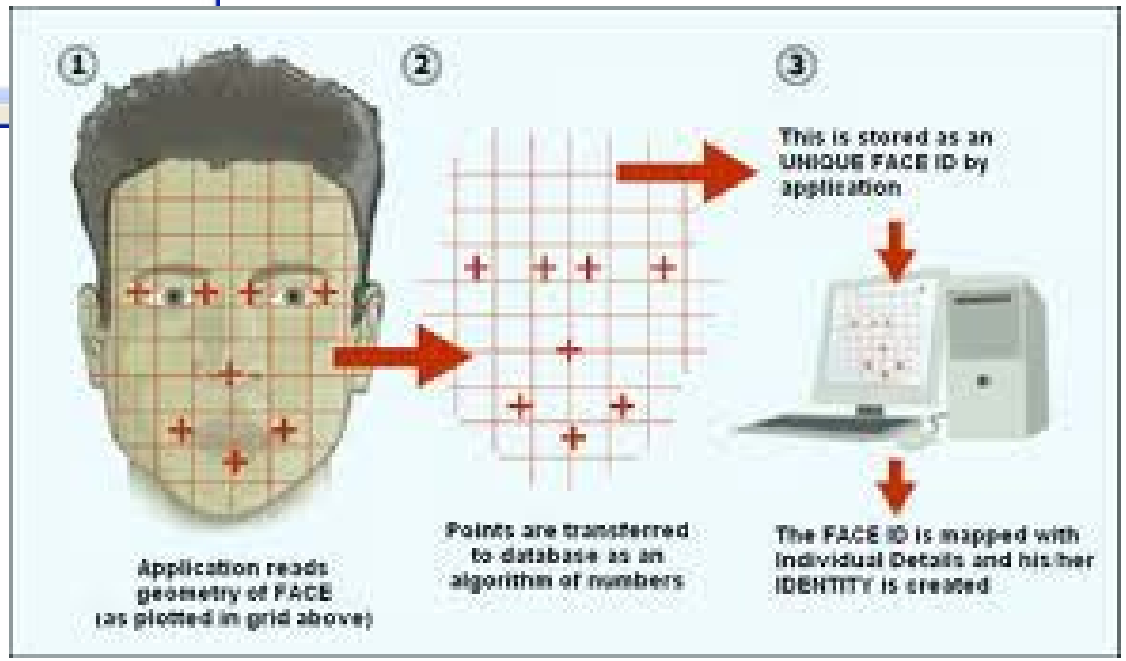


Ultrahigh resolution OCT cross section of a normal human macula
with 3 microns resolution

Security application



Fingerprint recognition



Face recognition

Typical operation

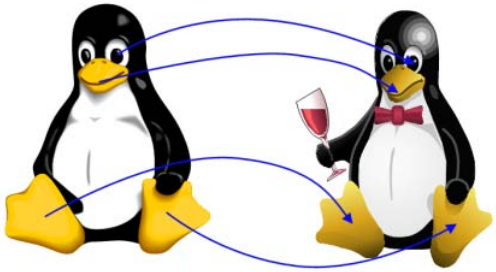
- Image registration
- Image enhancement
- Image recognition
- Image segmentation
- edge detection
- noise removal
- geometrical transformations such as rotating the image
- ……..

Image registration

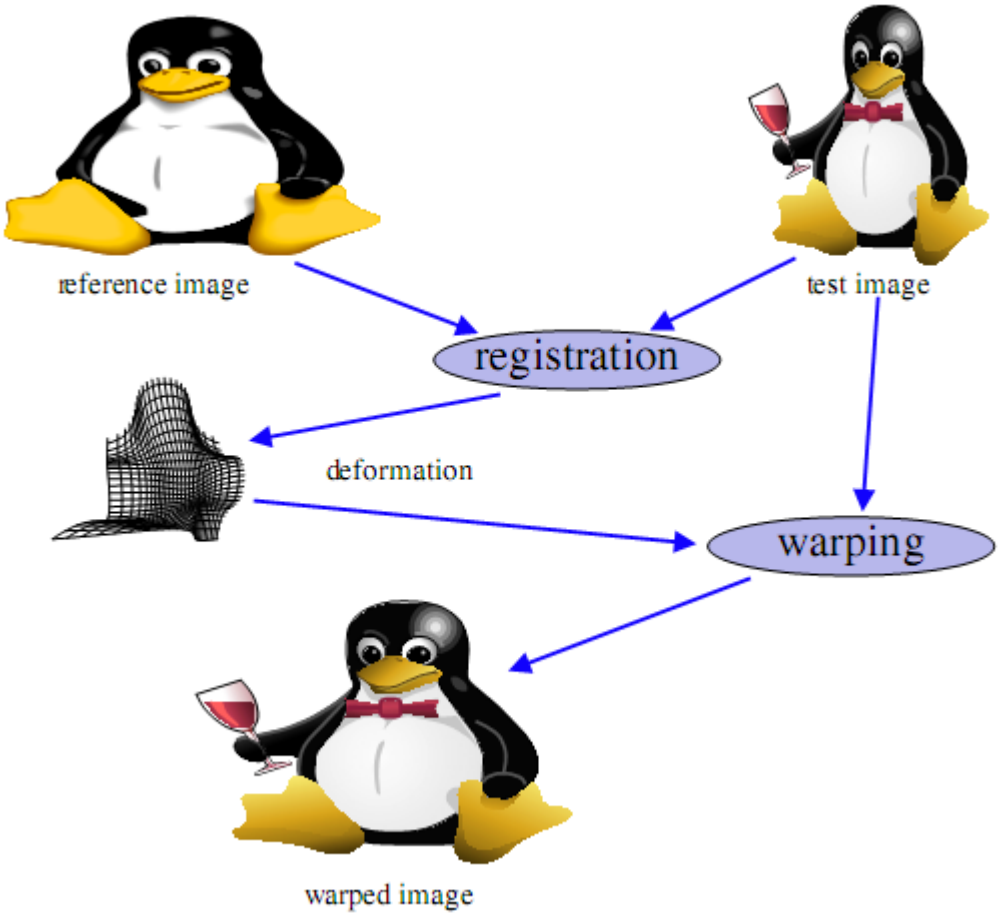
Registration is the determination of a geometrical transformation to set correspondence between data

- data may be multiple photographs,
- data from different sensors or modalities,
- from different times,
- or from different viewpoints

Image registration



Corresponding points



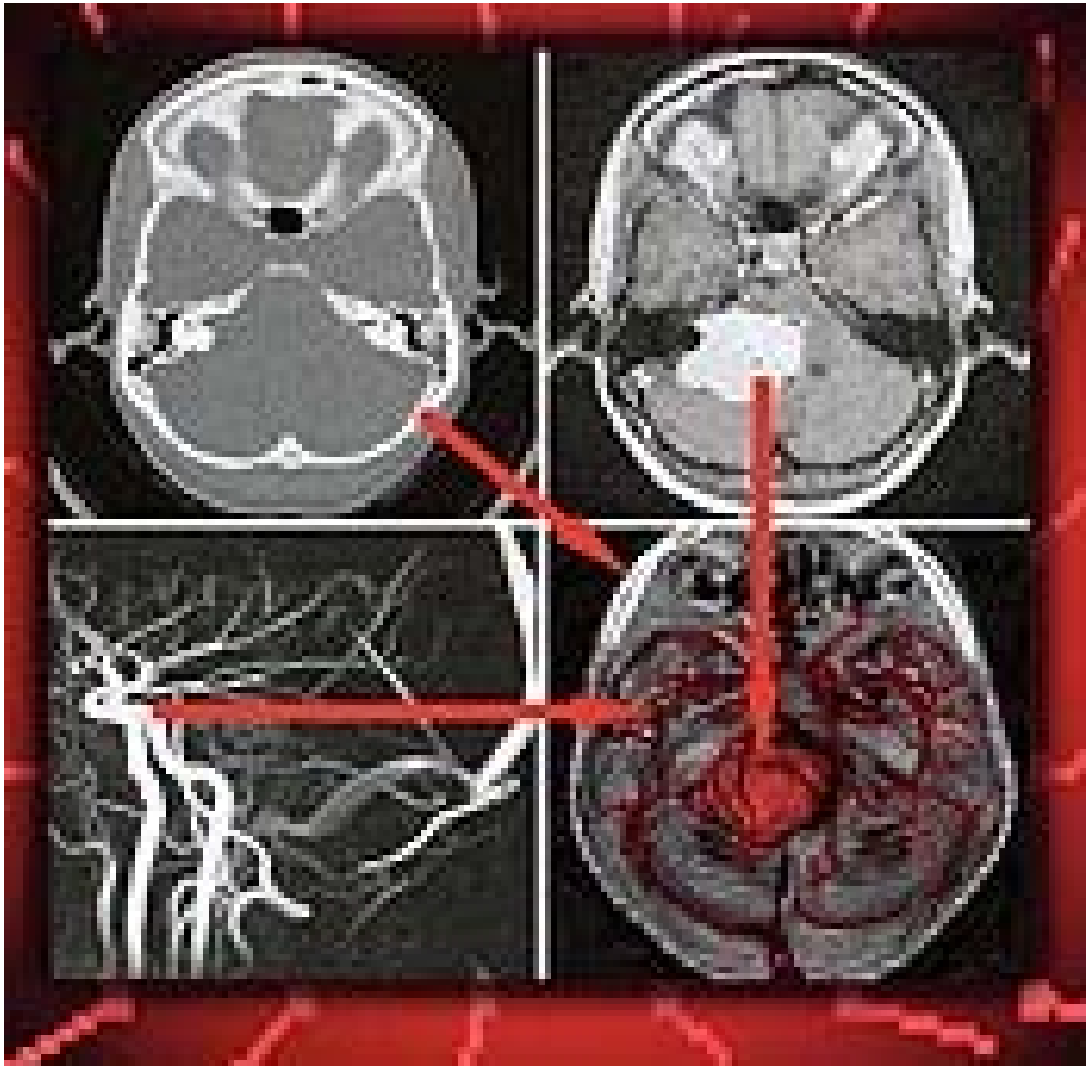


Image registration

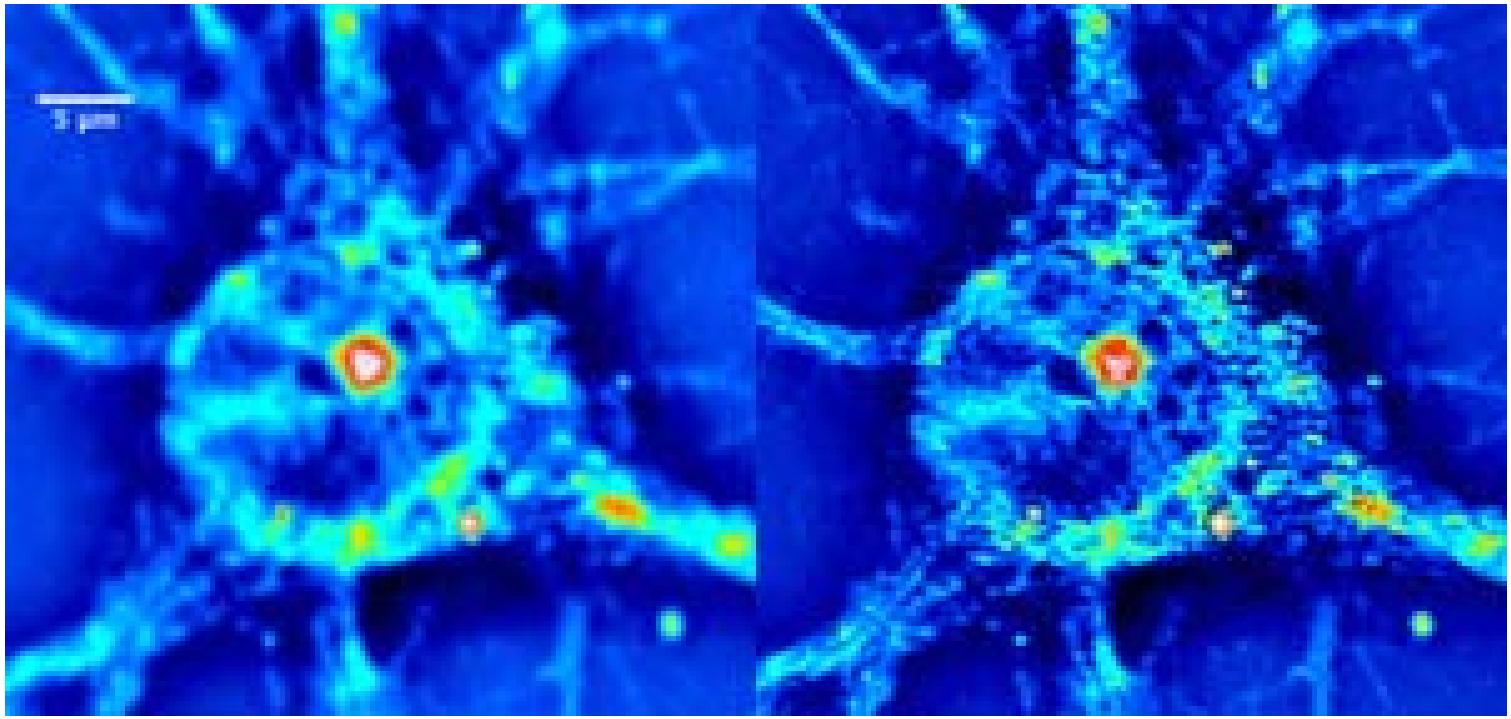
Example of different modalities

Image enhancement

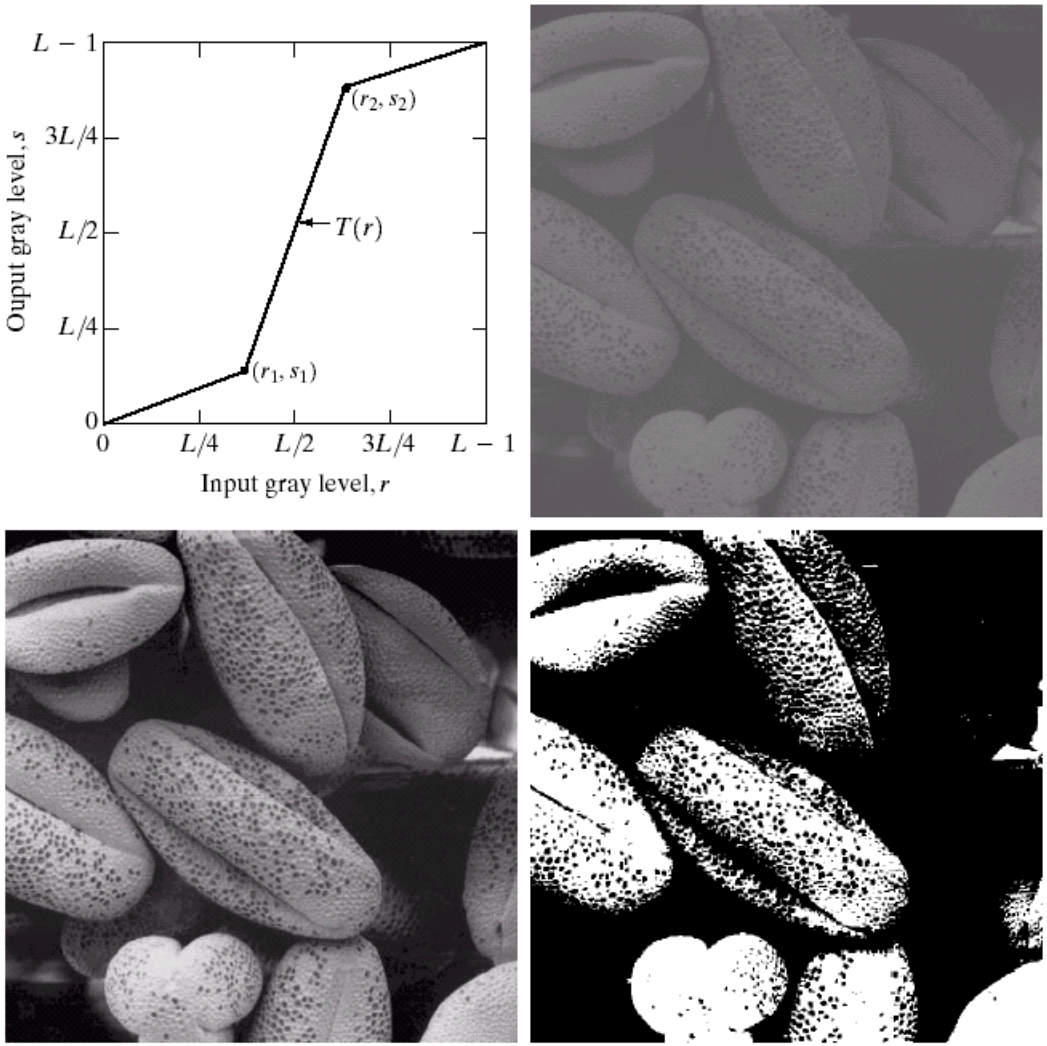
the process of improving the quality of the digitaly stored image

- make an image lighter or darker,
- or to increase or decrease contrast

Image enhancement

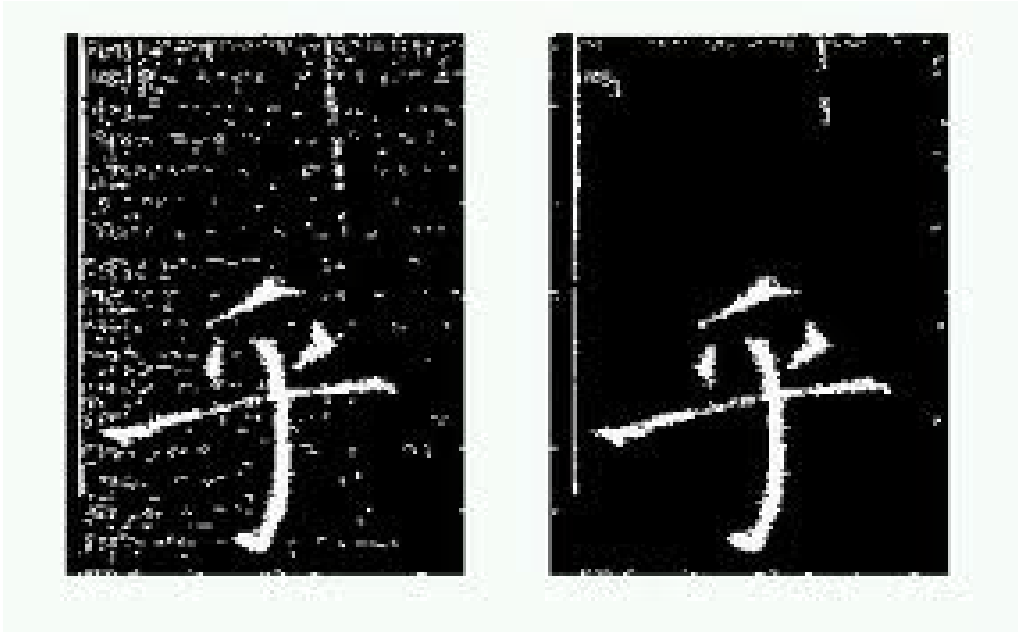


2.3x resolution enhancement

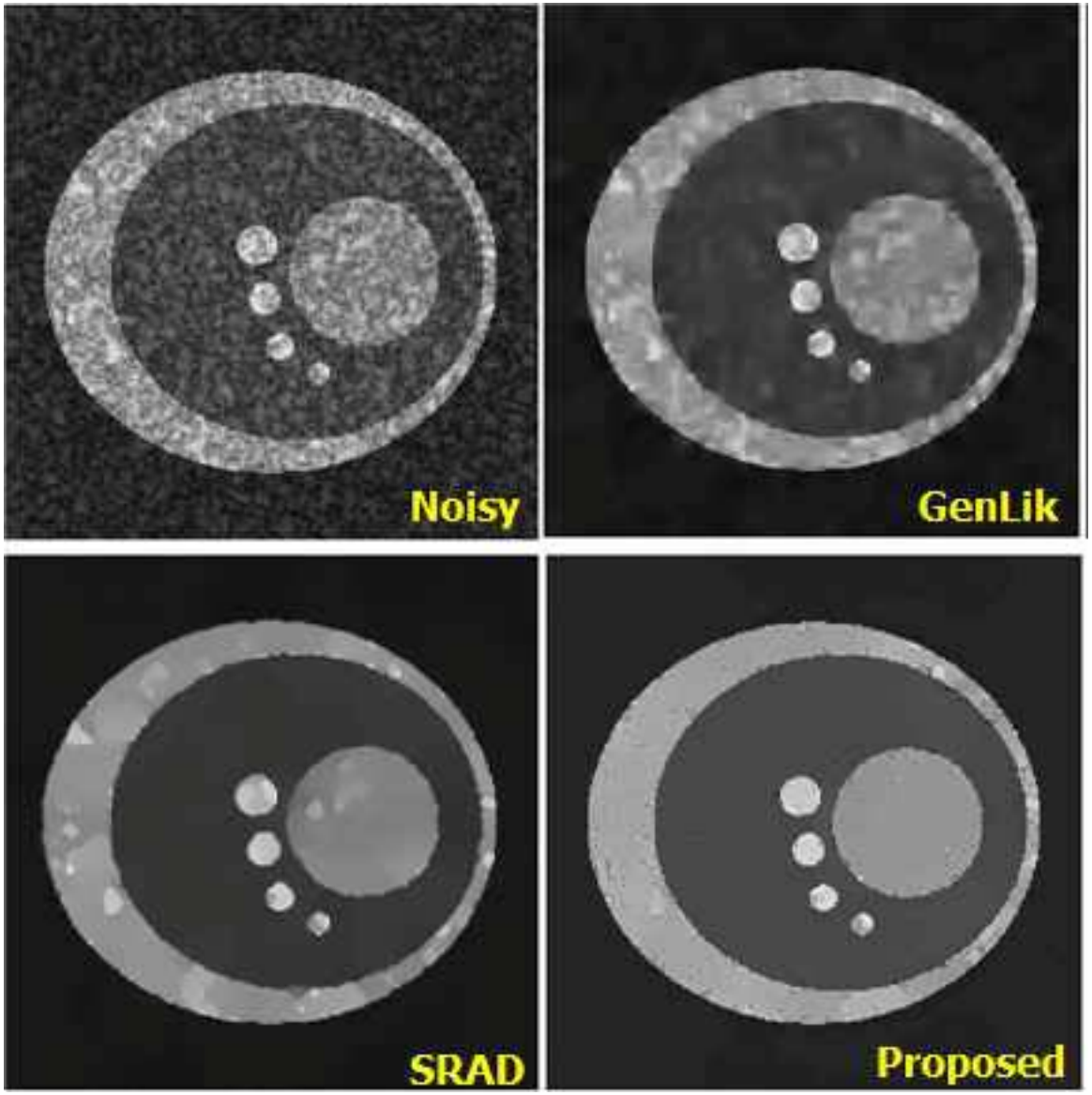


a b
c d

FIGURE 3.10 Contrast stretching. (a) Form of transformation function. (b) A low-contrast image. (c) Result of contrast stretching. (d) Result of thresholding. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)



Noise Removal



ultrasound image denoising

Image recognition

The identification of objects in an image

Steps:

1) Noise removal
2) Feature extraction to locate lines, regions and possibly areas with certain textures.

Feature extraction in

Face recognition

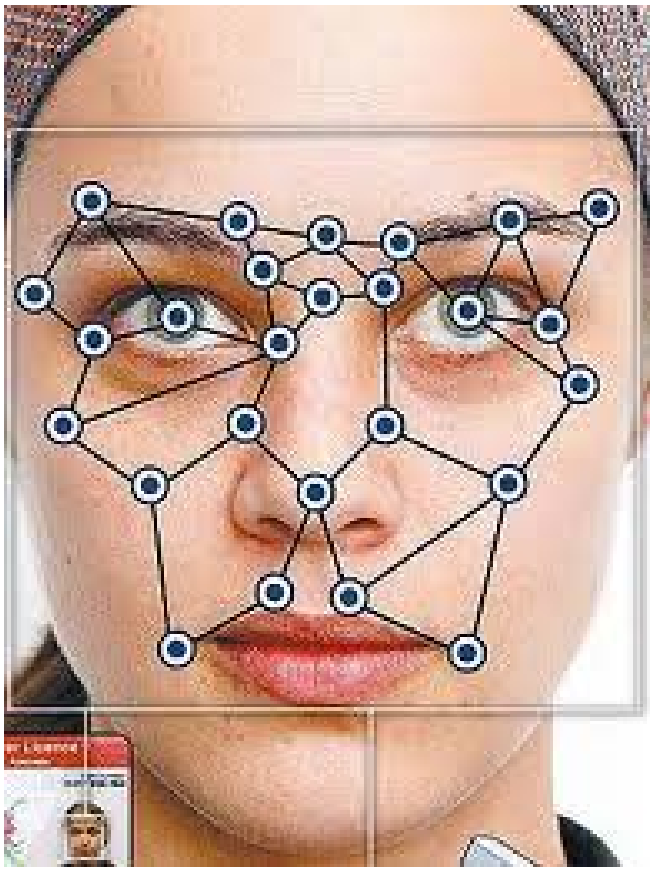
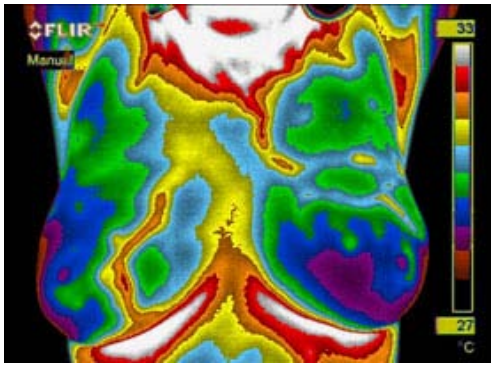
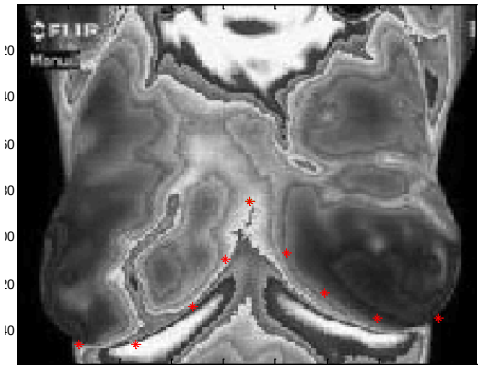


Image segmentation

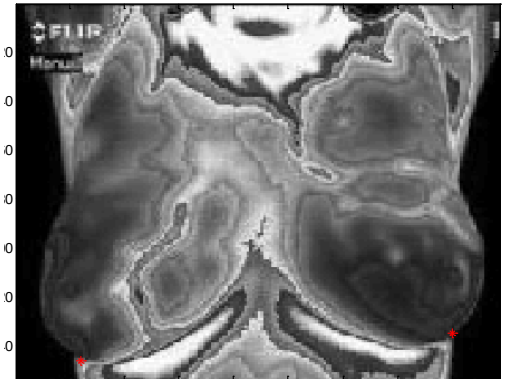
the process of partitioning a digital image into multiple segments

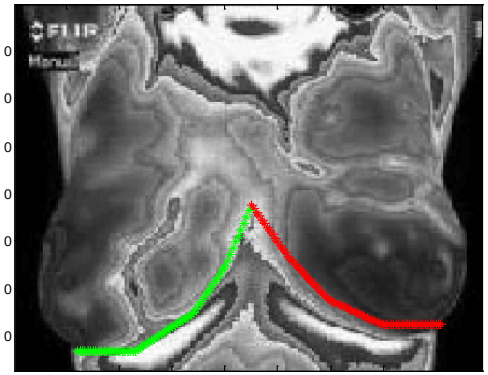


Breast thermography

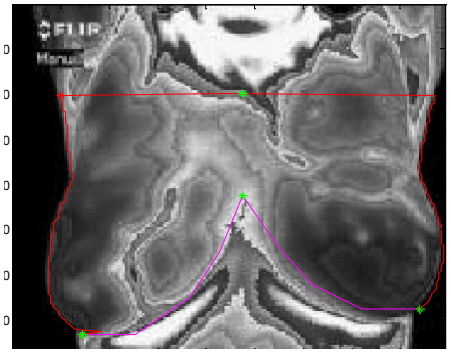


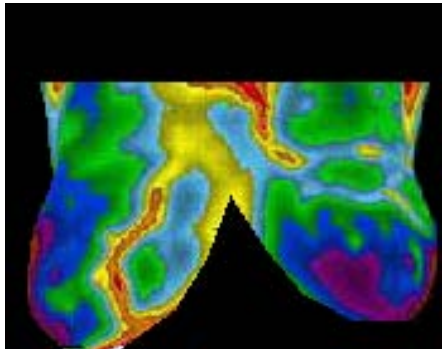
Automatic segmentaion of two breasts

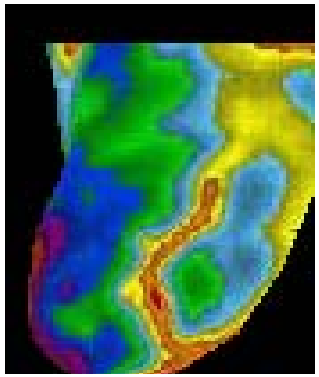


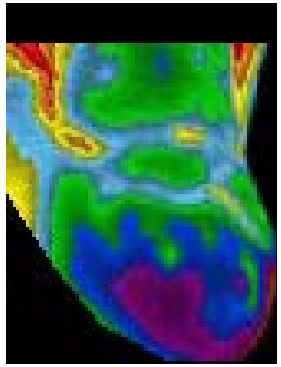


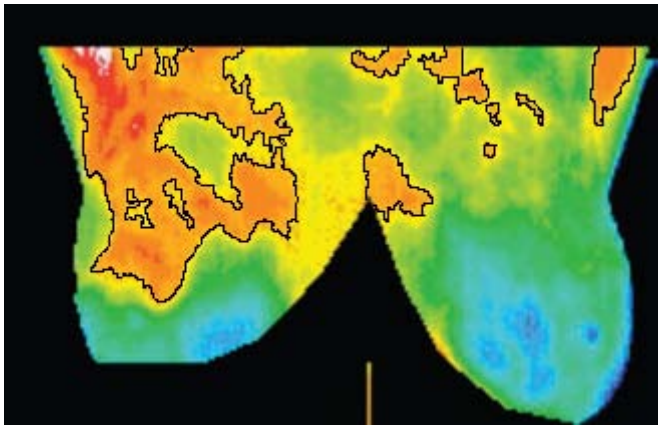
as if we started in HI res



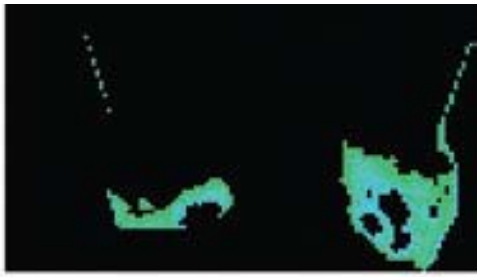


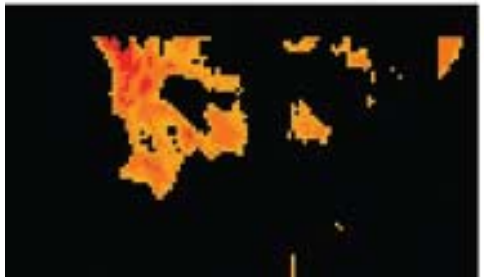


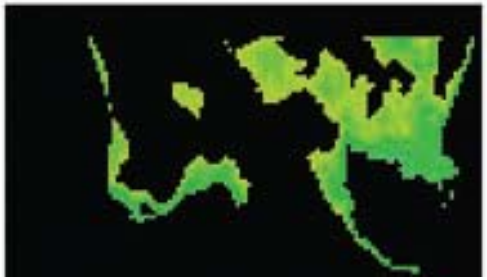




Breast thermography

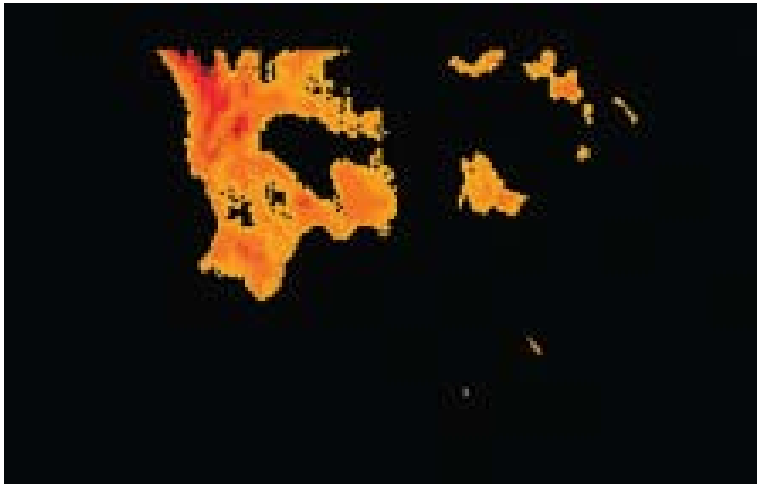




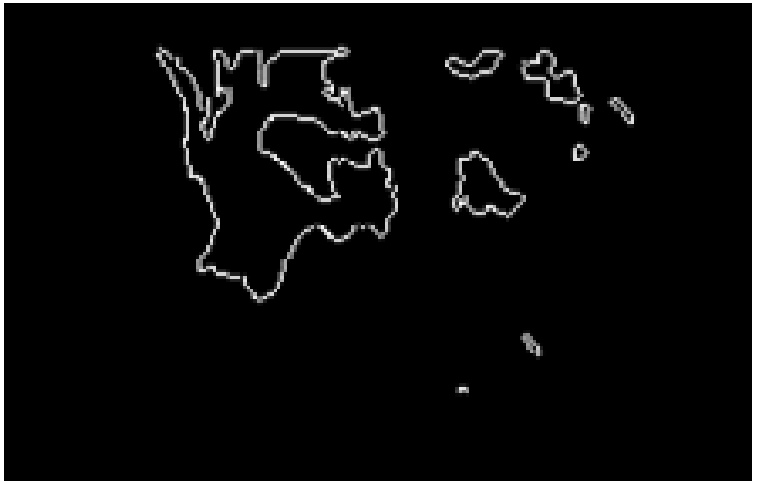


Color segmentation By fuzzy c means

Boundary Detection

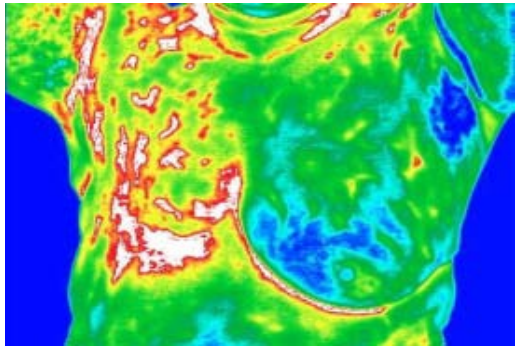


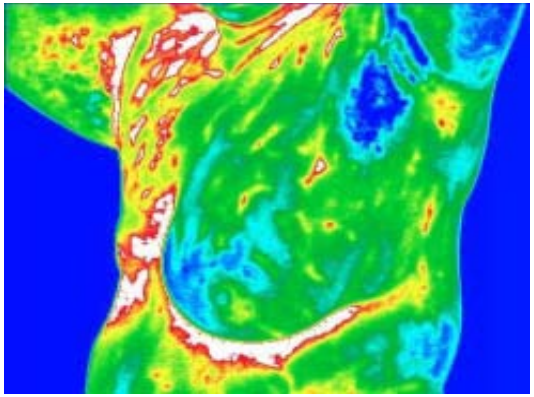
The first hottest region



The boundaries of the first hottest region

Example





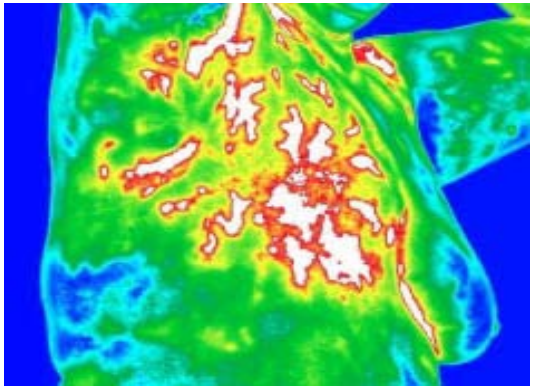


Image registration

different views


Thank you for your attention