

## A Short Introduction to Image Processing

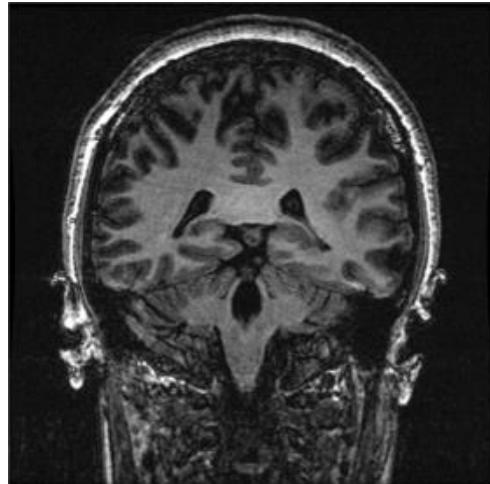
# Course Evaluation

Endsem – 40%

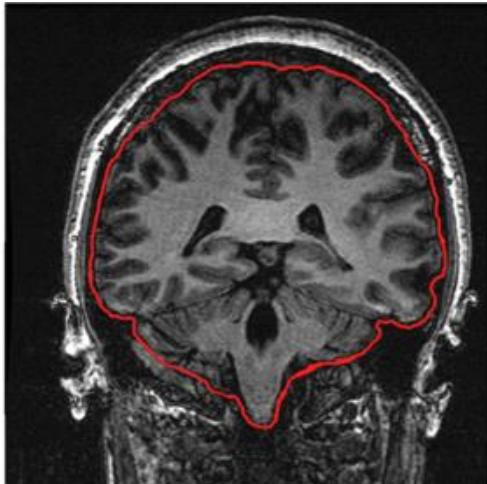
Insem – 20%

Course project/Viva voce – 20 %

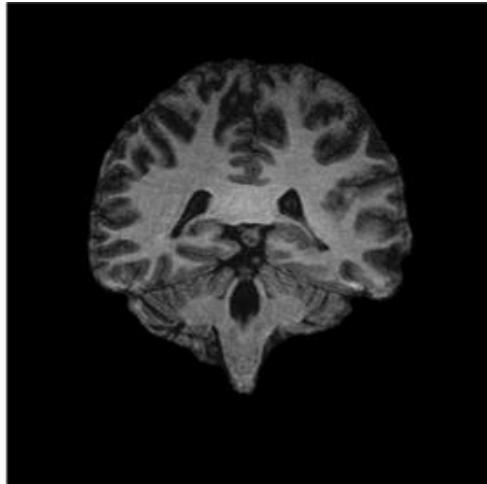
Practical exam – 20%



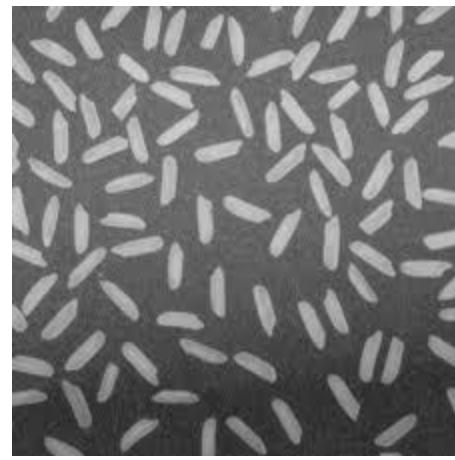
(A)



(B)



(C)





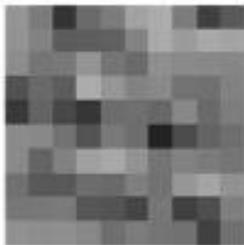
# What is an Image?

- 2-dimensional matrix of Intensity (gray or color) values

Set of Intensity values

$$I(u, v) \in \mathbb{P} \quad \text{and} \quad u, v \in \mathbb{N}.$$

Image coordinates  
are integers

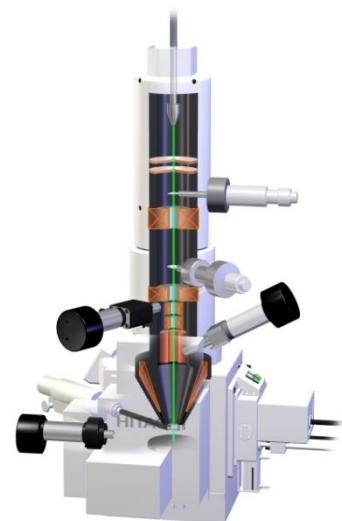


$$F(x, y)$$



148	123	52	107	123	162	172	123	64	89	...
147	130	92	95	98	130	171	155	169	163	...
141	118	121	148	117	107	144	137	136	134	...
82	106	93	172	149	131	138	114	113	120	...
57	101	72	54	109	111	104	135	106	125	...
138	135	114	82	121	110	34	76	101	111	...
138	102	128	159	168	147	116	129	124	117	...
113	89	89	109	106	126	114	150	164	145	...
120	121	123	87	85	70	119	64	79	127	...
145	141	143	134	111	124	117	113	64	112	...
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

$$I(u, v)$$





**Paul C. Lauterbur, 2003**



**Sir Peter Mansfield,  
2003**



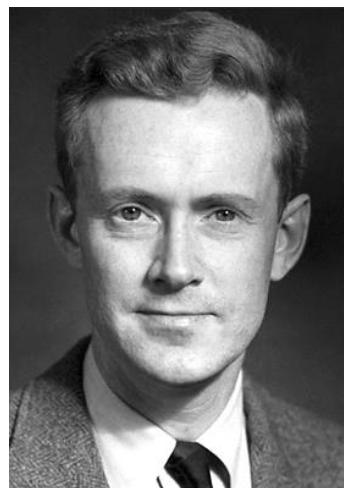
**Allan M. Cormack, 1979**



**Godfrey N. Hounsfield,  
1979**



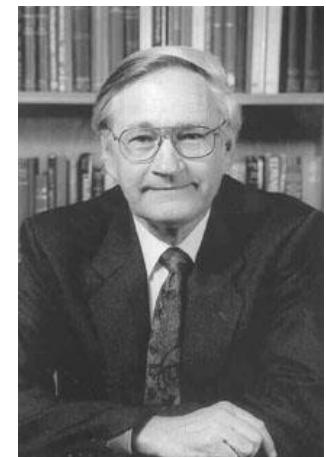
**Felix Bloch, 1952**



**Edward Mills Purcell,  
1952**

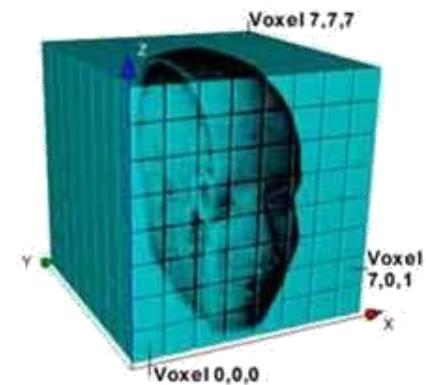
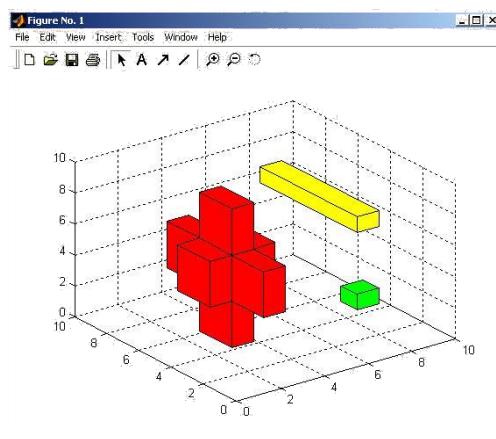
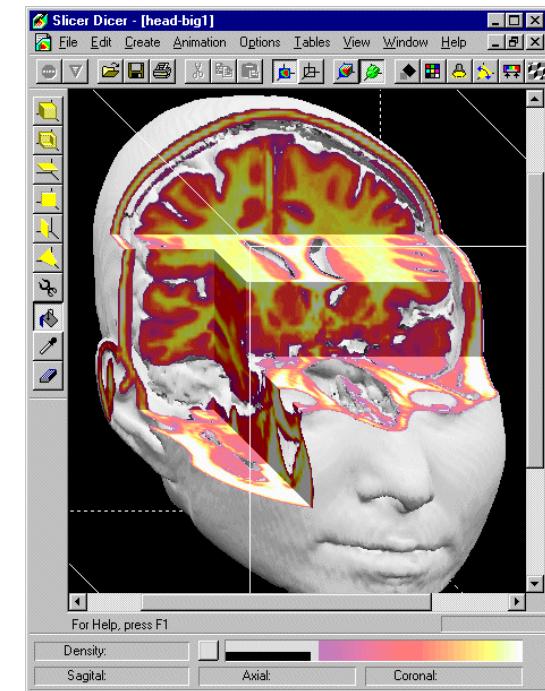
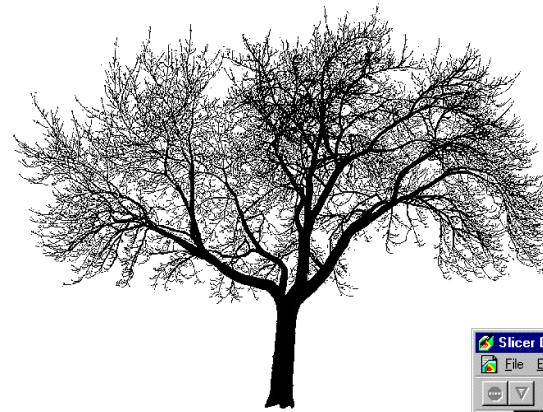


**Wilhelm Conrad  
Röntgen, 1901**



**Richard R. Ernst, 1991**

# Pixel and Voxel



A volume data set is built up from voxels on a regular 3D grid.

## Optical zoom and digital zoom



Original

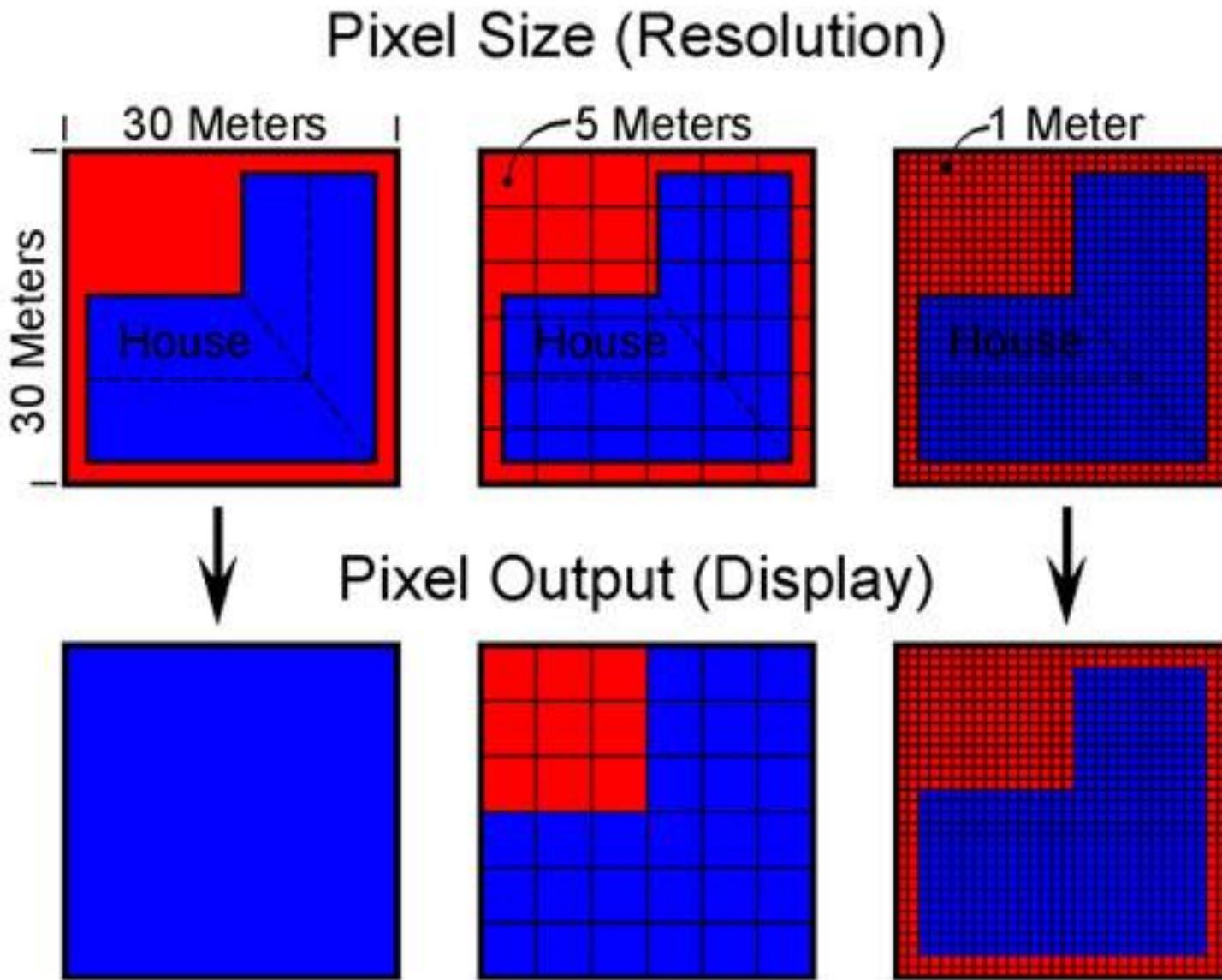


10x Optical



10x Digital

## Spatial resolution



# Spatial resolution

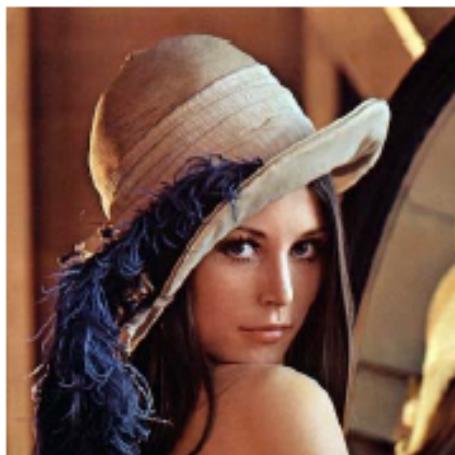


Full resolution details of the sample area: ( a ) satellite image in Google Earth with a 50 cm spatial resolution; ( b ) 10 cm spatial resolution orthophoto section photographed on Kodak film where the arrows indicate two white spots that are possibly flying birds. The 0.5 cm spatial resolution ortho image section recorded by the Interspect calibrated aerial camera of ( c ) a standing heron; and ( d ) a flying heron.

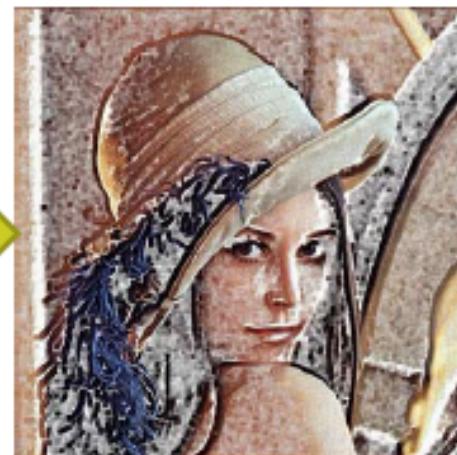
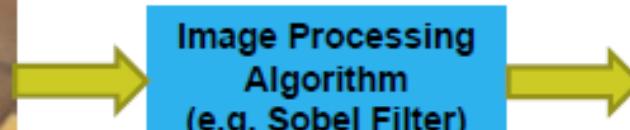


# What is image Processing?

- Algorithms that alter an input image to create new image
- Input is image, output is image



*Original Image*

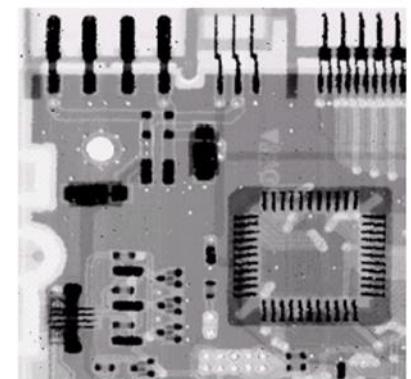
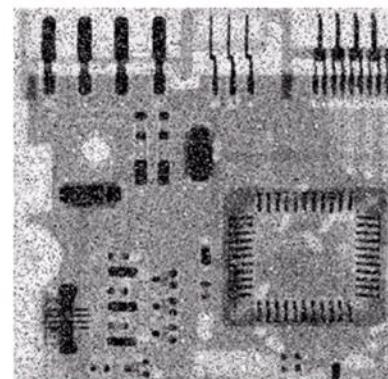
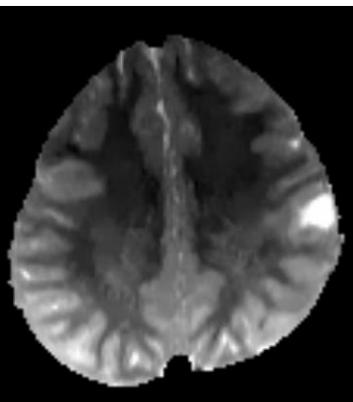
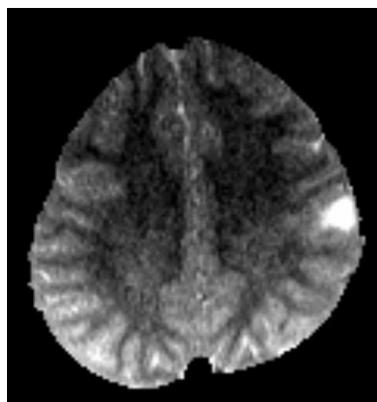
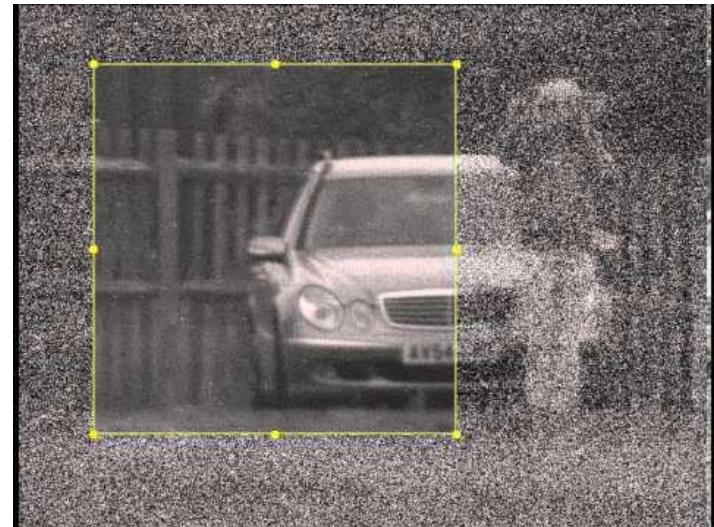


*Processed Image*

- Improves an image for human interpretation in ways including:
  - Image display and printing
  - Image editing
  - Image enhancement
  - Image compression

# Why Image Processing ?

- ▶ Improvement of pictorial information for human perception.



## Contrast Enhancement



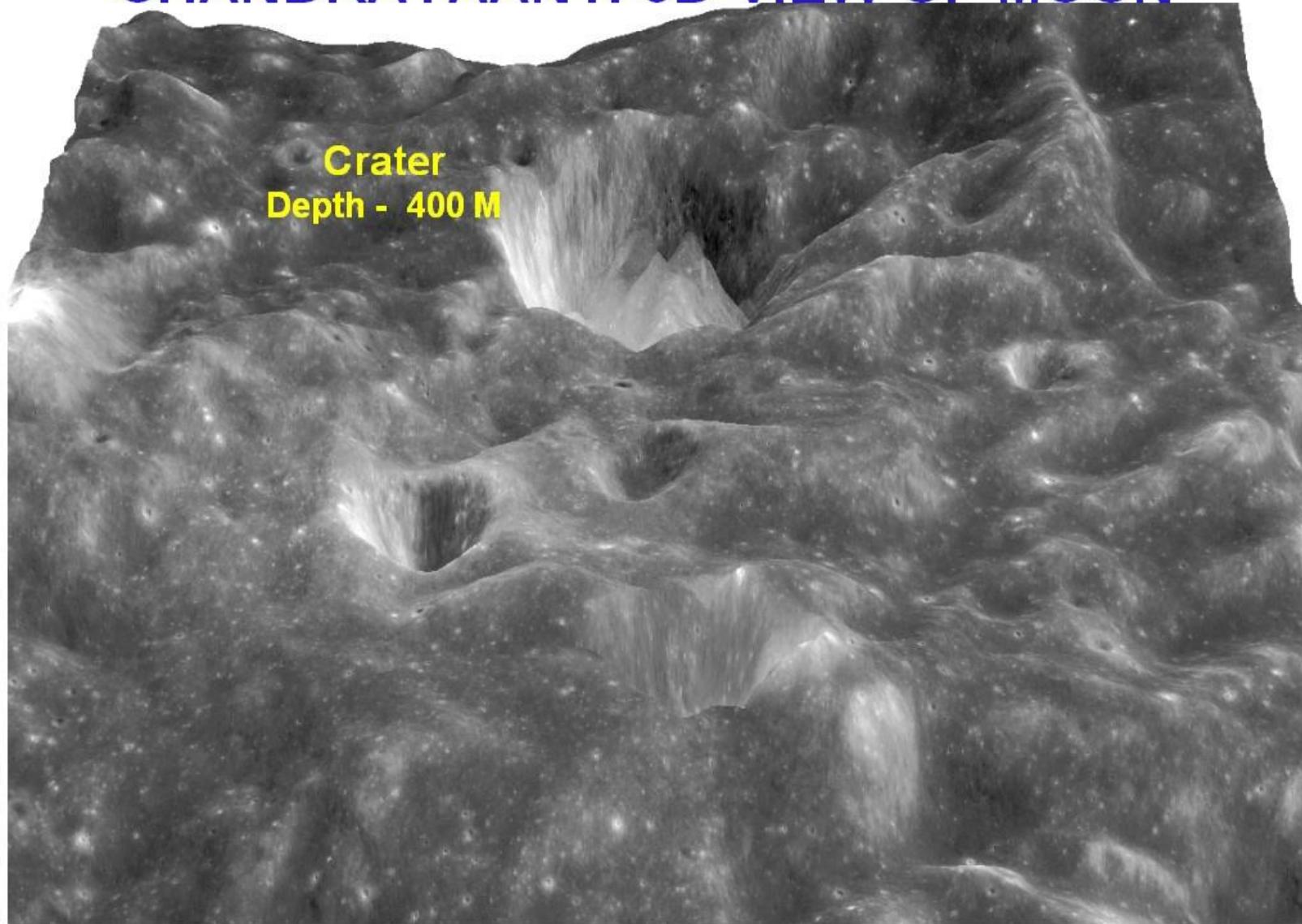
# Contrast Enhancement



# Deblurring



# CHANDRAYAAN1: 3D-VIEW OF MOON



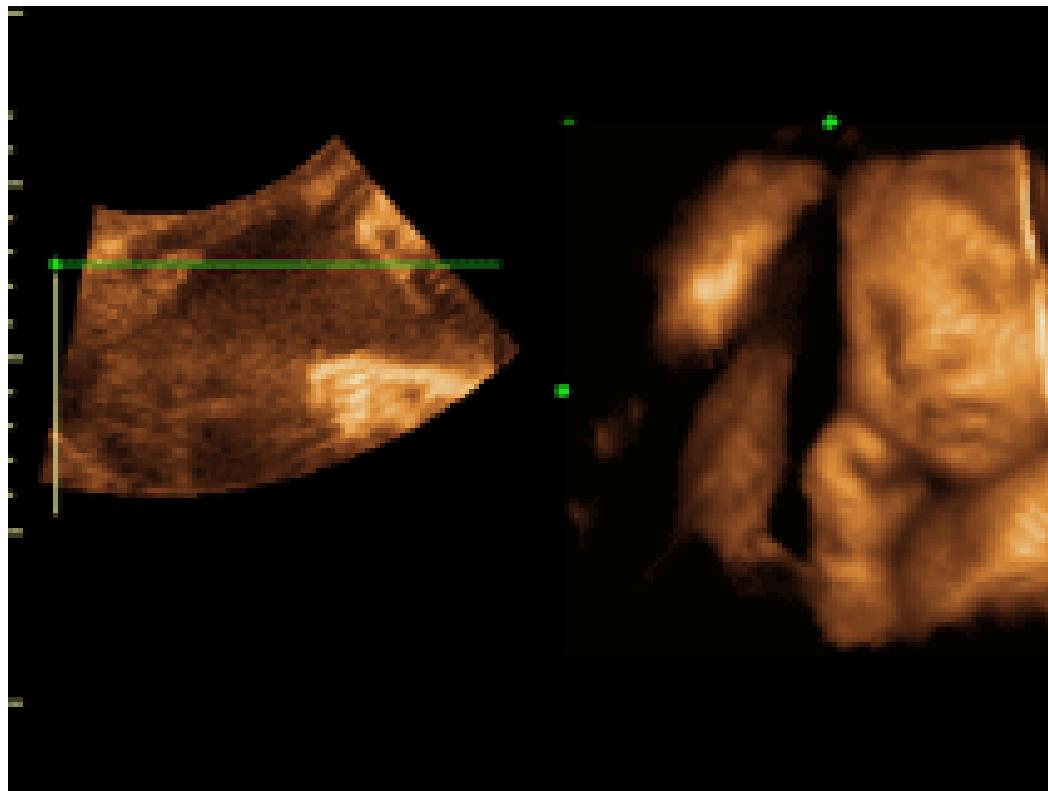
Terrain Mapping Camera  
5M resolution

Area – 10 X 10 km

DATE OF PASS - Nov 23, 2008

## 4D Ultrasound Images





# Machine Vision Applications

- ▶ Industrial machine vision for product assembly and inspection.
- ▶ Automated target detection and tracking.
- ▶ Fingerprint recognition.
- ▶ Machine processing for aerial and satellite imagery for whether prediction and crop assessment.
- ▶ Face detection.





## Example: Image Compression



Original, 2.1MB



JPEG Compression, 308KB (15%)



## Example: Image Inpainting

Damaged Image



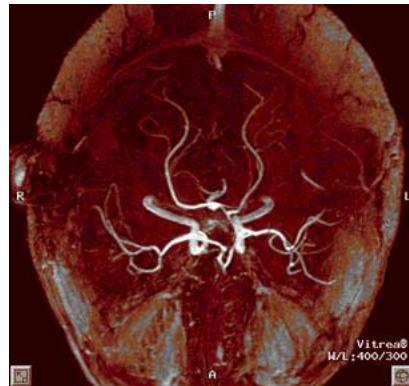
Restored Image



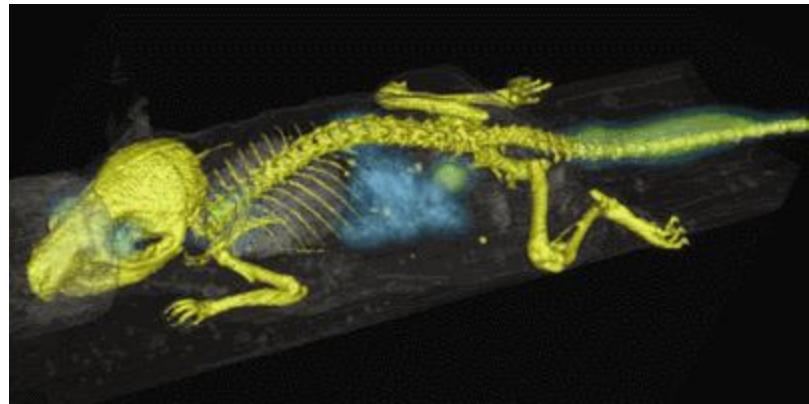
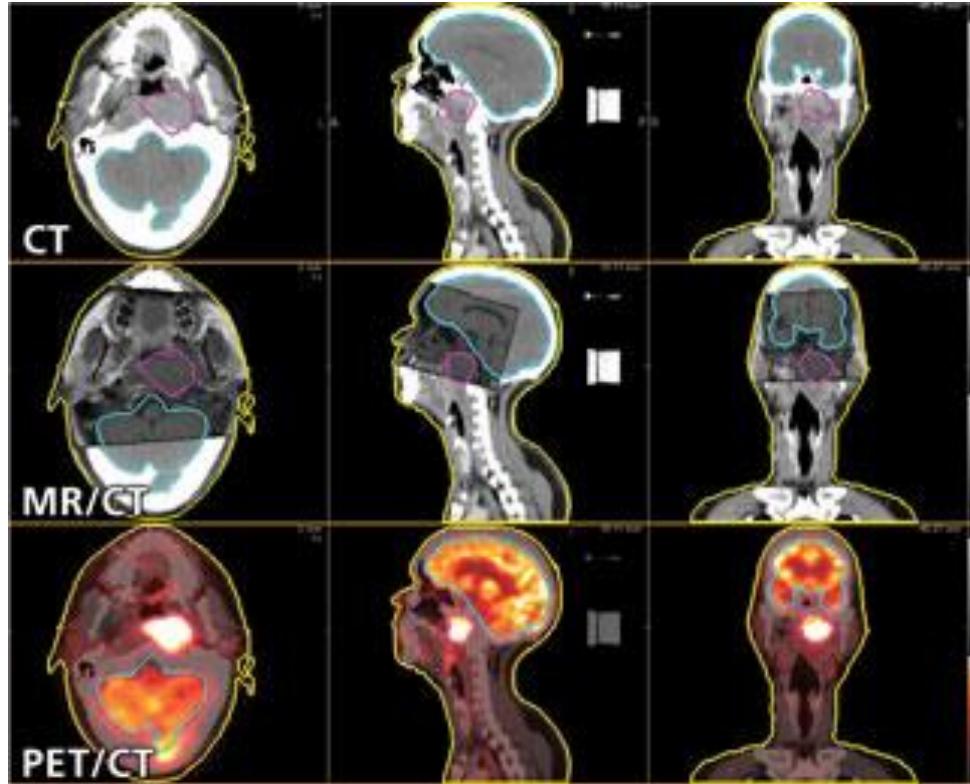
Credit: M. Bertalmio, G. Sapiro, V. Caselles, C. Ballester: *Image Inpainting*, SIGGRAPH 2000

Inpainting? Reconstruct corrupted/destroyed parts of an image

# Pseudo Coloring



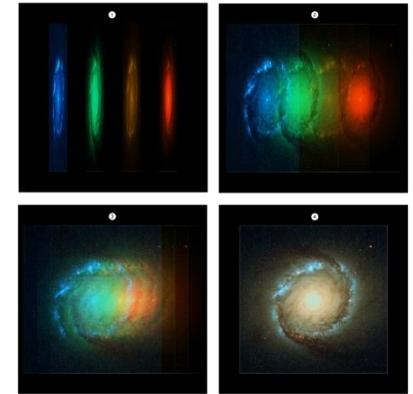
# Image Fusion



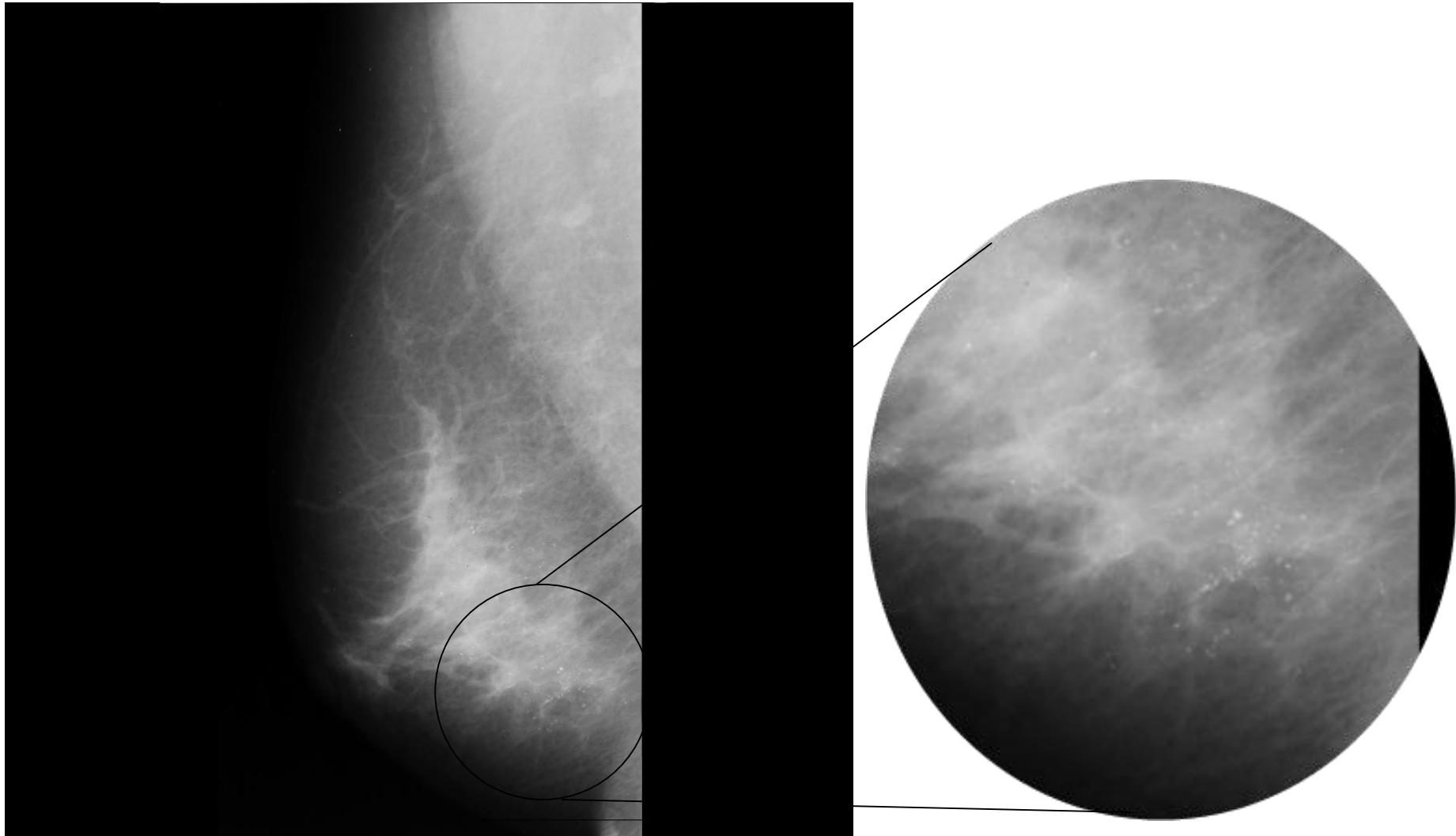
► Images(and video) are everywhere !

# Application Areas

1. Medical Imaging
2. Astronomy
3. Remote Sensing
4. Biometrics
5. Forensics
6. Archeology
7. Biological Sciences
8. Security Systems
9. Atmospheric sciences

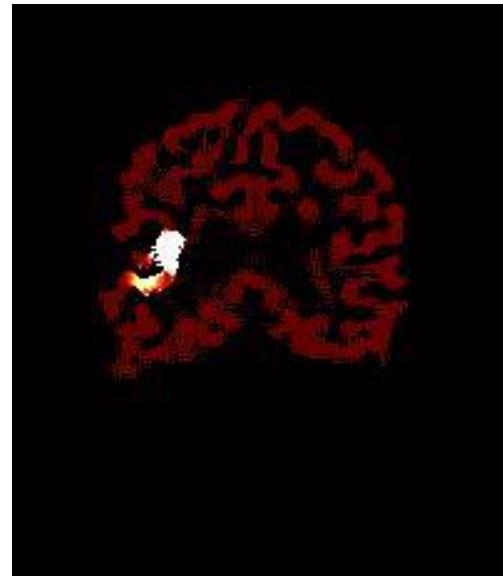
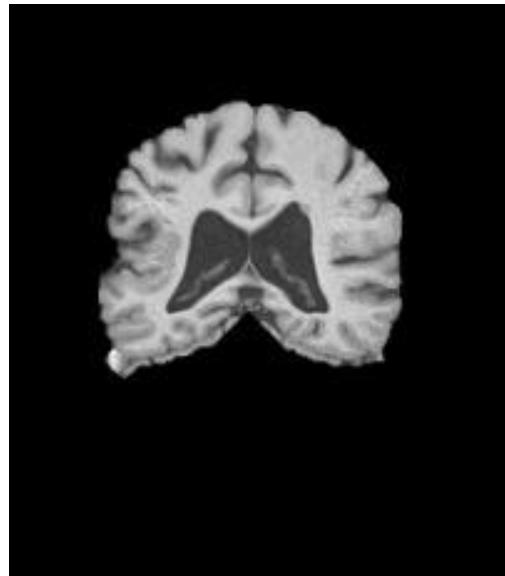


# Detection of micro calcifications from mammogram images

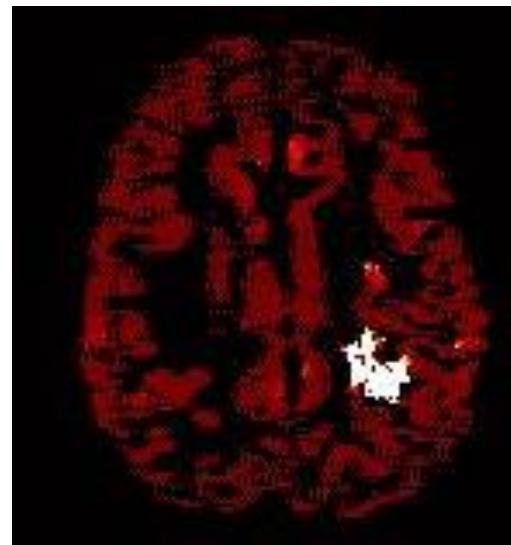
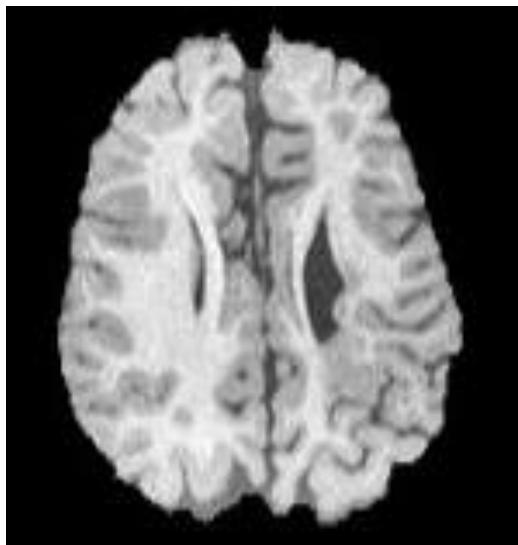




Brain Tractography

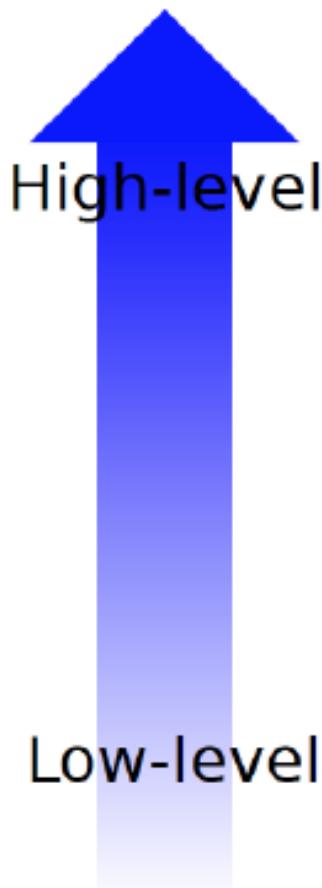


FCD Detection : Input  
MR image and the  
processed out put.





# Relationship with other Fields



## Computer Vision

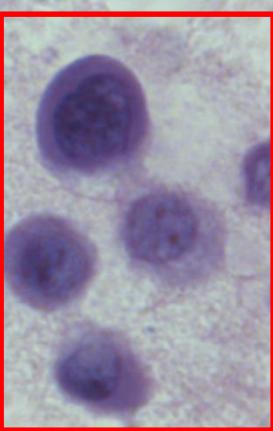
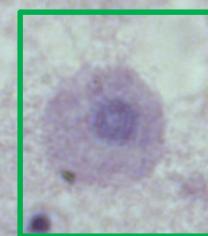
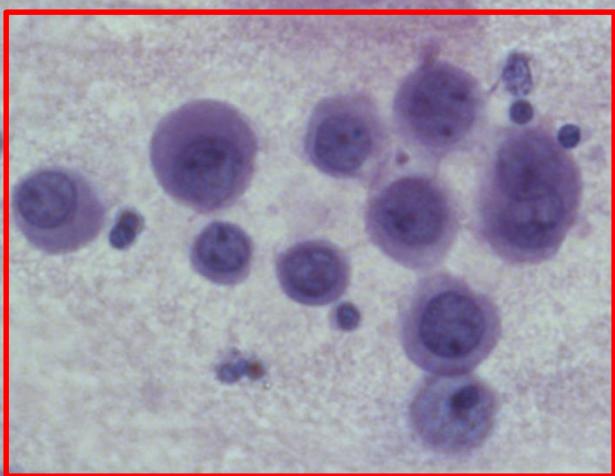
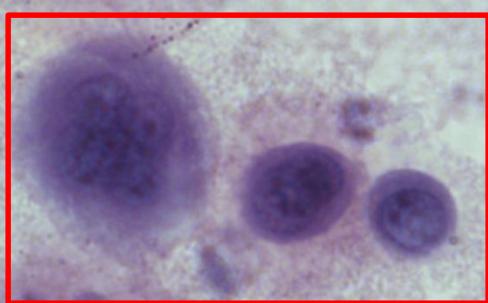
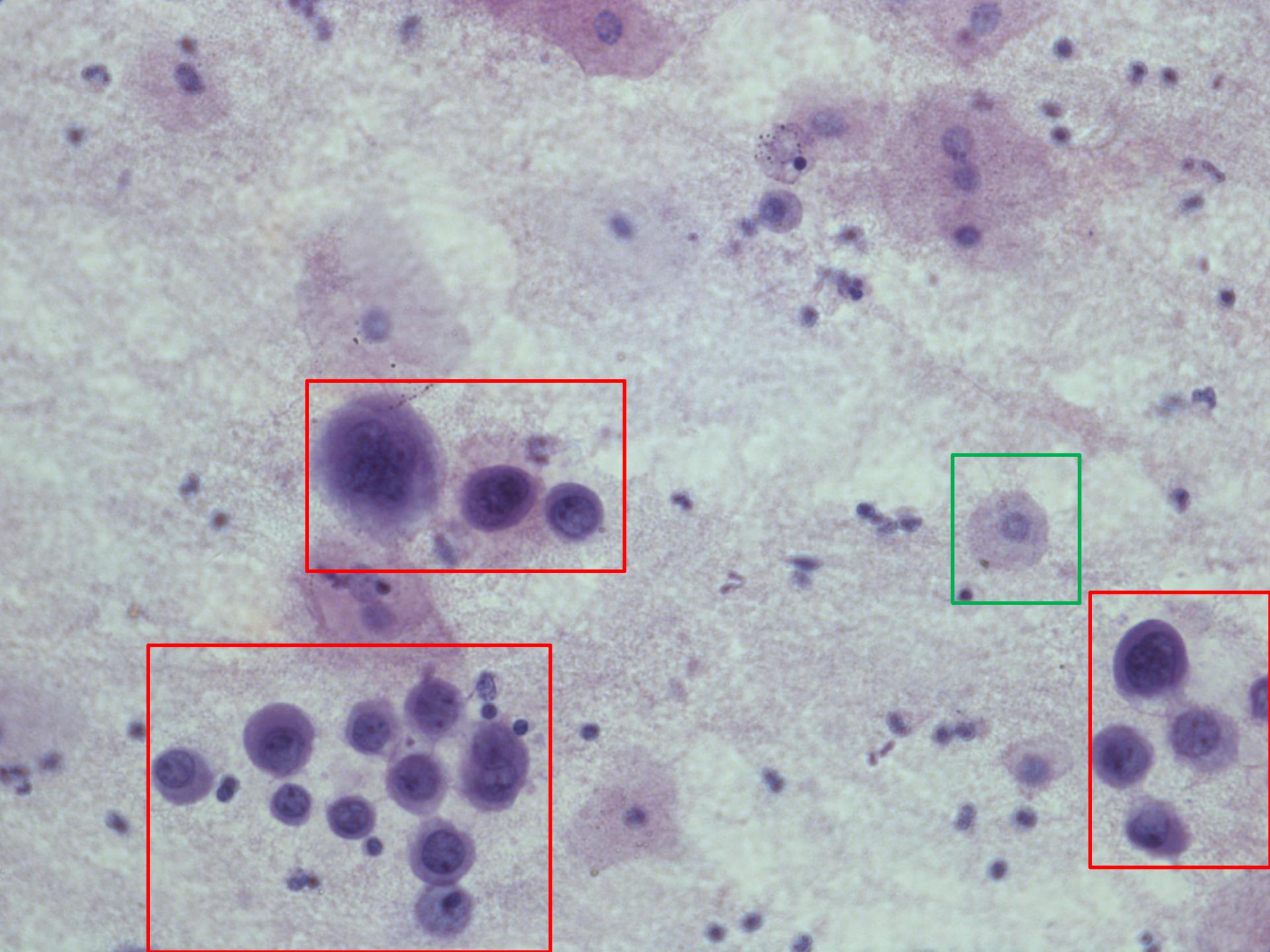
Object detection, recognition, shape analysis, tracking  
Use of Artificial Intelligence and Machine Learning

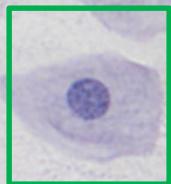
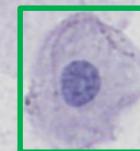
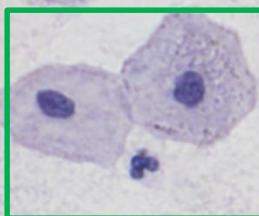
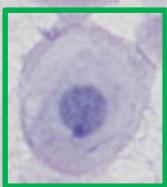
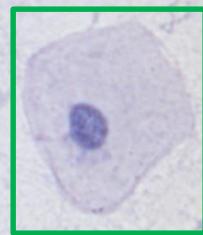
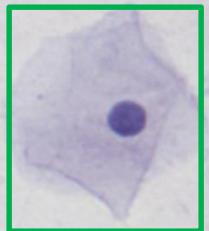
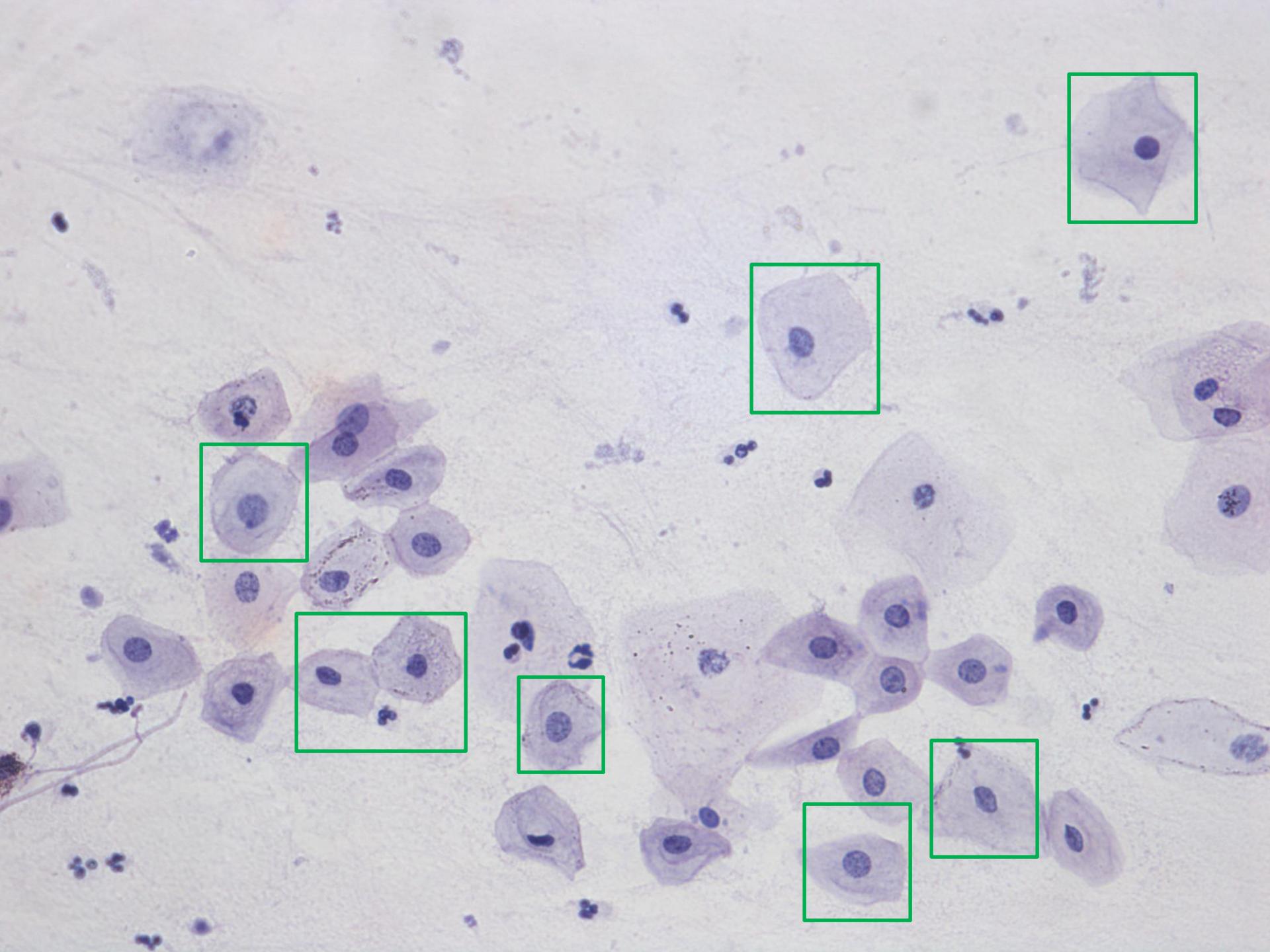
## Image Analysis

Segmentation, image registration, matching

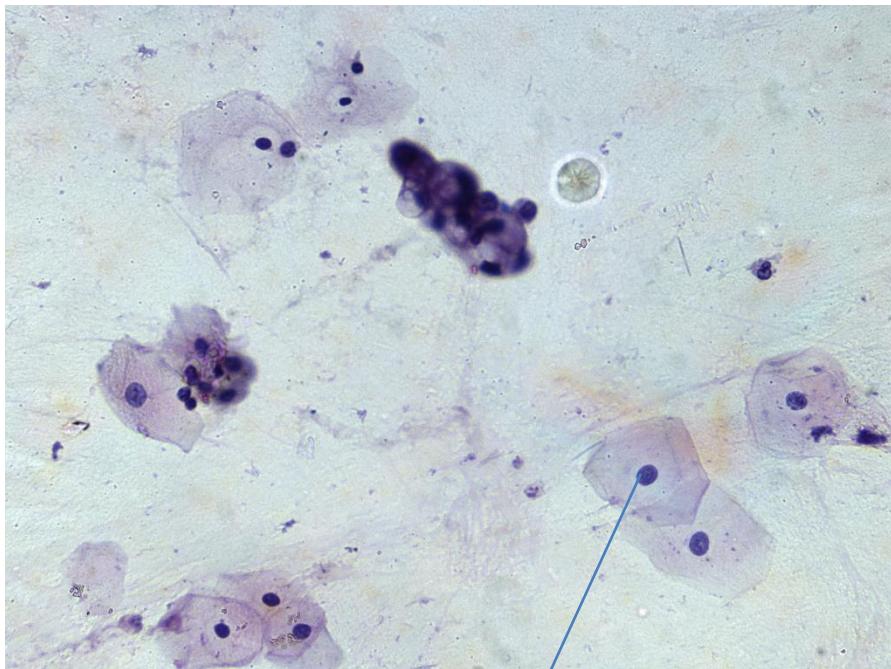
## Image Processing

Image enhancement, noise removal, restoration,  
feature detection, compression

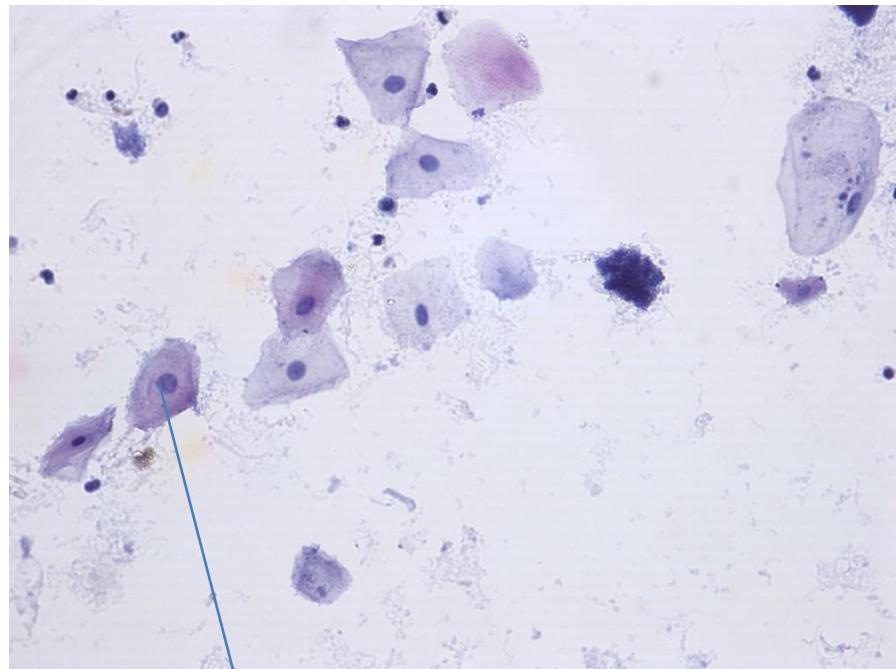




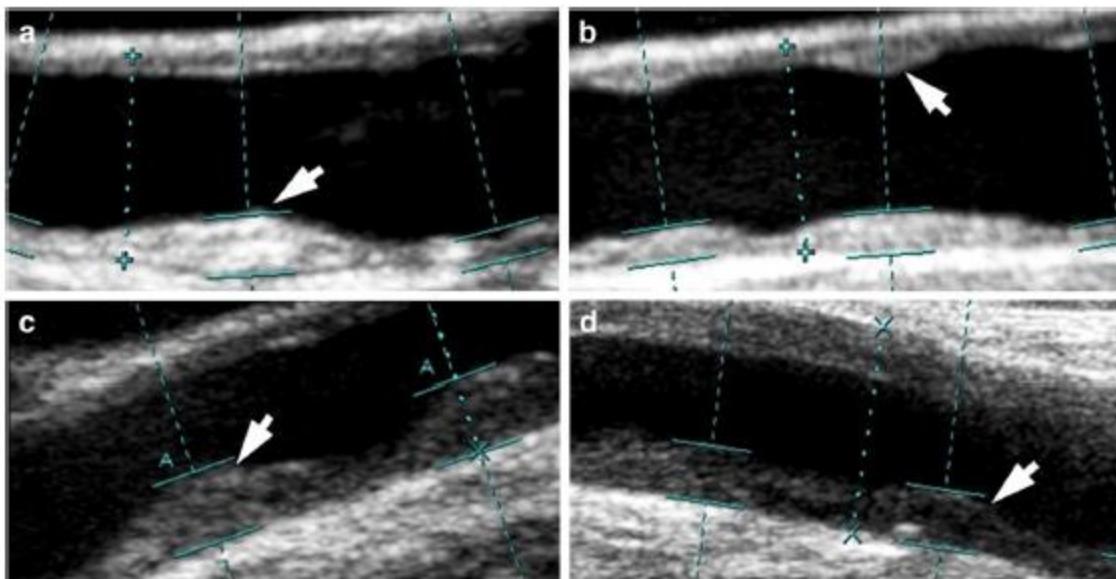
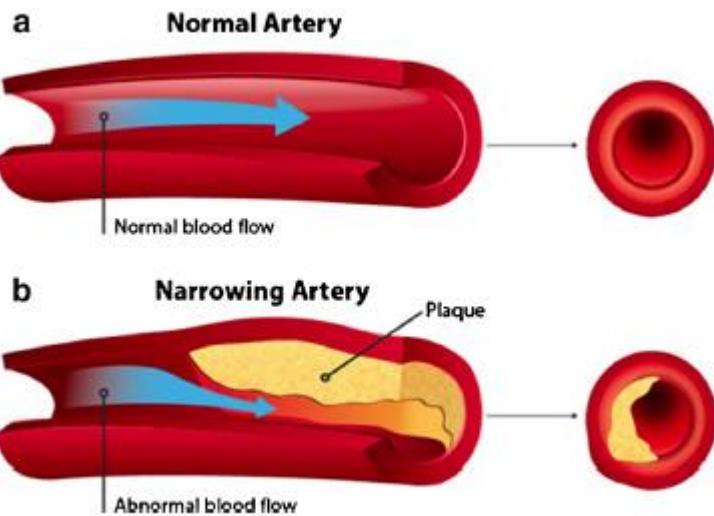
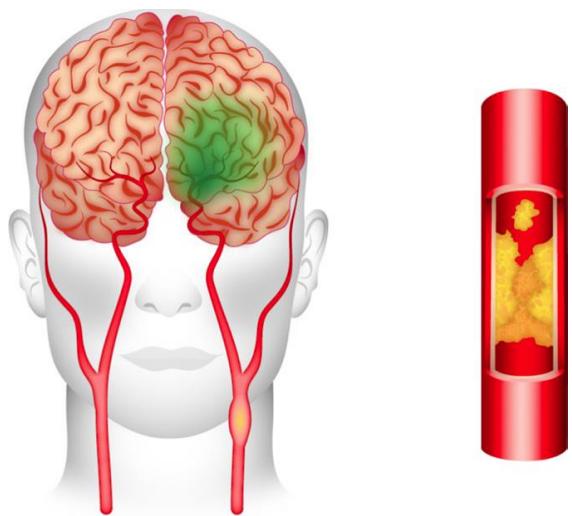
Normal appearing cells (patient with cancer)

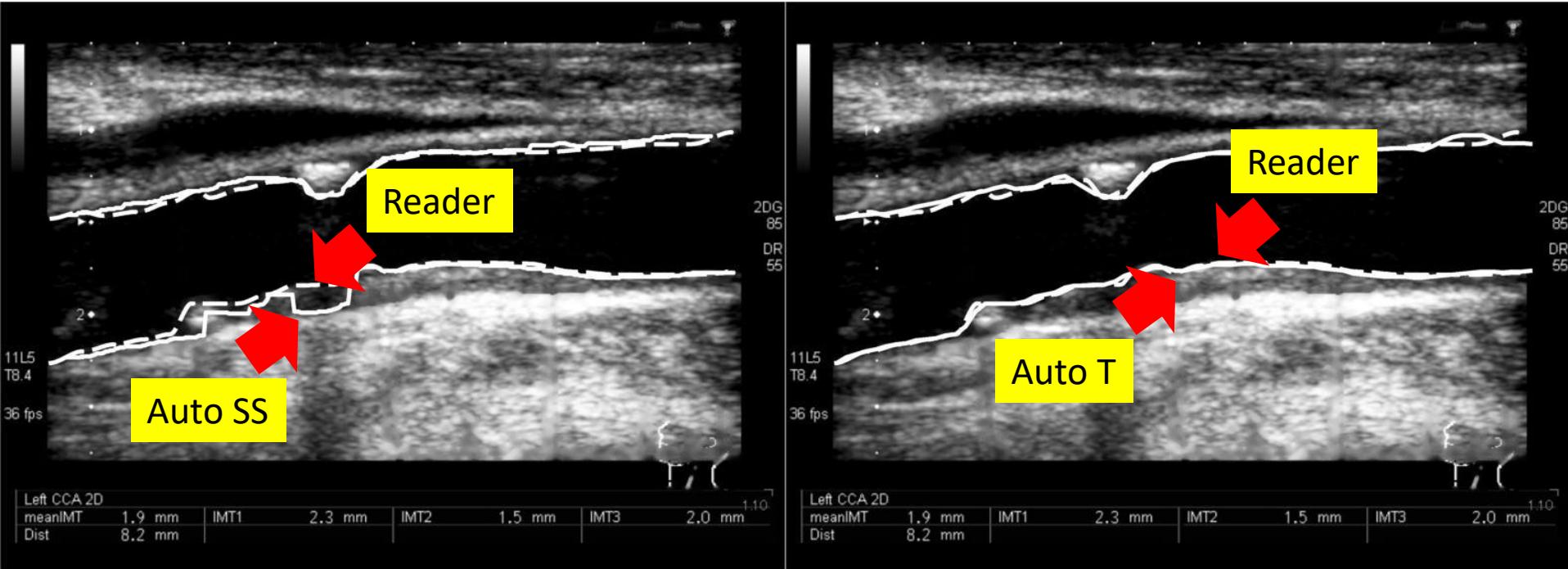


Normal cells(patient without cancer)

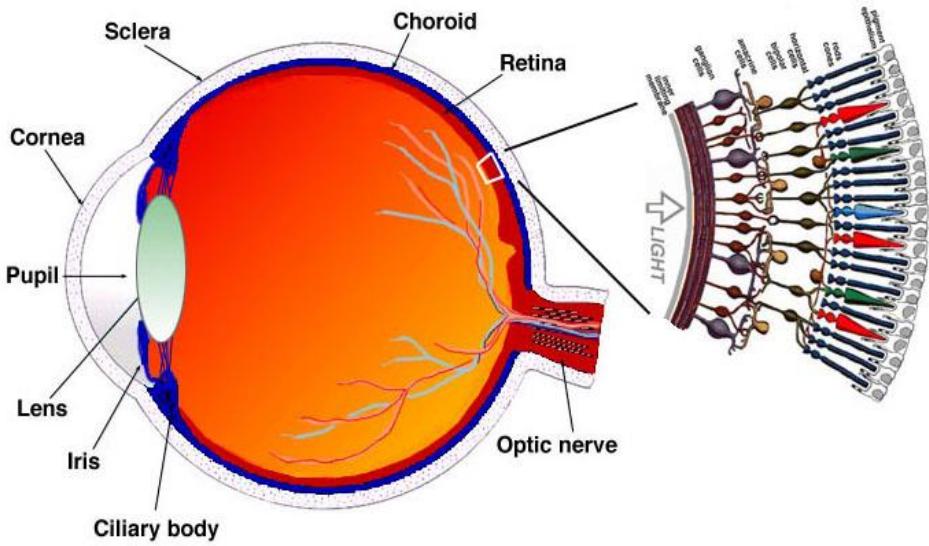


Cells tested for malignancy  
associated changes

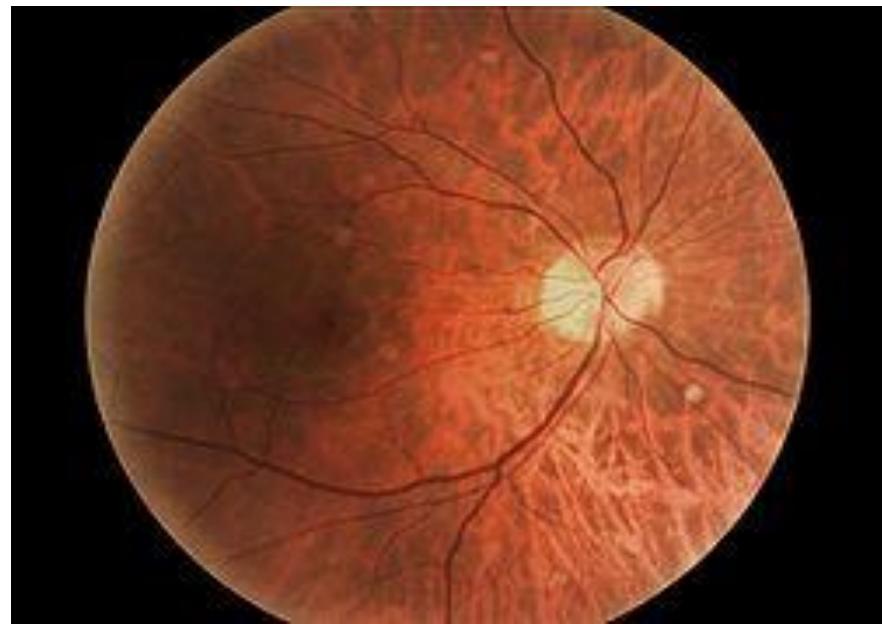




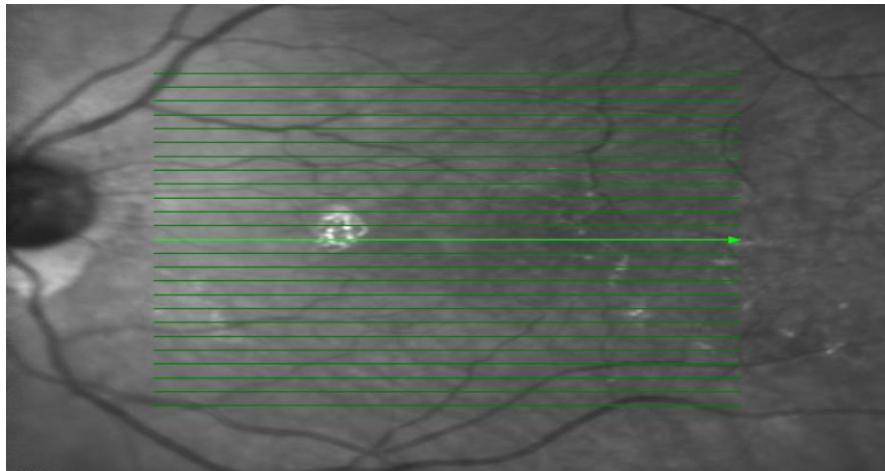
Carotid Auto LD borders compared against the Manual tracings on the grayscale image for both simple scale space (SS) and transformation methods (T)



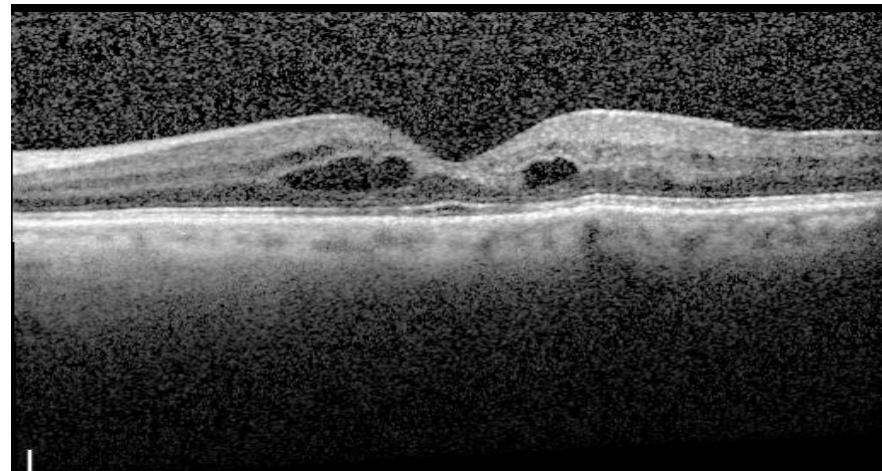
(a) Anatomy of the eye



(b) Fundus photography of retina

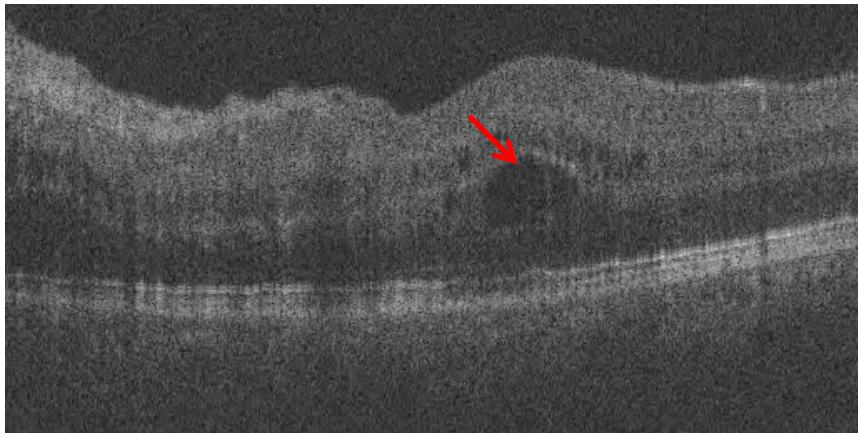


(c) Fundus image-representative scan.

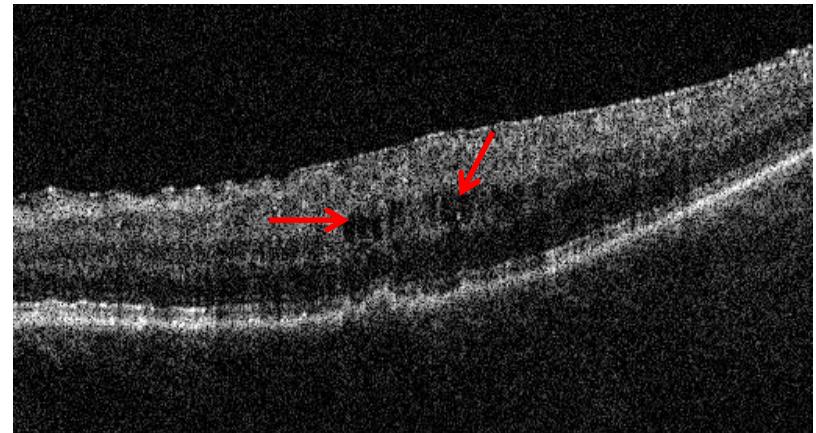


(d) OCT Scan of retina

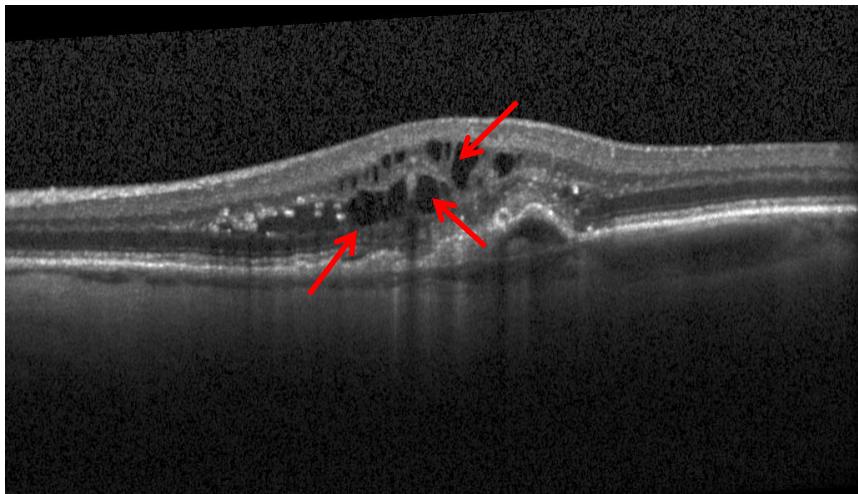
## Challenges: Scan quality and Vendor differences



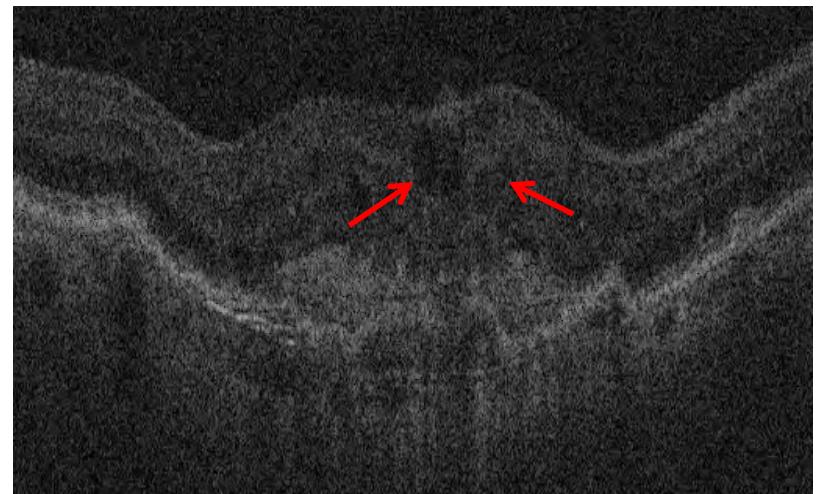
Cirrus



Nidek



Spectralis



Topcon

Arrows indicates the retinal cysts



Thank You