

# PRELUCRAREA IMAGINILOR



LABORATORUL DE ANALIZA SI PRELUCRAREA IMAGINILOR



# Chesiuni administrative

**Cod curs: 04.T.07.O.504 - 4 puncte credit**

**Curs: 2 ore/ spatamana**

**Laborator: 2 ore/ 2 saptamani, cu subgrupa**

**Punctare: 60 puncte examen (are si componenta orala)**

**40 puncte de laborator**

**20 test teoretic**

**20 test practic**



**LABORATORUL DE ANALIZA SI PRELUCRAREA IMAGINILOR**



# Bibliografie

<http://alpha.imag.pub.ro/cursuri>

C. Vertan, M. Ciuc

Tehnici Fundamentale de Prelucrarea și Analiza Imaginilor,  
Ed. MatrixROM, București, 2007.

R. Gonzales, R. Woods

Digital Image Processing, Ed. Prentice Hall, 2002

R. Gonzales, R. Woods

Digital Image Processing Using MATLAB, Ed. Prentice Hall, 2002

A.K. Jain

Fundamentals of Digital Image Processing, Ed. Prentice Hall, 1989

K.R. Castleman

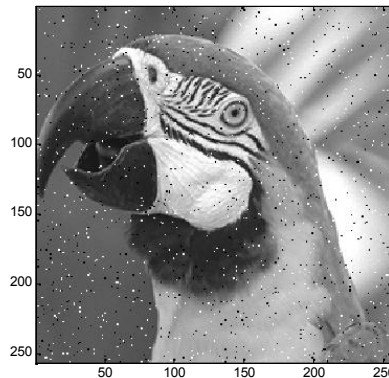
Digital Image Processing, Ed. Prentice Hall, 1996



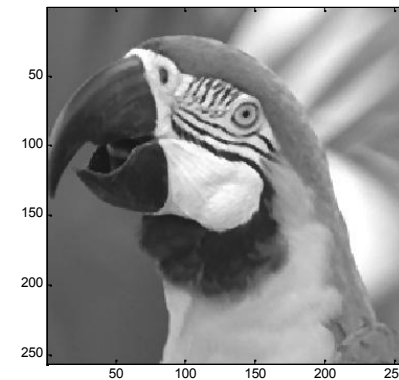
# Definire

**Image processing** is any form of signal processing for which the input is an image, such as photographs or frames of video; the output of image processing can be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.

(Wikipedia)



Procesare de imagini



Prelucrare de imagini

- Prelucrare optica
- Prelucrare analogica
- Prelucrare digitala -> procesare digitala cu calculatorul



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- **Prelucrarea imaginilor** -> imagini care sunt obținute pe baza unor mărimi fizice preluate din scena reală de către senzori

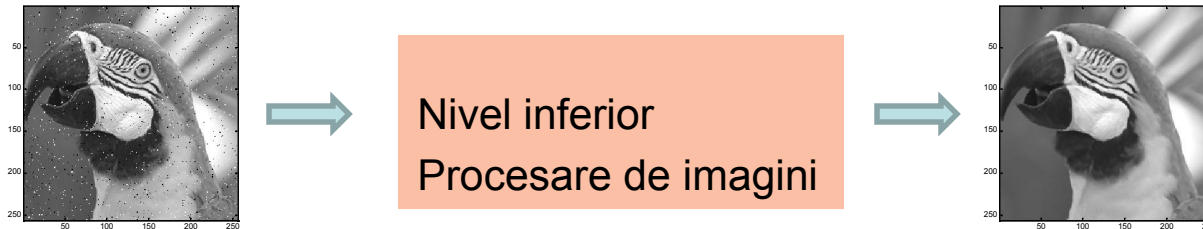
### Scopul:

- Îmbunătățirea imaginii pentru utilizatorul uman
- Procesarea datelor de tip imagine pentru utilizator masina (memorare, transmisie)

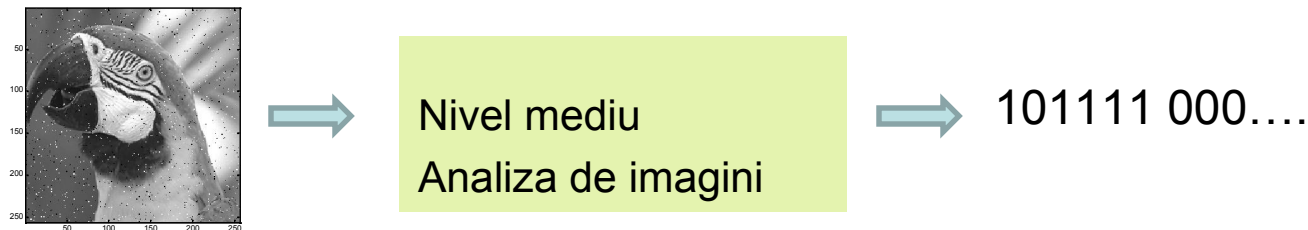


# Clasificare – nivel de prelucrare

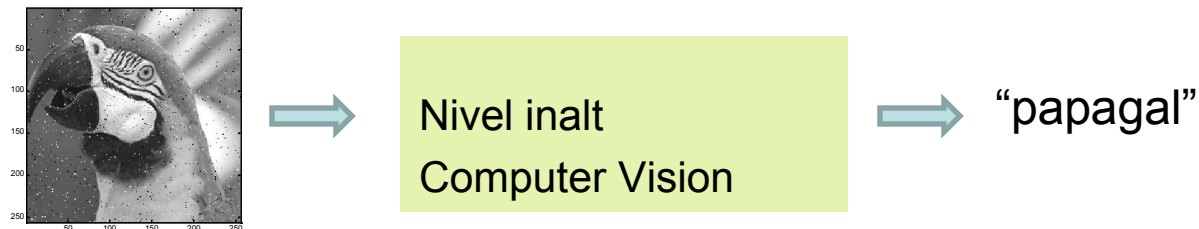
- Nivel inferior -prelucrare de imagini (image-image)



- Nivel mediu – analiza imaginii (caracteristici calculate pentru rezolvarea unei probleme)



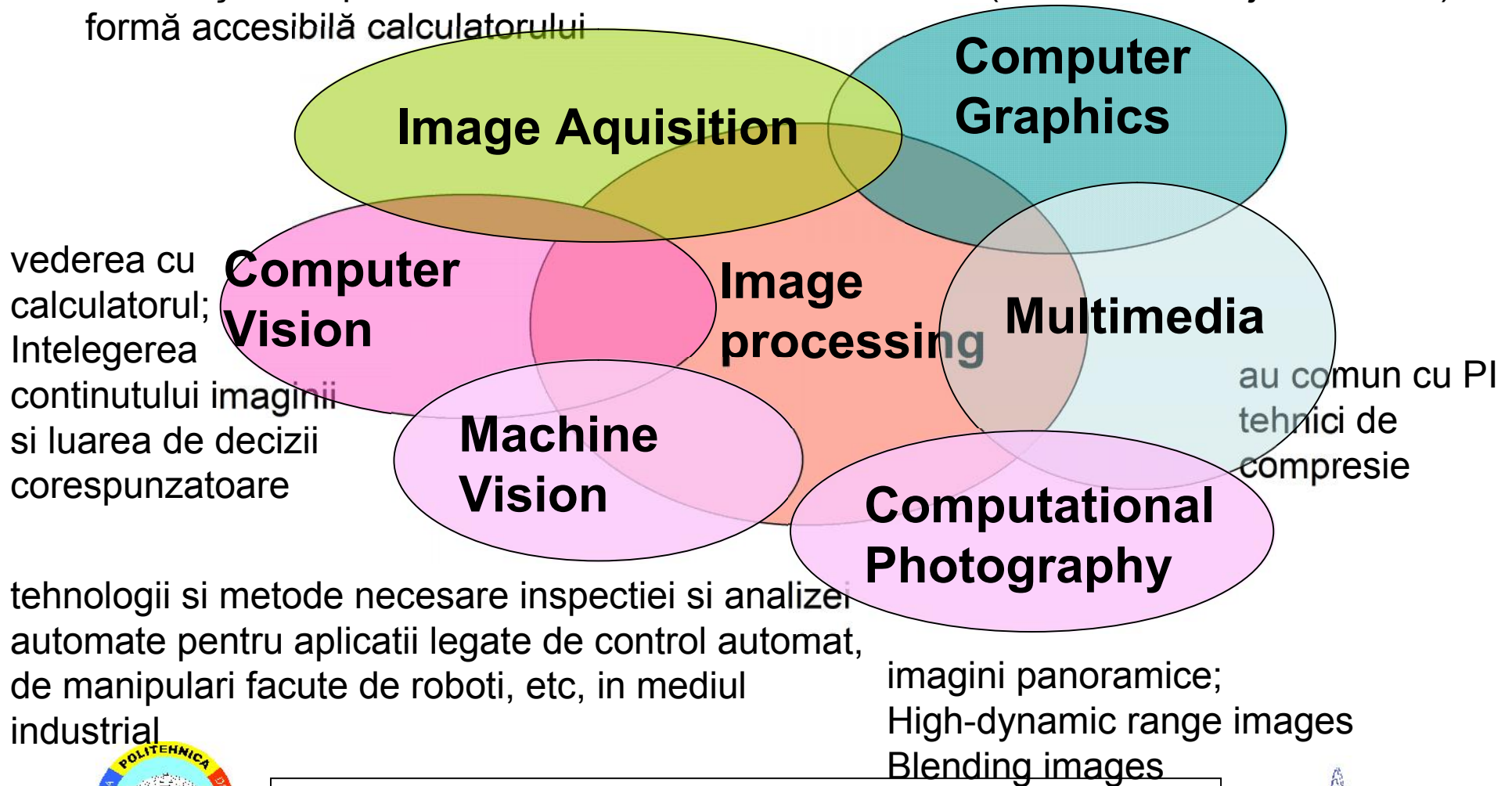
- Nivel inalt - intelegerea continutului imaginii



# Intersectia cu alte domenii

masurarea marimilor fizice ale scenei și transpunerea lor într-o formă accesibilă calculatorului

imagini create cu calculatorul (animatii, filme, jocuri video)

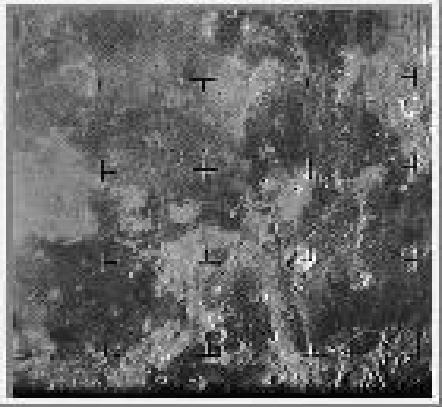


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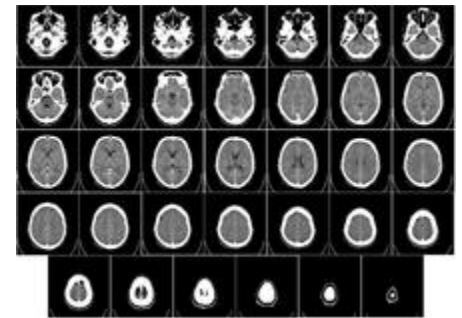
# Etape - istorie

- Procesarea digitala:
  - dezvoltarea calculatoarelor (1960 - suficient pt a prelucra imagini) +
  - programul spatial => 1964 imbunatatirea imaginii lunii folosind calculatorul - Jet Propulsion Laboratory (Pasadena California)



This is the first image of the Moon taken by the Ranger 7 spacecraft on 31 July 1964 at 13:09 UT (9:09 AM EDT) about 17 minutes before impacting the lunar surface.  
([http://en.wikipedia.org/wiki/Ranger\\_program](http://en.wikipedia.org/wiki/Ranger_program))

- Primul concept de fotografie digitala: “*Mozaic Guidance for Interplanetary Travel*” de Eugene F. Lally  
(Jet Propulsion Laboratory) 1961-> arie de fotodetectori cu ieşiri procesate digital(pt control navigării cosmice (spre Marte).



- Imagini medicale (anii 70 - tomografie computerizata)

([http://en.wikipedia.org/wiki/Computer\\_tomography](http://en.wikipedia.org/wiki/Computer_tomography))

Computed tomography of human brain, from base of the skull to top. Taken with intravenous contrast medium



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# Domenii de utilizare



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# IMAGISTICA MEDICALA

## Tomografie computerizata



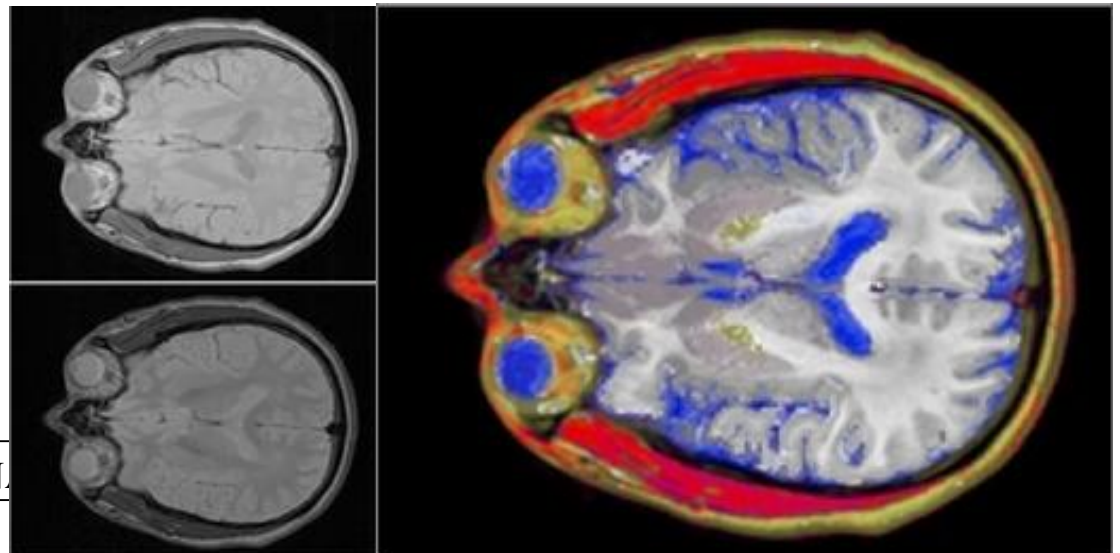
Scanner EMI - scanner cu raze X

tomos=felie, graphein= a scrie

## Tomografie RMN

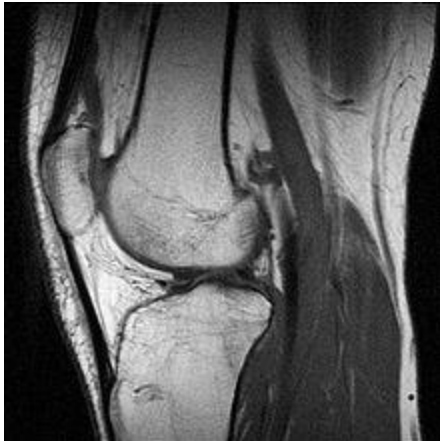


**Magnetic resonance imaging (MRI), nuclear magnetic resonance imaging (NMRI), or magnetic resonance tomography (MRT)**

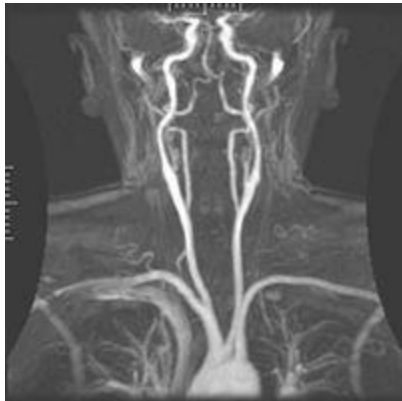


AN.

# Imagistica medicala

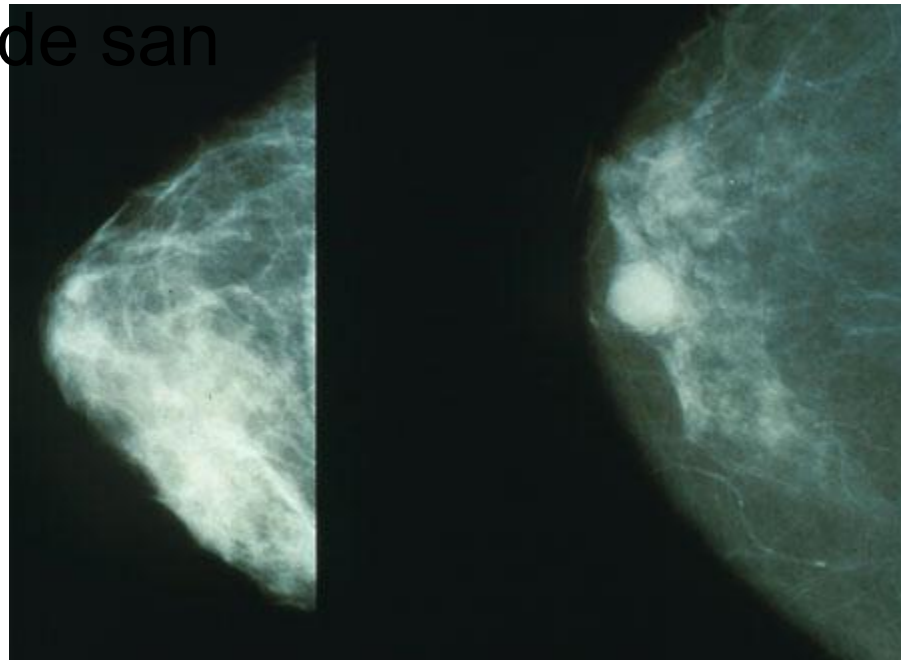


Img. RMN genunchi



RMN vase de sange

Mamografie –detectie cancer de san



Normal / cancer



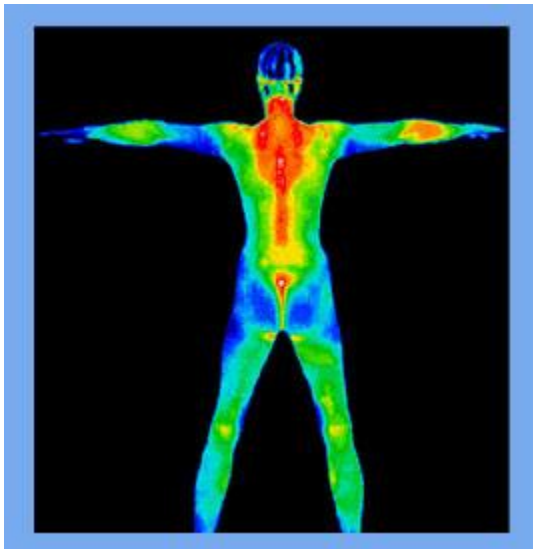
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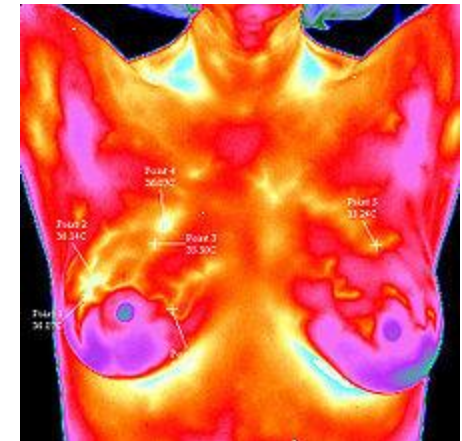
# Imagistica medicala - Imagini termografice

(Digital Infrared Thermal Imaging)

termografie: imagini pe baza radiatiei electomagnetice din spectrul infrarosu



Right breast cancer



<http://en.wikipedia.org/wiki/Thermology>

Colors indicate increases or decreases in infrared radiation emitted from the body surface

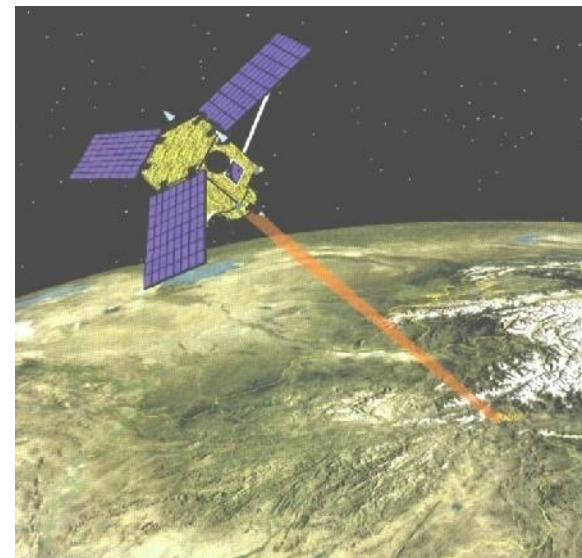
[http://en.wikipedia.org/wiki/Digital\\_infrared\\_thermal\\_imaging\\_in\\_health\\_care](http://en.wikipedia.org/wiki/Digital_infrared_thermal_imaging_in_health_care)



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# Imagini satelitare



## Satelit teledectie Spot 1 in 1986

Athens as seen  
by the Spot-5  
satellite in 2002

Generatia 6-7

-banda pancromatica (vizibil) 455-745 nm

-banda albastru 455-525 nm

-banda verde 530-590 nm

-banda rosie 675-695 nm

-banda infrarosu apropiat 760-890 nm

Rezolutie 1.5 m pt pancromatic; 6m pt

multispectral

## IKONOS

*eikōn*

Satelit comercial 1994

Rezolutie: 0.8 m pt pancromatic;

4 m multispectrale



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# Supraveghere video

- supraveghere trafic
- supraveghere obiective
- supraveghere evenimente de interes



Surveillance cameras on a corner

Surveillance camera mounted on the walls of Rosenbad, one of the Swedish's government buildings in central Stockholm.



[http://en.wikipedia.org/wiki/Video\\_surveillance](http://en.wikipedia.org/wiki/Video_surveillance)

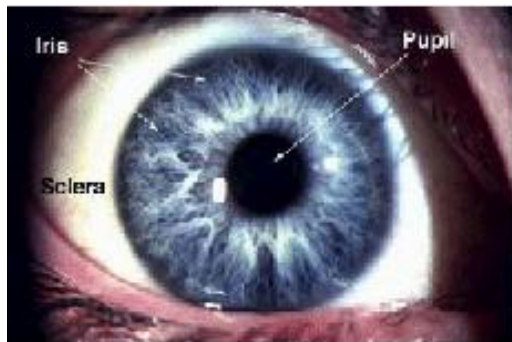


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# Supraveghere video

## Sisteme biometrice de identificare



scanare iris



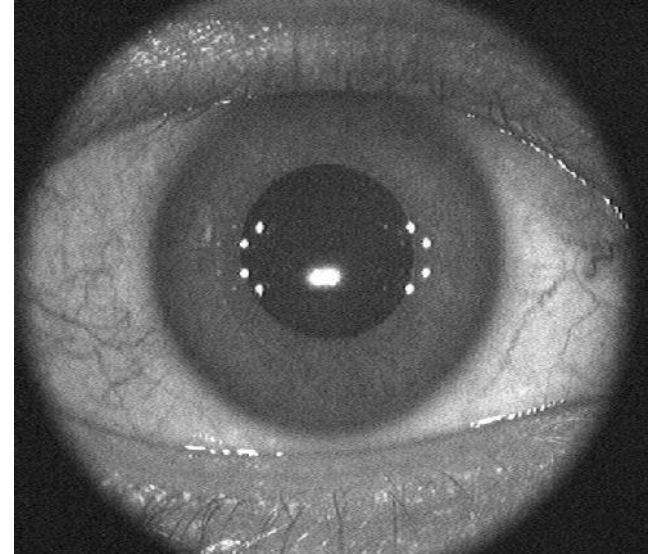
amprente



recunoastere fata

# Eye tracking

- urmărirea stării de oboseală a soferului
- publicitate
- chirurgie

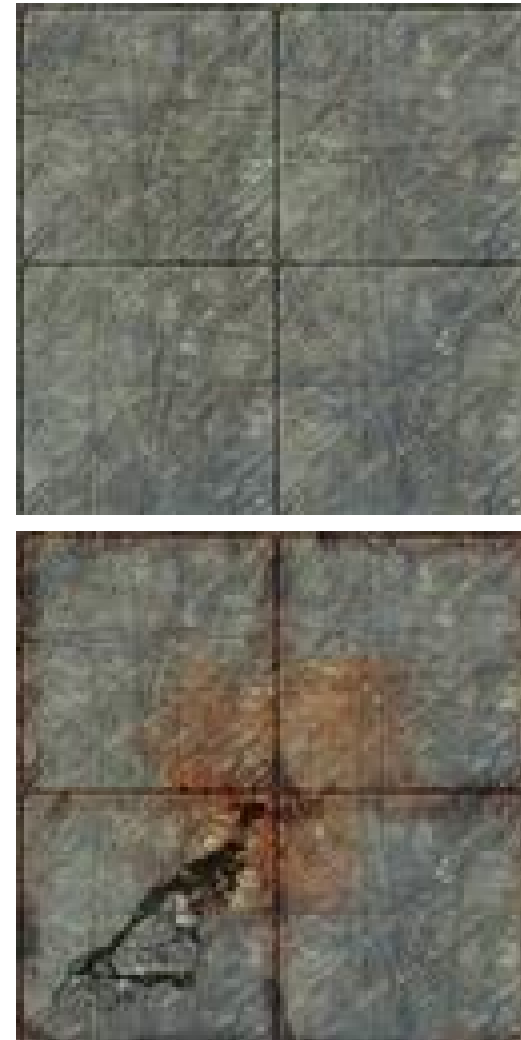


# Aplicatii industriale

## Robot cu camera



## Testarea calitatii



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# Recunoasterea numarului de inmatriculare



The system must be able to deal with different styles of license plates

[http://en.wikipedia.org/wiki/Automatic\\_number\\_plate\\_recognition](http://en.wikipedia.org/wiki/Automatic_number_plate_recognition)



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# Aplicatii legate de fotografia digitala

## Corectia imaginilor in aparatul foto

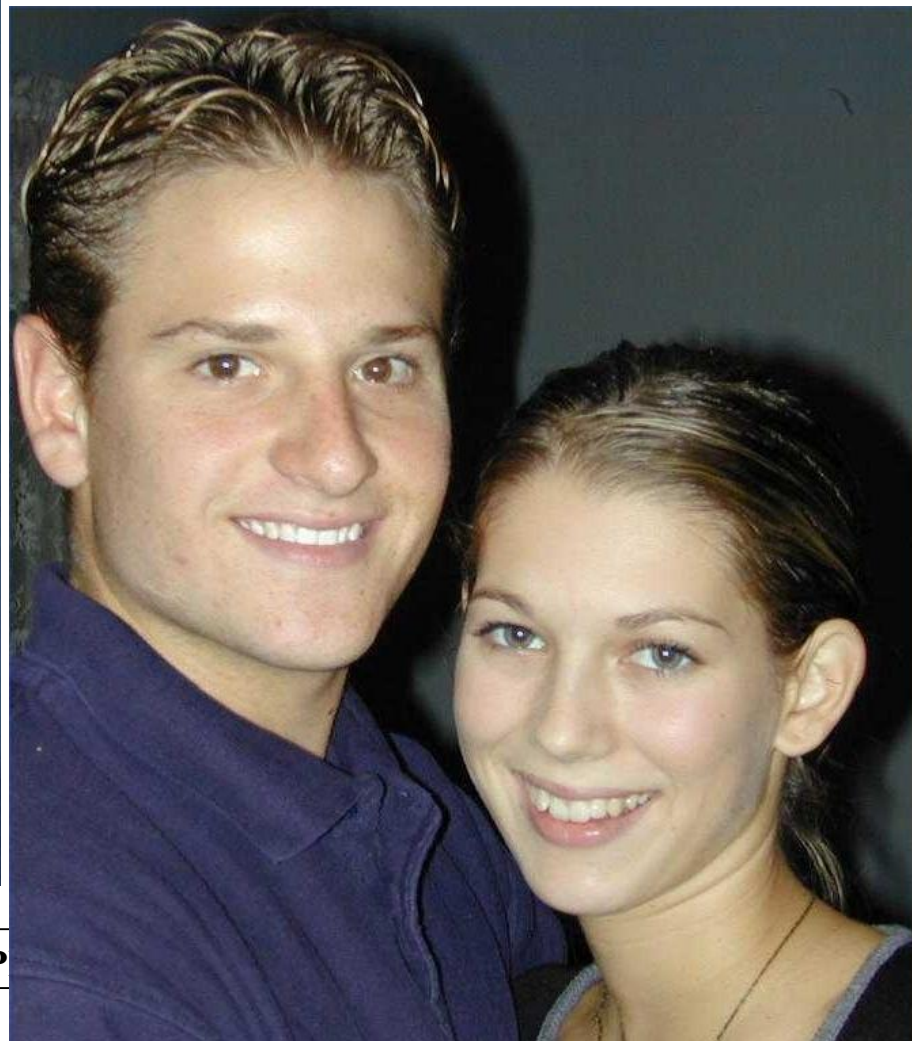
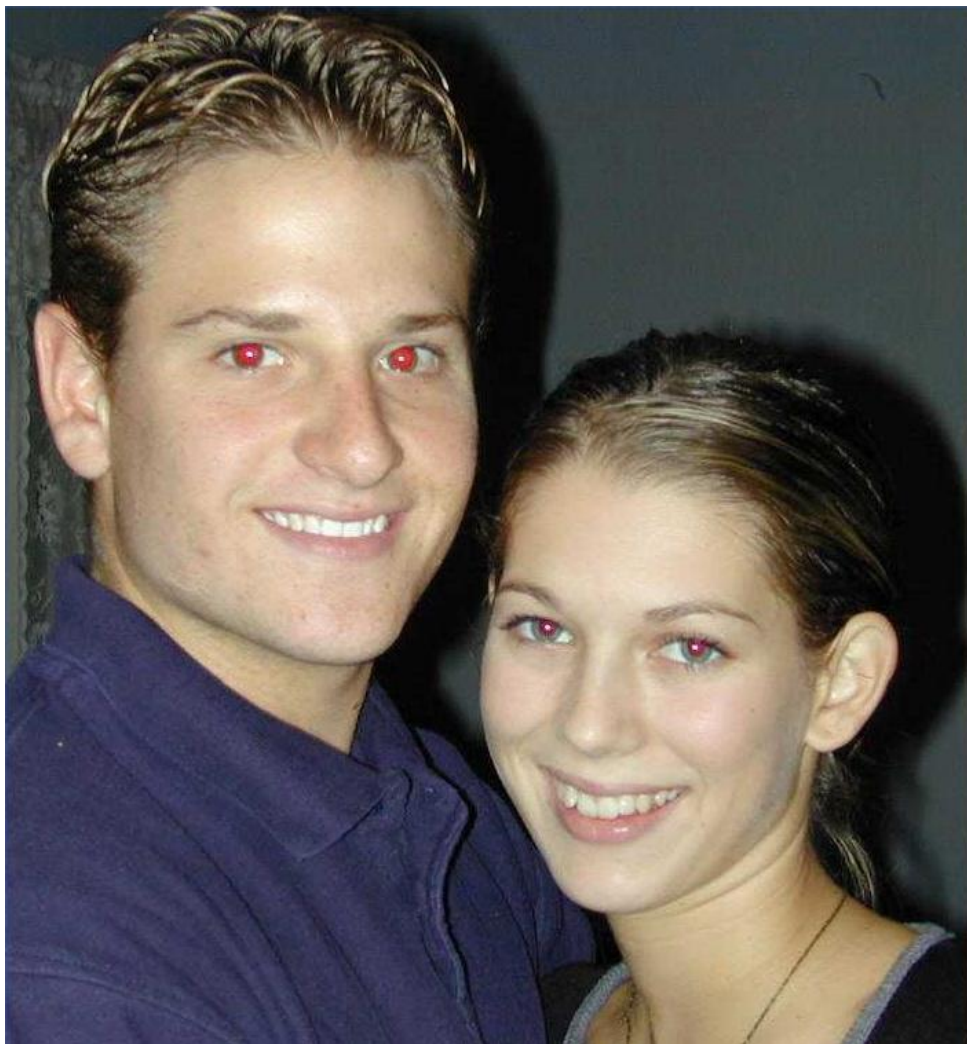
- Ochi rosii
- Iluminare
- Puncte defecte si praf
- Deblurare



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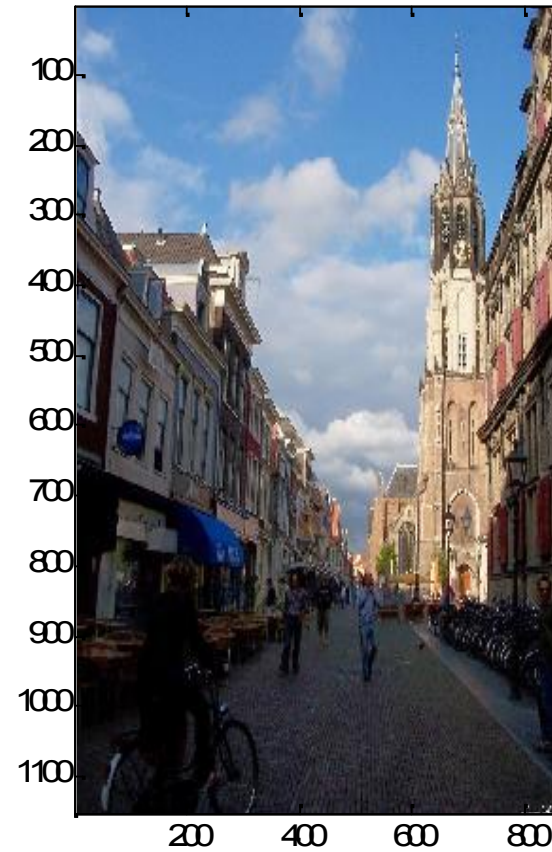
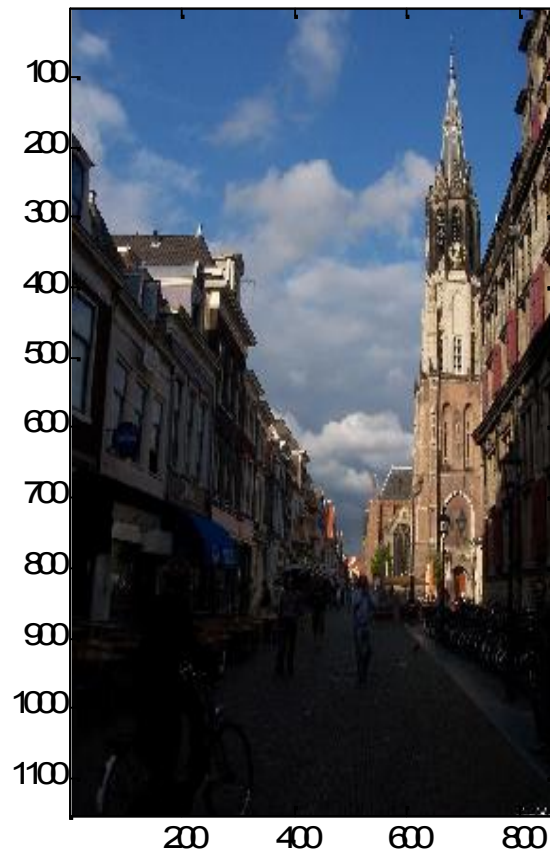


# Corectie ochi rosii

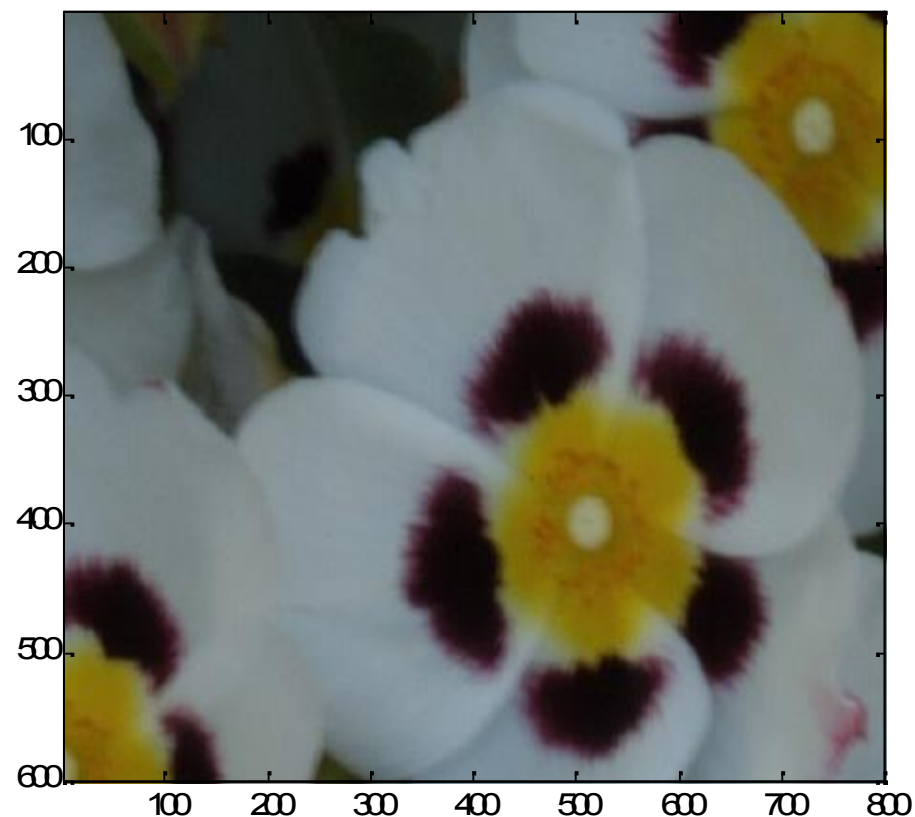


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# Corectia iluminarii



# Corectie puncte defecte si praf



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# Corectie orbi



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# Deblurare



# Curs PI

- Introducere
- Sistemul vizual uman
- Spatii de culoare
- Imbunatatirea imaginilor
- Transformari geometrice
- Filtrare liniara
- Filtrare neliniara
- Filtrare adaptiva
- Elemente de morfologie matematica
- Transformari unitare.Filtrare in frecventa
- Restaurarea imaginilor
- Compresia imaginilor
- Exemple de aplicatii -demozaicare



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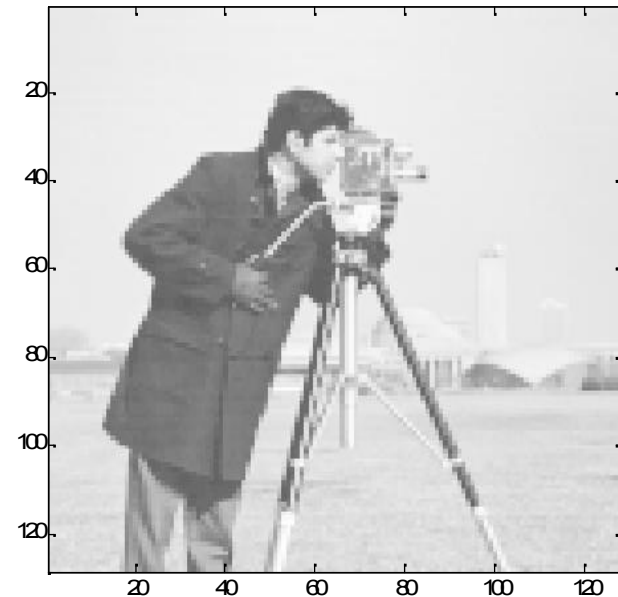
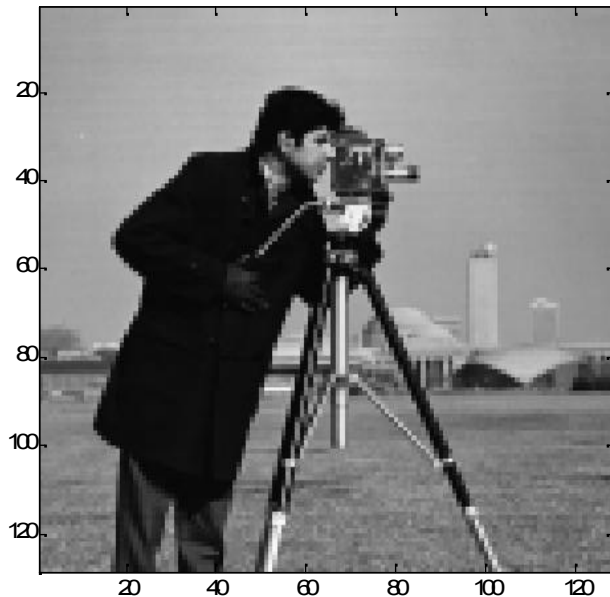
# Prelucrarea de imagini

- Imbunatatire- cresterea contrastului
- Filtrare
- Restaurare
- Compresie
- Transformari geometrice
- Operatii morfologice



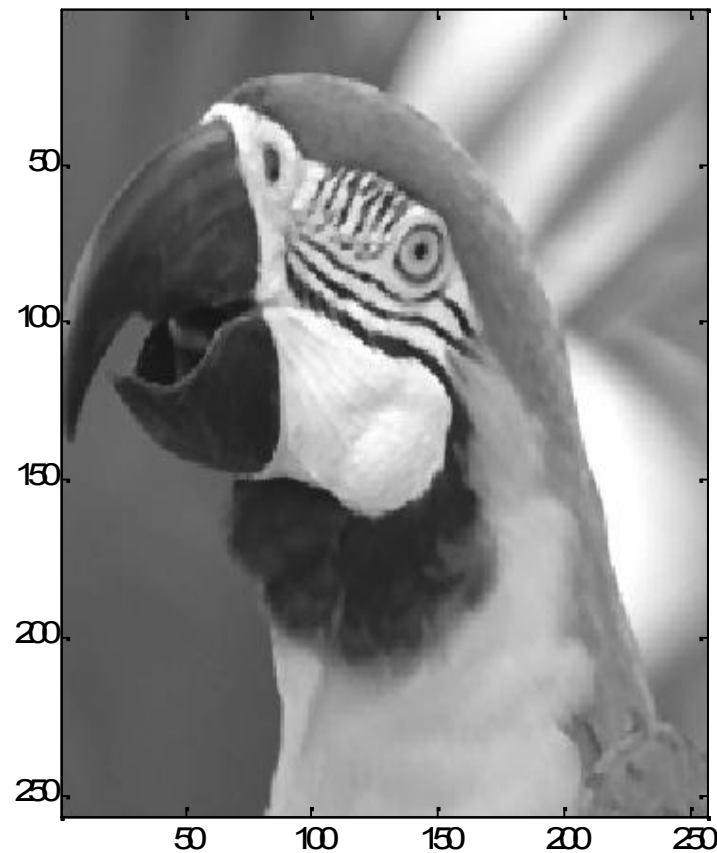
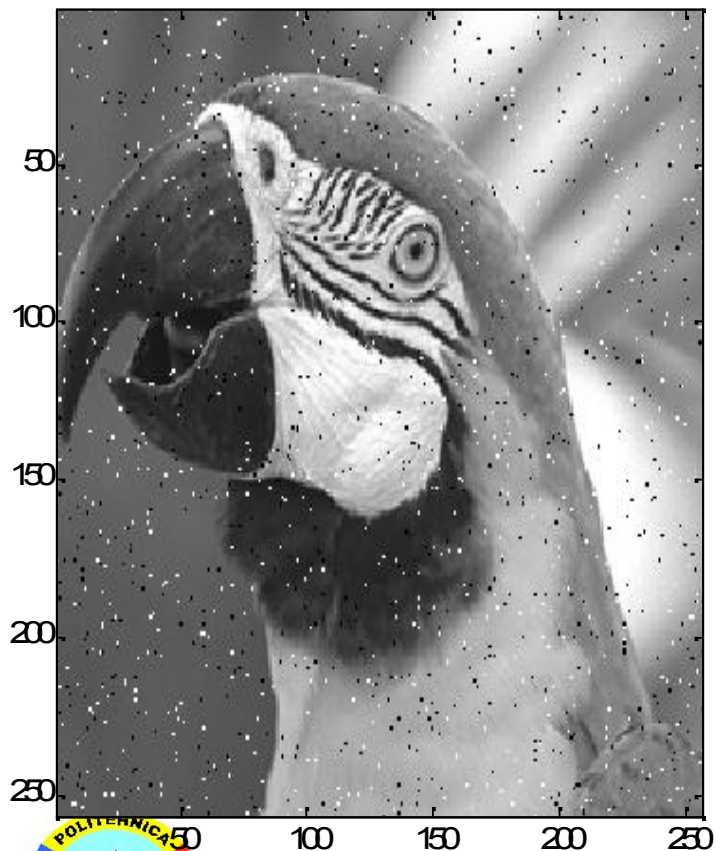
# Imbunatatirea

- evidentierea detaliilor
- cresterea contrastului (apreciere subiectiva)
- Reducerea degradarilor perceptuale



# Filtrarea imaginilor

- Eliminarea zgomotului



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# Restaurare

- Reducerea degradarilor si deformarilor [introduse in timpul achizitie], pe baza modelului matematic al degradarii; criteriu obiectiv de apreciere.

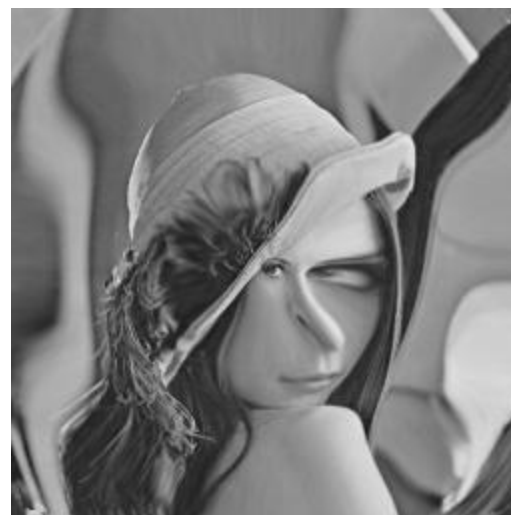
Burda



Restaurata



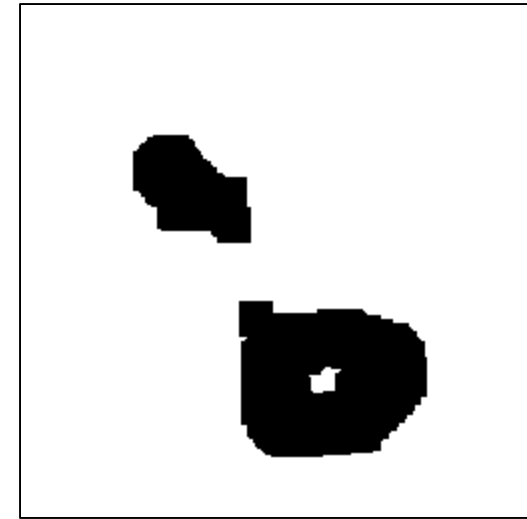
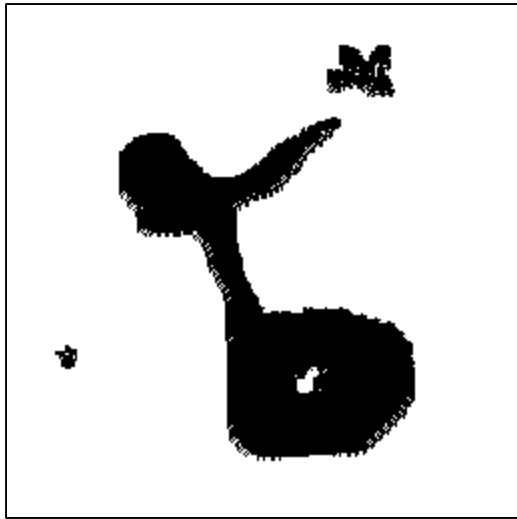
# Operatii geometrice



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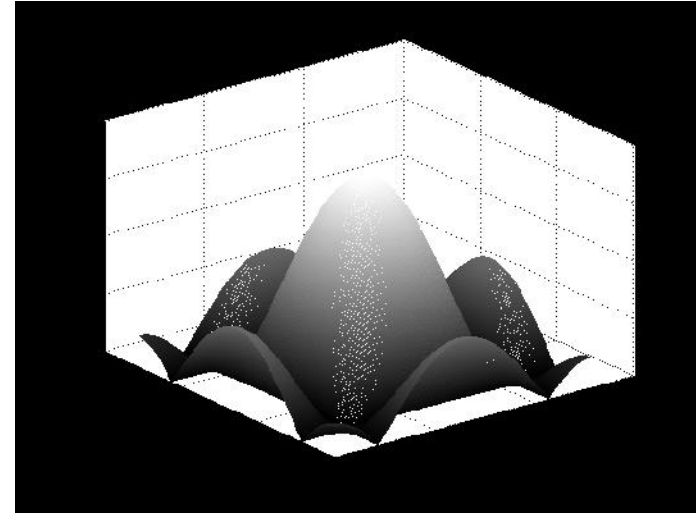


# Operatii morfologice

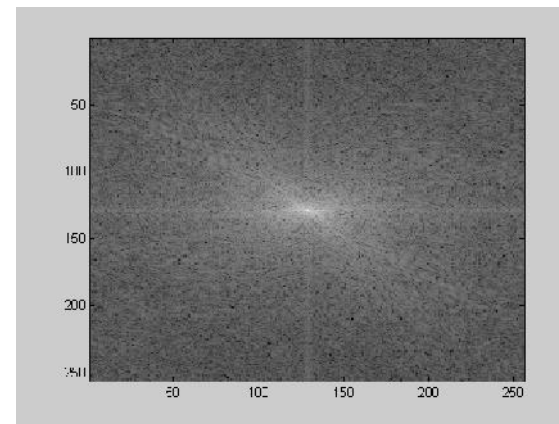
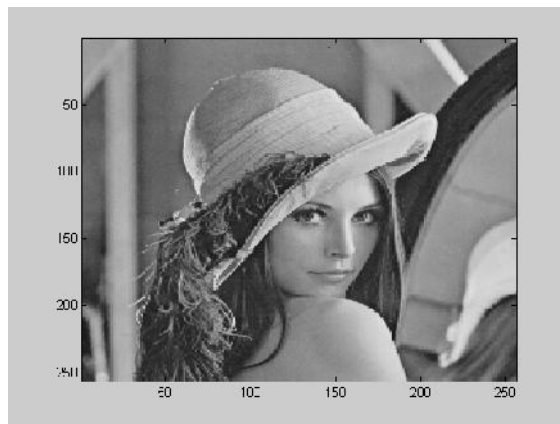


# Transformari unitare

Spectrul unui nucleu trece jos



Imaginea si spectrul ei



# Compresie

Reducerea cantitatii de informatie (date) necesara stocarii/ transmiterii imaginii.



# Notiuni introductive



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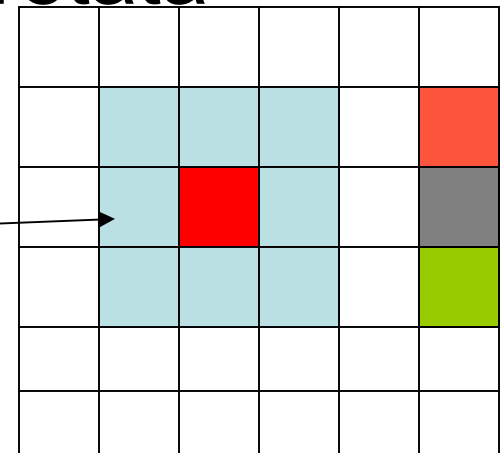
# Imaginea

Imaginea este un ansamblu de valori plasate dupa o forma spatiala de dimensiune supra-unitara (plan, volum, ... dar nu o dreapta).

Imagine  $f(x,y)$ ,  $x,y$  coordonate spatiale

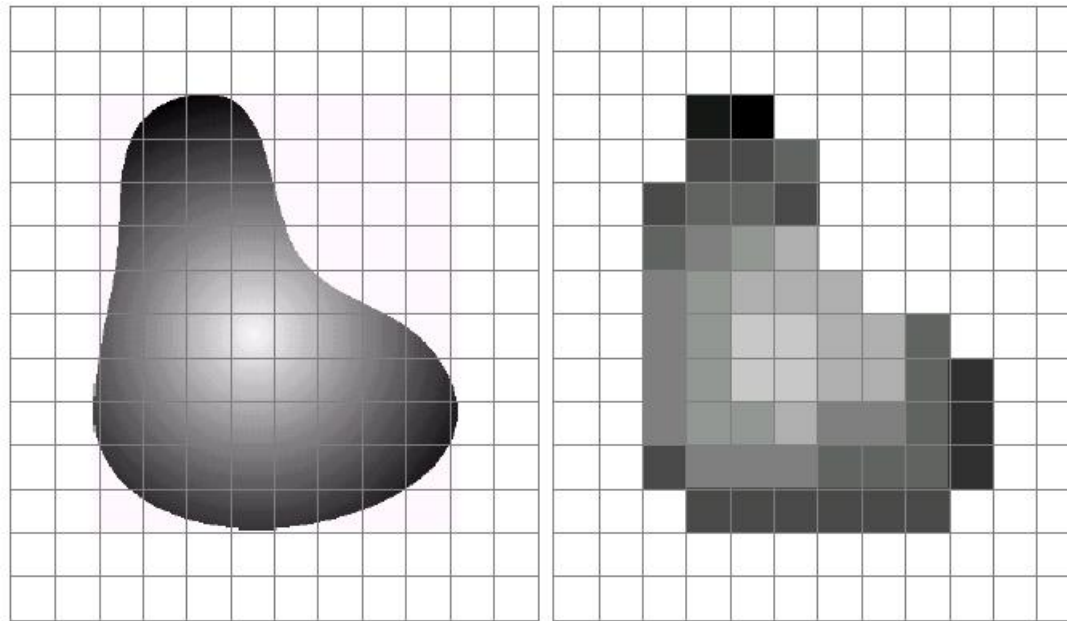
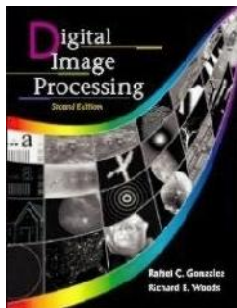
Imaginea digitala poate fi interpretata ca un tablou sau matrice.

Elementul de baza al imaginii - pixel  
(picture element )



# Imaginea digitala

Esantionare si cuantizare =>  
valorile digitale



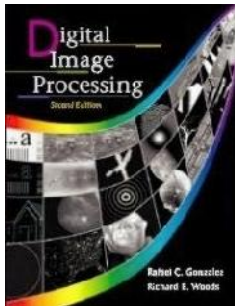
a b

**FIGURE 2.17** (a) Continuous image projected onto a sensor array. (b) Result of image sampling and quantization.

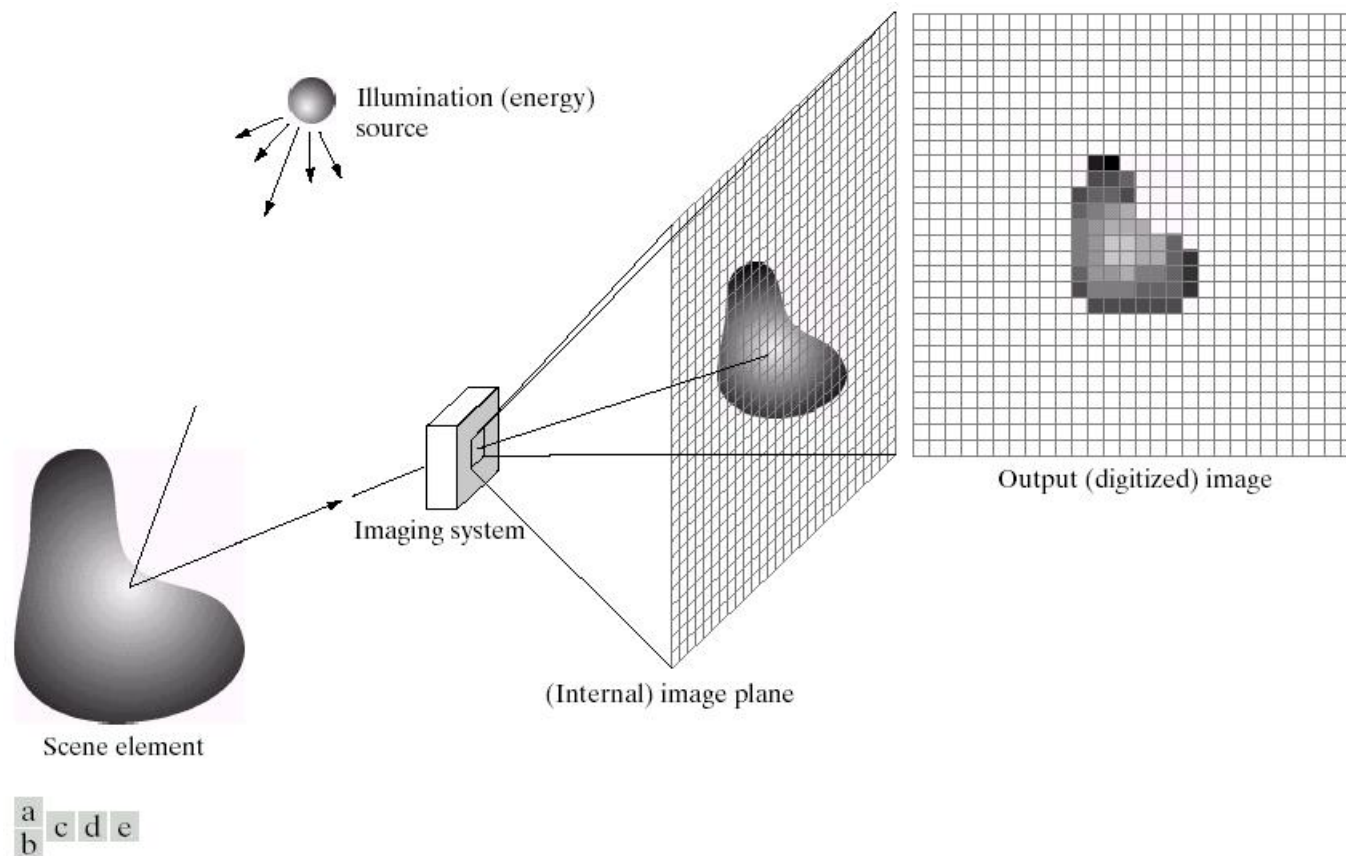


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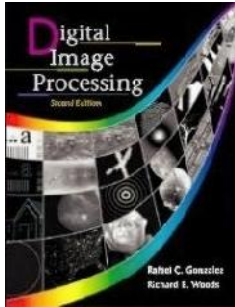


## Chapter 2: Digital Image Fundamentals

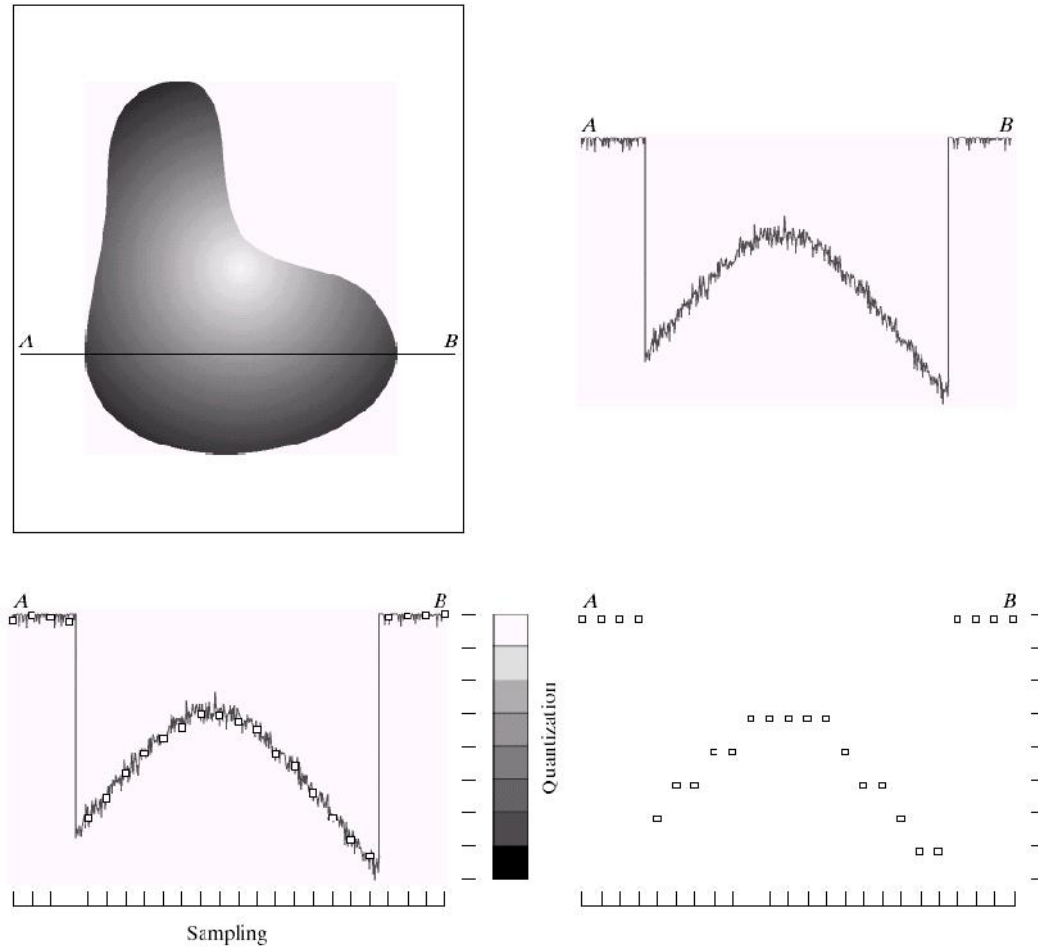


**FIGURE 2.15** An example of the digital image acquisition process. (a) Energy (“illumination”) source. (b) An element of a scene. (c) Imaging system. (d) Projection of the scene onto the image plane. (e) Digitized image.





## Chapter 2: Digital Image Fundamentals

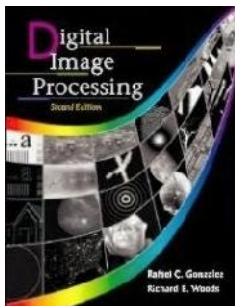


LABO

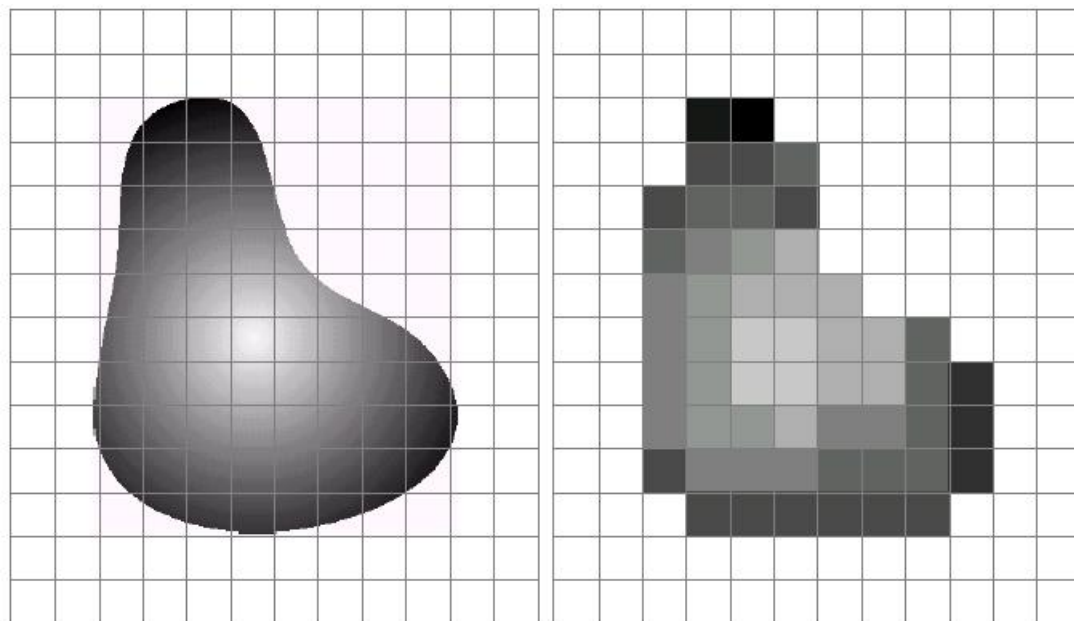


**FIGURE 2.16** Generating a digital image. (a) Continuous image. (b) A scan line from  $A$  to  $B$  in the continuous image, used to illustrate the concepts of sampling and quantization. (c) Sampling and quantization. (d) Digital scan line.





## Chapter 2: Digital Image Fundamentals

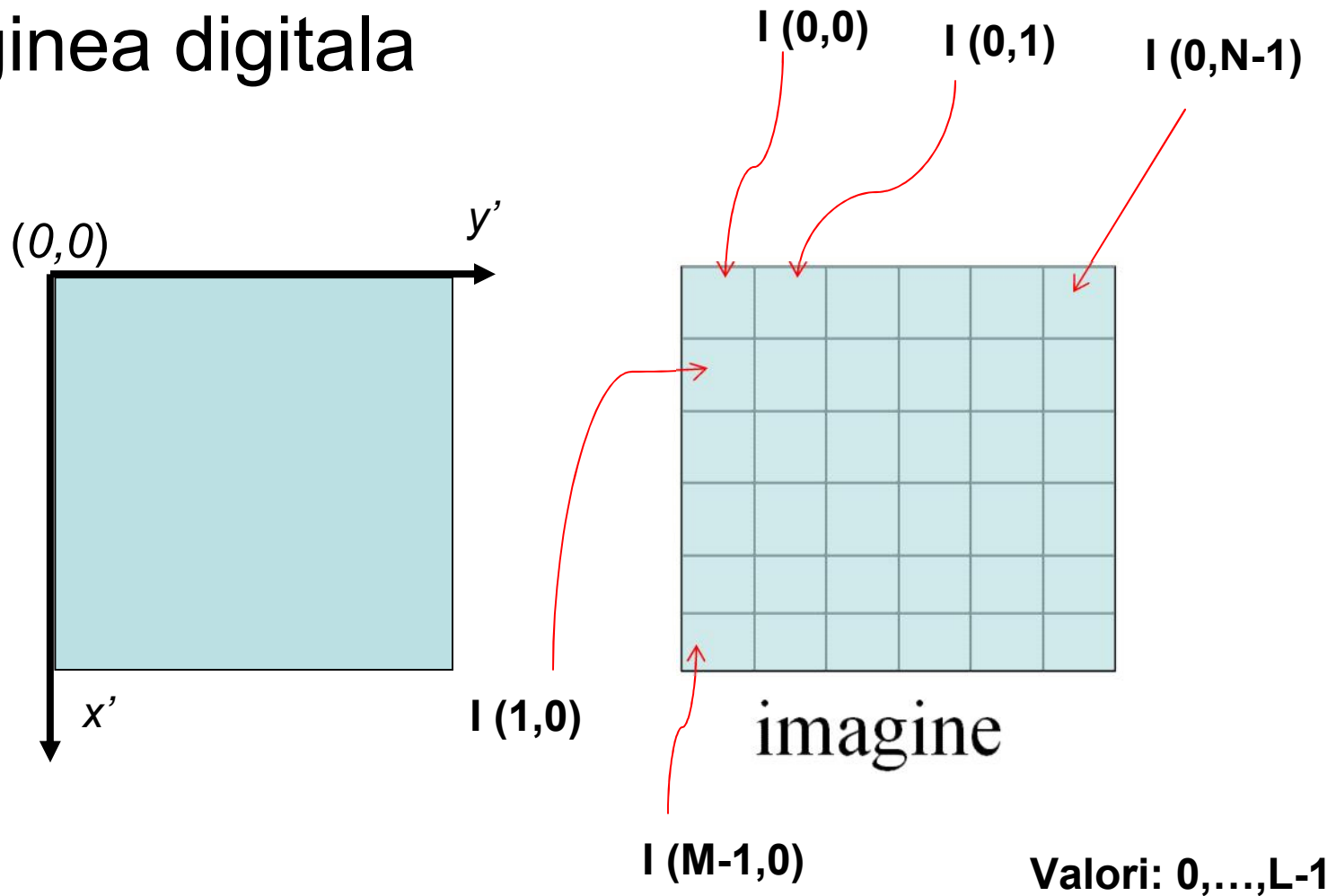


a b

**FIGURE 2.17** (a) Continuous image projected onto a sensor array. (b) Result of image sampling and quantization.

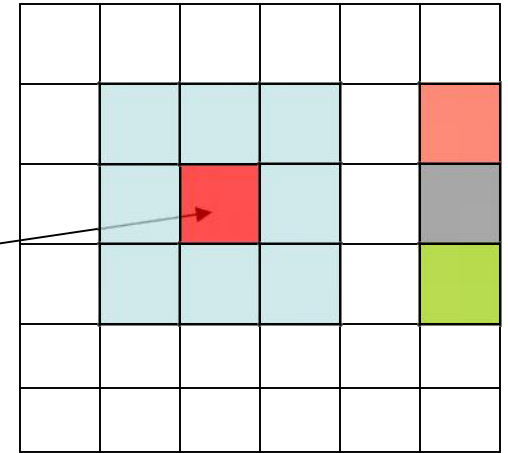
# Imaginea digitala

Imaginea digitala



# Imaginea

Elementul de baza al imaginii - **pixel**  
(picture element )



Pixelul:

- valoare => culoarea (sau nivelul de gri)-aici pixelul indicat e rosu
- pozitia (informatia spatiala) :linia si coloana (pixelul indicat: linia 3, coloana 3)



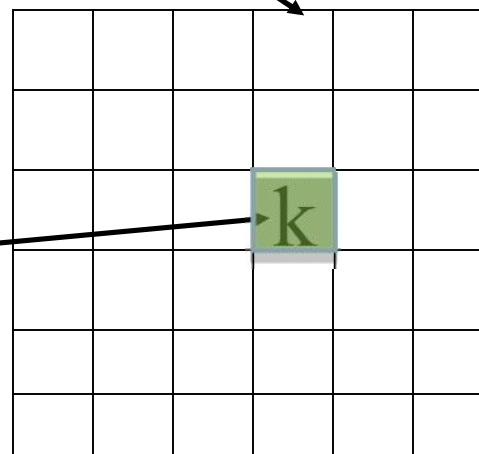
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# Caracteristicile pixelului

pozitie: linie, coloana

valoare



imagine

dimensiune

forma

legatura cu realitatea fizica



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# Dimensiunea pixelului

Ce dimensiune are in scena reala obiectul care in imagine are 1 pixel ?

Dimensiune pixel =  $1 / \text{Rezolutie}$

Ex: un document scanat

300 dpi  $\longrightarrow$  1 pixel =  $1 / 300''$



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# Rezolutia

- Rezolutia spatiala- masura a celor mai mici detalii vizibile
  - perechi de linii discernabile pe unitatea de distanta (ex 100 linii/mm)
  - dots (pixels) pe unitatea de distanta (dpi) – cartile 2400 dpi
- Rezolutia referitoare la intensitate- masura a celor mai mici detalii discernabile in nivelul de intensitate



## Rezolutie spatiala



512 x 512



256x256



128x128

## Rezolutie spatiala



512 x 512



256 x 256



128 x 128



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# Rezolutia referitoare la intensitate



256 nivele de gri



64 nivele de gri



16 nivele de gri



8 nivele de gri



4 nivele de gri



2 nivele de gri

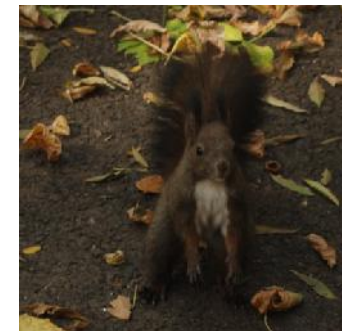


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# Clasificare

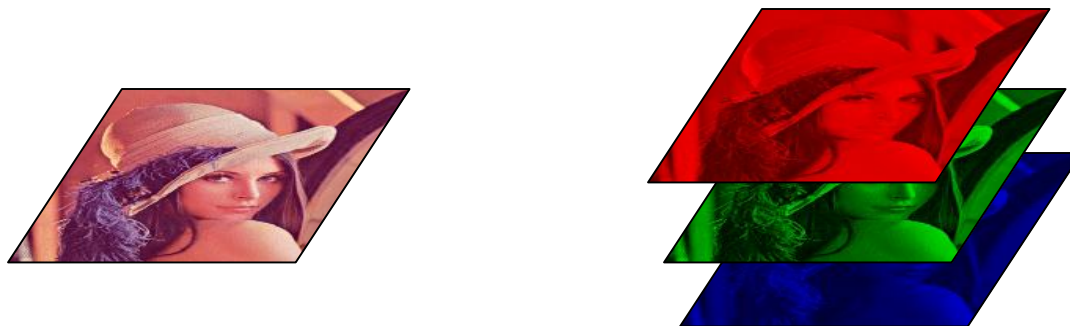
- Tipuri de imagini dupa valori
  - Scalare (orice valoare e un scalar)
    - binare
    - cu nivele de gri
  - Vectoriale
    - imaginile color (3 componente)
    - Imagini satelitare (3-200 componente)
    - Imagini termografice (2-5 componente in banda de infrarosu)



# Imagini vectoriale

Imagini color: vectori de 3 componente

(R, G, B) - reprezentare tipica, dar nu unica

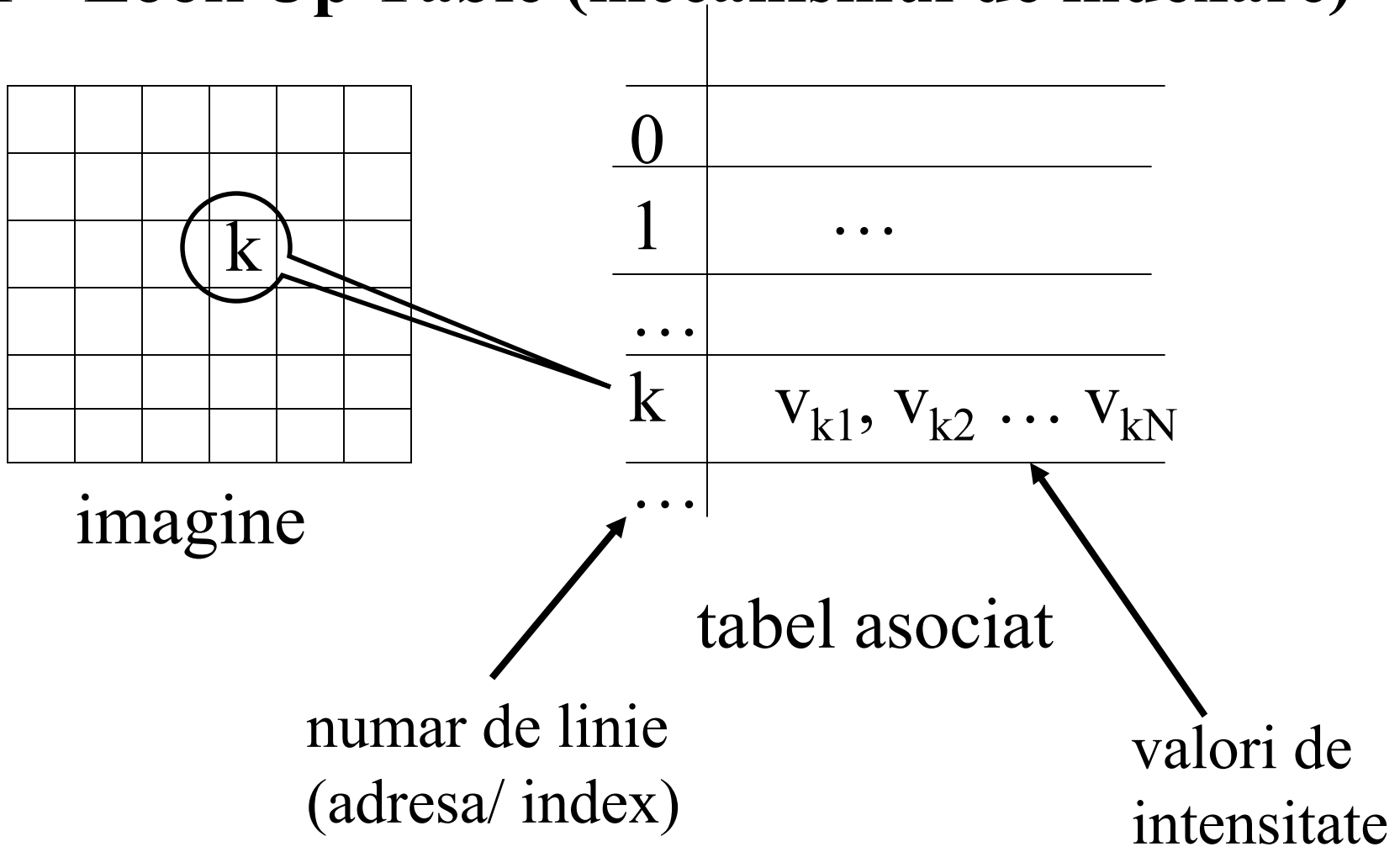


# Clasificare

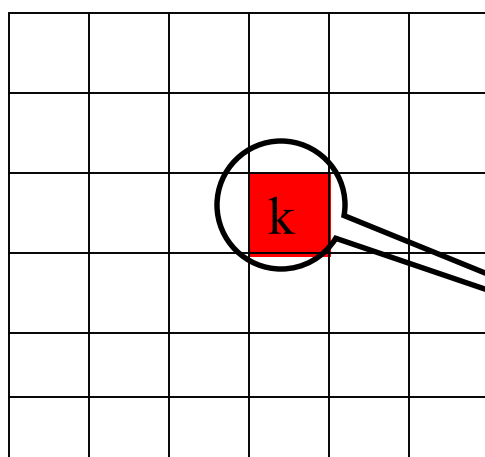
- Tipuri de imagini dupa natura lor
  - vizibile
  - nonvizibile
- Tipuri de imagini dupa semnificatia valorilor
  - Imagini de intensitate (direct proportionale cu marimea fizica masurata in scena: culoare, intensitate luminoasa)
  - Imagini indexate -valorile din imagine sunt indecsi (adrese) intr-un tabel asociat imaginii in care se gaseste informatia



# LUT - Look Up Table (mecanismul de indexare)



# Imagini color indexate



imagine

|     |                            |
|-----|----------------------------|
| 0   |                            |
| 1   |                            |
| ... |                            |
| k   | $R_k=255 \ G_k=0, \ B_k=0$ |
| ... |                            |

tabel de culoare

Imagine  $\longrightarrow$  tabela de culoare  $\longrightarrow$  Afisare

# Imagini indexate



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R



# Relatii intre pixeli

- pixelul p de la coordonata  $(x,y)$  are 4 vecini (pe orizontala si verticala)->V4:  
 $(x+1,y), (x-1,y), (x,y+1), (x,y-1)$
- pixelul p de la coordonata  $(x,y)$  are 8 vecini (pe orizontala, verticala si diagonala) )->V8:  
 $(x+1,y), (x-1,y), (x,y+1), (x,y-1),$   
 $(x+1,y+1), (x+1,y-1), (x-1,y+1), (x-1,y-1)$



# Adiacenta

- Doi pixeli,  $p$  si  $q$  sunt adiacenti dc pixelul  $q$  este in  $V_4$  a pixelului  $p$
- Doi pixeli,  $p$  si  $q$  sunt adiacenti dc pixelul  $q$  este in  $V_8$  a pixelului  $p$



# Masuri de distanta

Pixelii:  $p(x_1, y_1)$ ,  $q(x_2, y_2)$ ,  $z(x_3, y_3)$

**Distanța euclidiană:**

$$D_e(p, q) = [(x_1 - x_2)^2 + (y_1 - y_2)^2]^{1/2}$$

**Distanța city-block (L1 distance):**

$$D(p, q) = |x_1 - x_2| + |y_1 - y_2|$$

**Distanța chessboard ( $L_\infty$ ):**

$$D(p, q) = \max\{|x_1 - x_2|, |y_1 - y_2|\}$$



# Stocarea imaginilor - fisiere de imagini

- Img-pentru imagini indexate, patrute, cu nivele de gri.
- RAW, TIFF, BMP,JPG

