

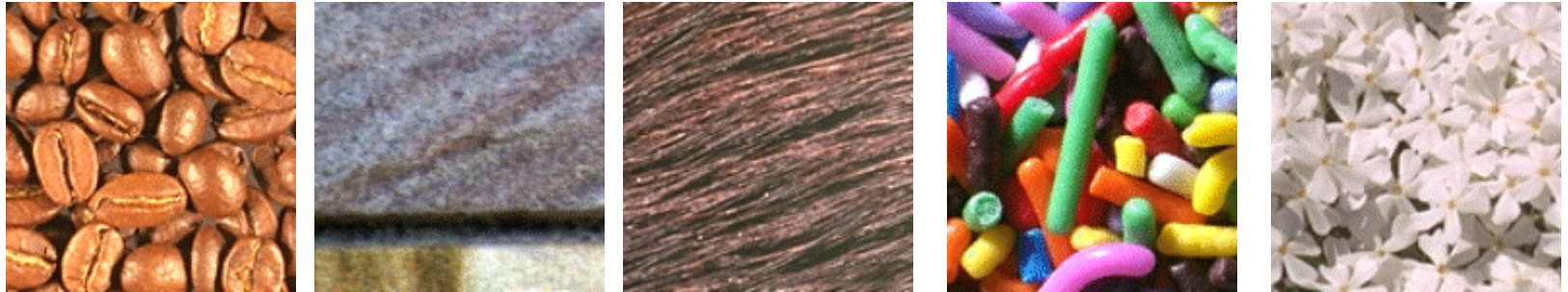
DESCRIEREA TEXTURILOR

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Textura



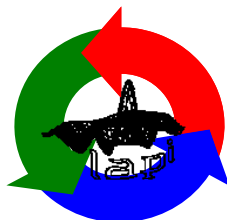
Nu exista definitii definitive ale texturii; textura este descrisa prin termeni lingvistici precum : regularitate, omogenitate, granularitate, ...

Textura : aspect similar in orice parte a sa, la o scala fixata.

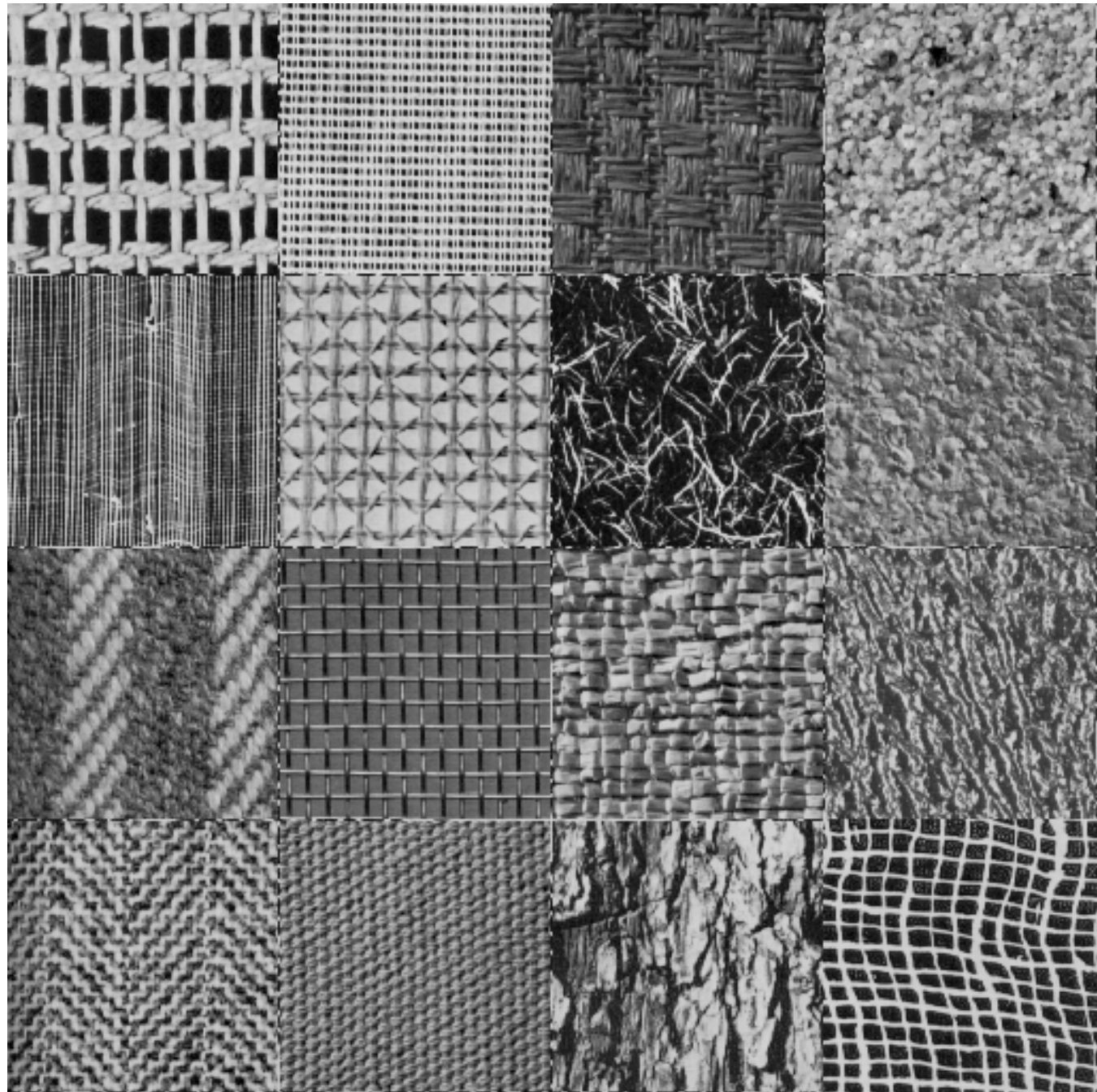


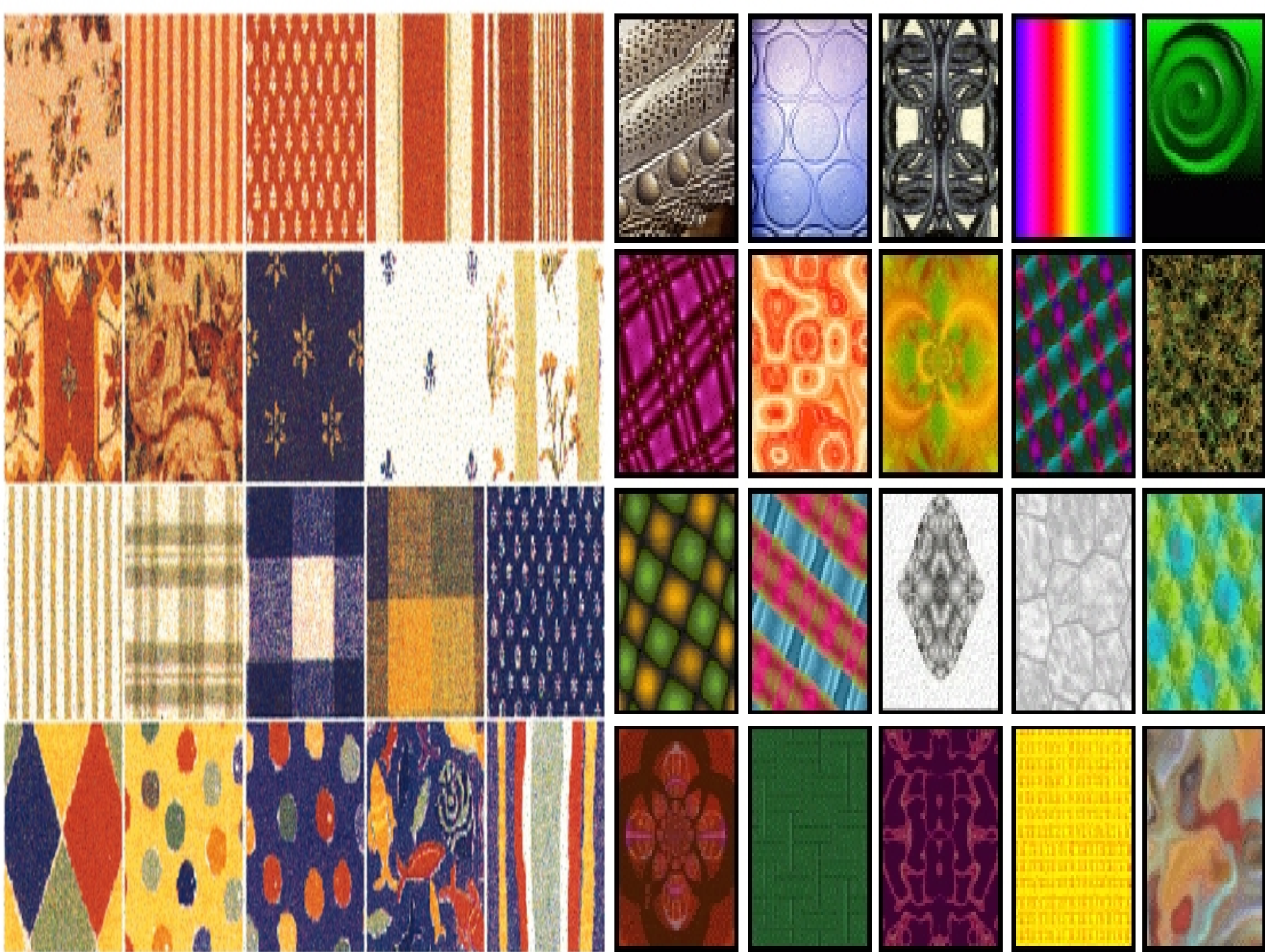
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albumul Brodatz
(120 texturi)





Descrierea texturilor

Descrierea texturii este în principal bazată pe interpretarea valorilor pixelilor ca realizări ale unor procese aleatoare corelate. Descrierile vor fi deci de tipul unor **distributii** ale unor caracteristici (valoare, energie, variație) în domeniul spațial al imaginii sau în domeniul de frecvență (caracterizare spectrală).

Descriere statistică:

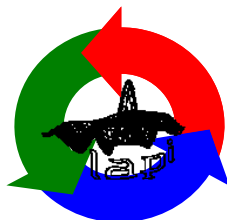
- descriere prin momente (descriptori de ordinul 1)

- descriere prin distributii spațiale (distributii de ordin cel puțin 2).

- descrierea în domeniul de frecvență

- descrierea prin modele (AR, fractali, ...)

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Distributii de ordinul 1

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Descrierea prin momente (distributii de ordin 1)

textura = colectie de pixeli, realizari particulare ale unui proces aleator

Histograma regiunii este atunci functia de densitate de probabilitate a v.a., din care se pot calcula familii de momente statistice de diferite ordine.

Ipoteze implicite:

textura este generata de un proces aleator stationar

procesul aleator este si **ergodic** !!!

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Distributii de ordinul 2

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Matricea de coocurenta

Fie o textura definita pe suportul spatial al regiunii R .

Matricea de coocurenta a regiunii grupeaza probabilitatile de aparitie in regiunea R a diferitelor perechi de valori posibile ale pixelilor ce satisfac o regula impusa de plasament spatial.

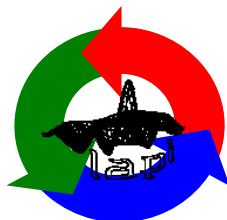
Regula de plasament spatial este existanta unei separari spatiale $\mathbf{t} = (\Delta i, \Delta j)$ intre pixelii ce formeaza perechea.

$$M_{\mathbf{t}}(a,b) = \text{Prob} \{R(\mathbf{x}) = a \text{ si } R(\mathbf{x}+\mathbf{t}) = b\}$$

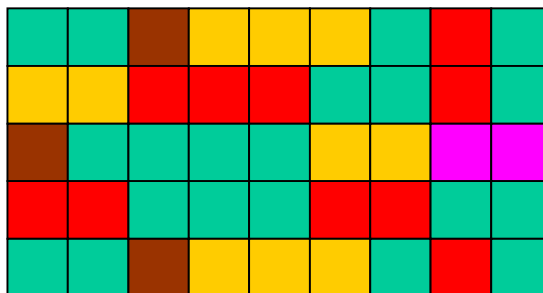
M este o matrice patrata, de dimensiune egala cu numarul de valori posibile diferite ale valorilor pixelilor.

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Exemplu :



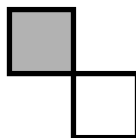
Matricea de coocurenta

Culorile sunt coduri vizuale pentru numere :

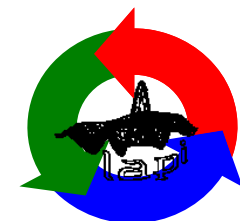


Valorile pixelilor sunt deci cuprinse in $[1, 5]$, matricea de coocurenta va avea dimensiunea 5.

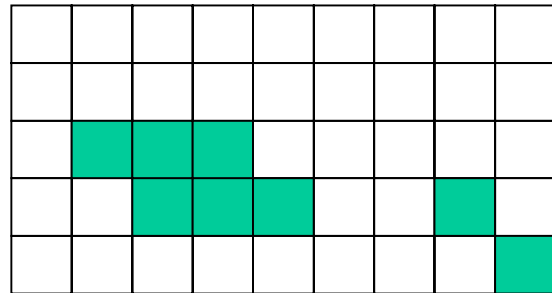
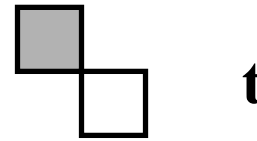
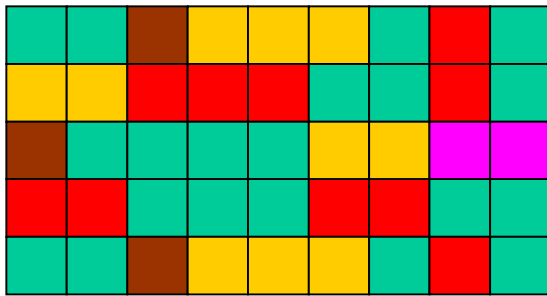
Vector de translatie : $(1, 1)$ (perechi de puncte situate pe diagonala, la distanta de 1).



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Matricea de coocurență

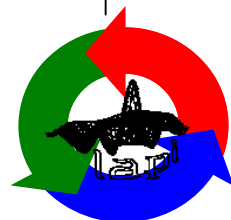


4 perechi de pixeli de
valorile specificate in
relatia spatiala specificata

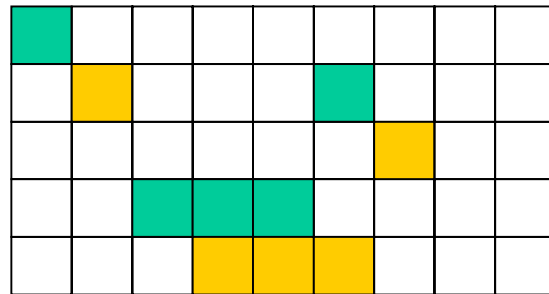
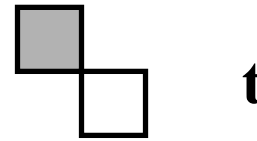
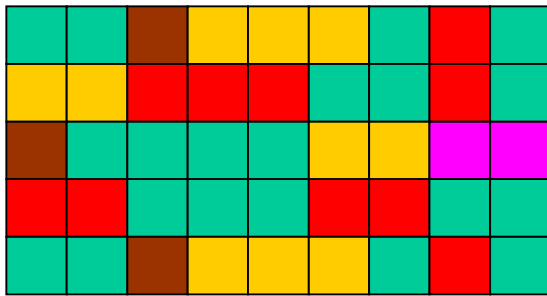
se normalizeaza la numarul
total de perechi (32)

						
						
			4			
						
						
						

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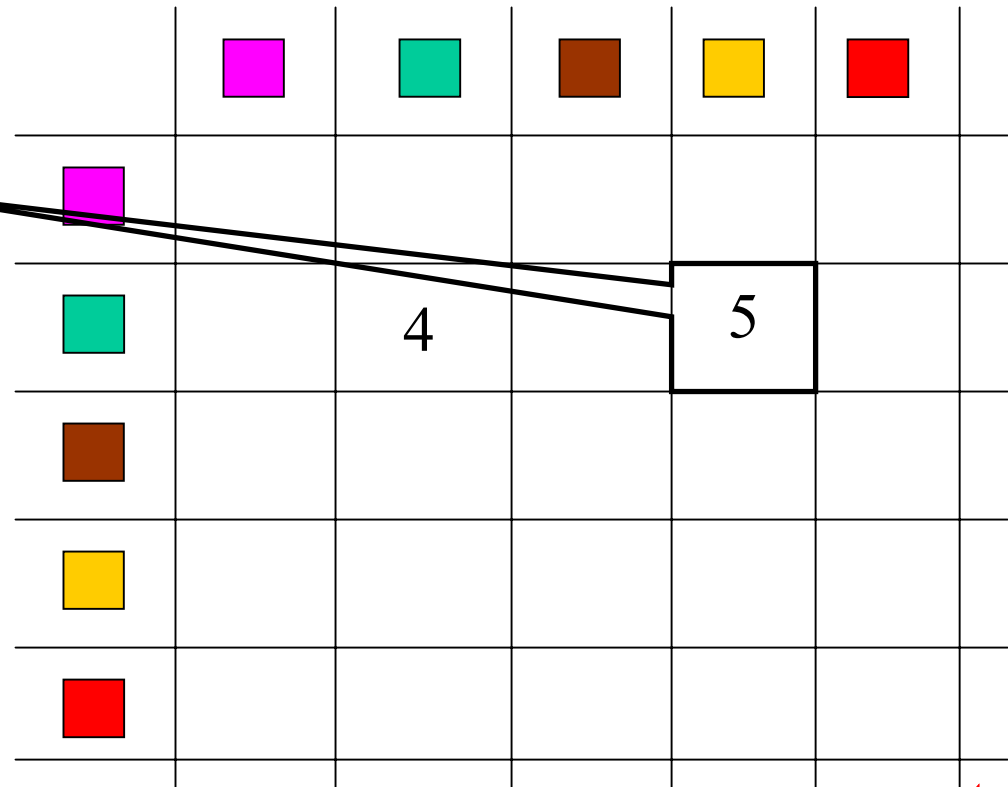


Matricea de coocurență

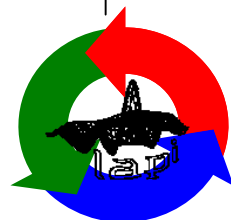


6 perechi de pixeli de
valorile specificate in
relatia spatiala specificata

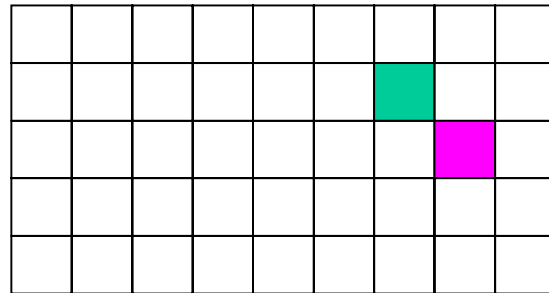
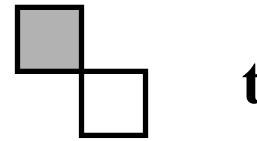
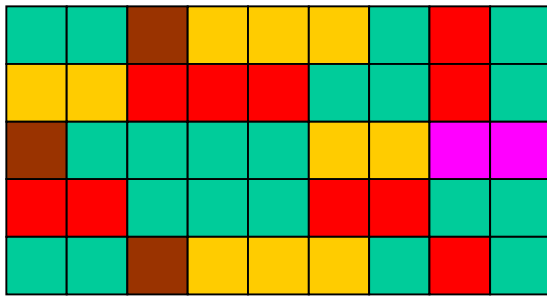
se normalizeaza la numarul
total de perechi (32)



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Matricea de coocurență



1 pereche de pixeli de
valorile specificate in
relatia spatiala specificata

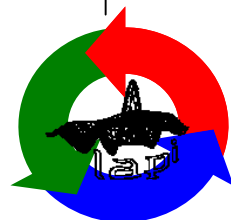
se normalizeaza la numarul
total de perechi (32)

1

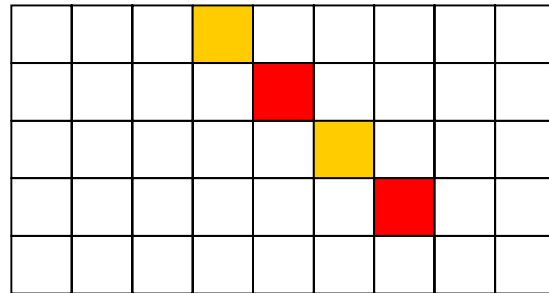
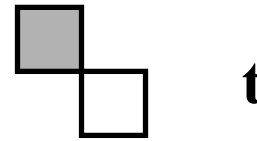
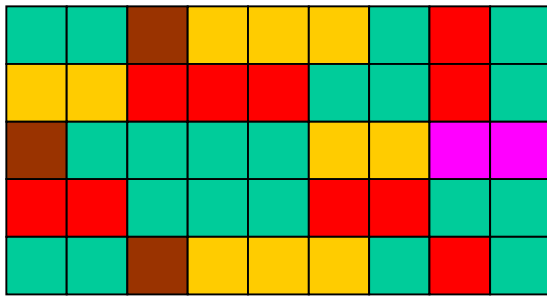
4

5

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Matricea de coocurență



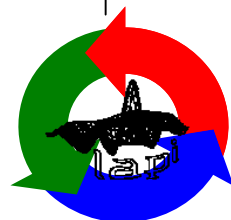
2 perechi de pixeli de
valorile specificate in
relatia spatiala specificata

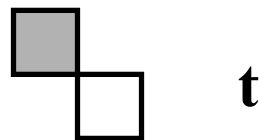
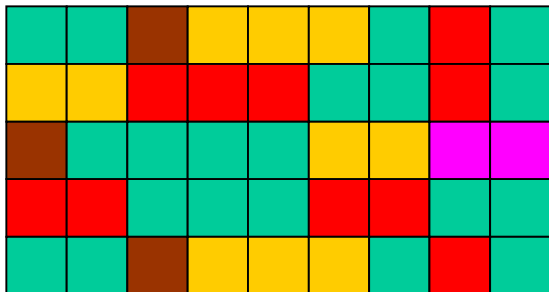
se normalizeaza la numarul
total de perechi (32)

						
						
	1	4		5		
						
						
						

2

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Matricea de coocurenta

matrice rara

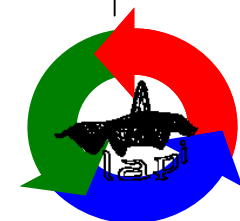
continutul se schimba
la modificarea lui **t**

se poate folosi ca atare
(functie scalara de
doua variabile)

$\frac{1}{32}$

						
	0	1	0	0	0	
	1	4	0	5	3	
	0	0	0	0	2	
	0	5	0	0	2	
	1	5	1	0	1	

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omogenitatea și omogenitatea locală

$$O = \frac{1}{N_{nz}} \sum_a \sum_b M_t^2(a, b)$$

$$O_{loc} = \frac{1}{N_{nz}} \sum_a \sum_b \frac{1}{1 + (a - b)^2} M_t(a, b)$$

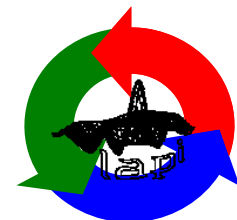
uniformitatea

$$U = \sum_a M_t^2(a, a)$$

directivitatea

$$D = \sum_a M_t(a, a)$$

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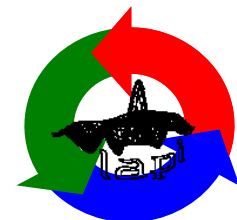
contrastul

$$C = \frac{1}{N_{nz} (L-1)^2} \sum_k \sum_{|a-b|=k} M_t(a, b)$$

entropia

$$H = 1 - \frac{1}{N_{nz} \log N_{nz}} \sum_a \sum_b M_t(a, b) \log M_t(a, b) \delta(M_t(a, b))$$

etc



Matricea de coocurenta Haralick

$$M = M_{t1} + M_{t2} + M_{t3} + M_{t4}$$

$$t1 = (0, 1)$$

$$t2 = (0, -1)$$

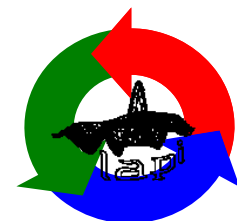
$$t3 = (1, 0)$$

$$t4 = (-1, 0)$$

adica o matrice cumulata de coocurenta
pentru vecinatatea de baza V4

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LABORATORUL DE ANALIZA ȘI PRELUCRAREA IMAGINILOR



Matricea de coocurenta generalizata

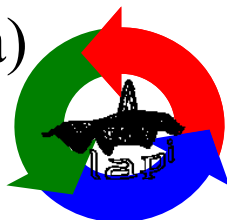
Fie o textura definita pe suportul spatial al regiunii R .

Matricea de coocurenta generalizata a regiunii grupeaza probabilitatile de aparitie in regiunea R a diferitelor perechi de pixelilor avand diferite valori ale unei trasaturi caracteristice, ce satisfac o regula impusa de plasament spatial.

Trasaturi caracteristice : valoare (nivel de gri)
 medie in vecinatate
 neuniformitate (laplacian)

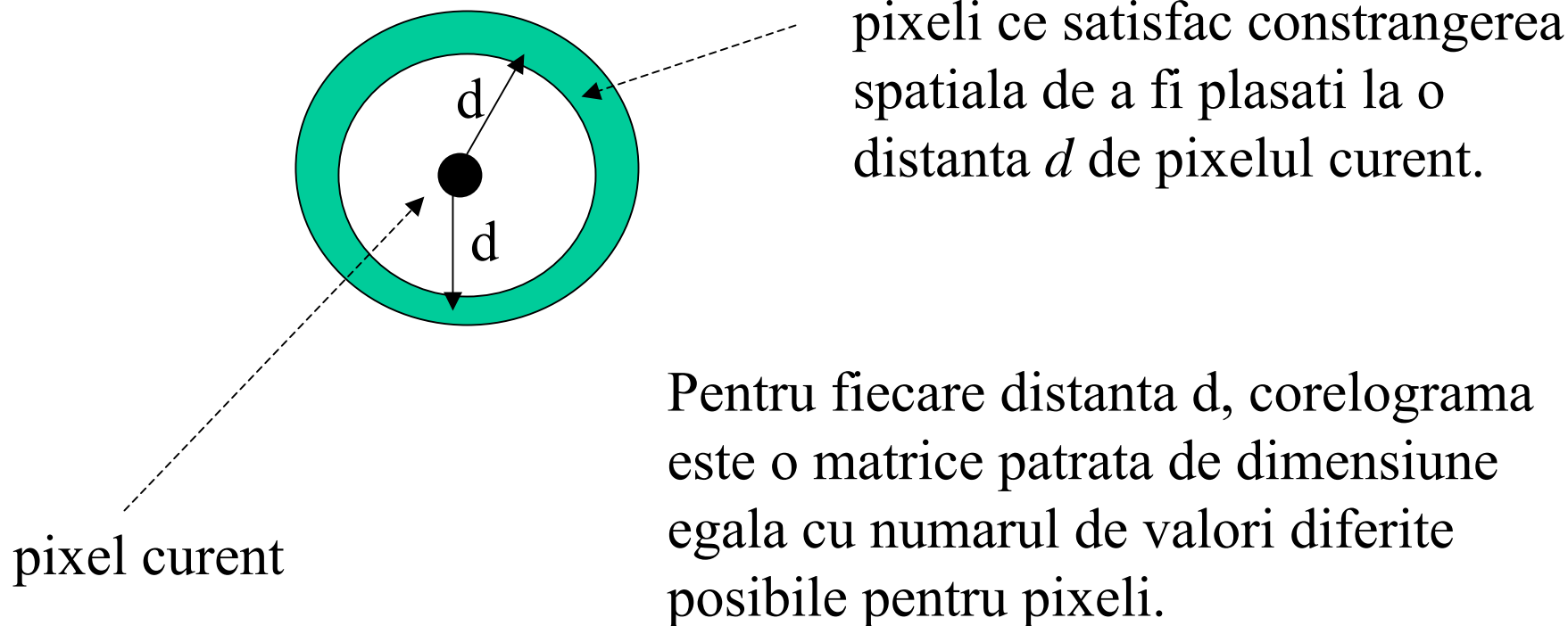
Realtie spatiala : translatie (ca la coocurenta)
 distanta de separare (corelograma)

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Corelograma

Corelograma este o matrice care grupeaza probabilitatile de a avea o pereche de pixeli de valori specificate separati de o distanta fixata.



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LABORATORUL DE ANALIZA ȘI PRELUCRAREA IMAGINILOR



Auto-corelograma

Simplificare : se calculeaza doar perechile de pixeli avand **aceeasi** valoare (auto-corelograma), pentru diferite distante.

Autocorelograma va avea un numar de coloane dat de numarul de distante diferite la care se face calculul si un numar de linii egal cu numarul de valori posibile diferite ale pixelilor.

Distantele corespund in general metricilor discrete city-block (L_1) si chess-board (L_∞).

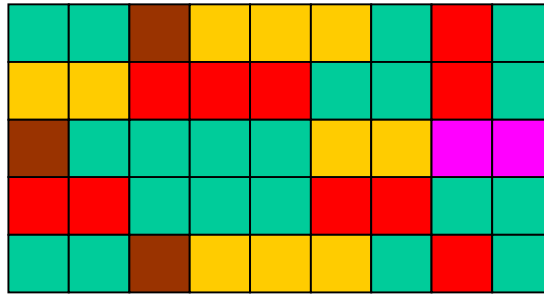
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LABORATORUL DE ANALIZA ȘI PRELUCRAREA IMAGINILOR



Auto-corelograma

Exemplu :



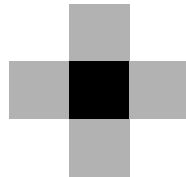
Culorile sunt coduri vizuale pentru numere :



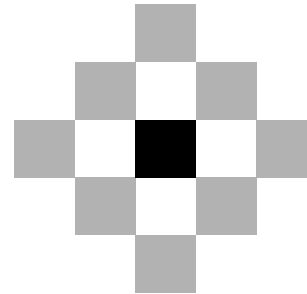
Valorile pixelilor sunt deci cuprinse in $[1, 5]$, auto-corelograma va avea 5 linii.

Consideram distanta city-block (L1 - suma modulelor diferentelor de coordonate) si distantele 1 si 2 (2 coloane in auto-corelograma).

d=1



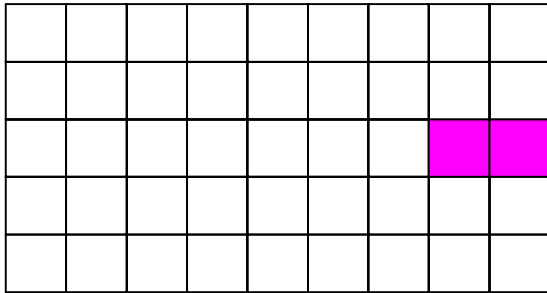
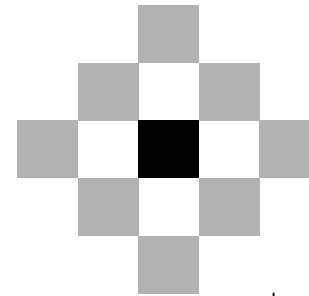
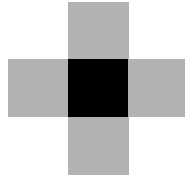
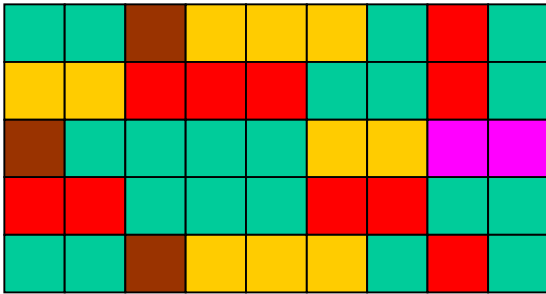
d=2



C. VERTAN



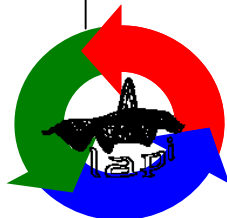
Auto-corelograma



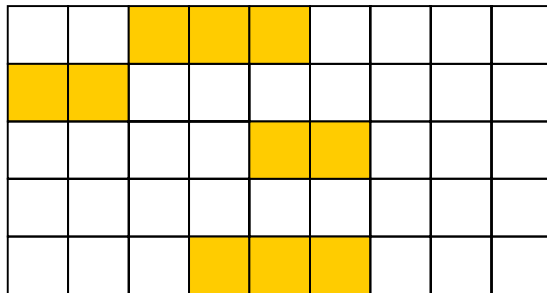
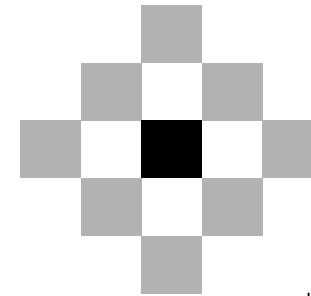
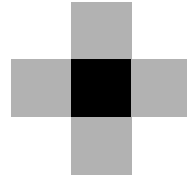
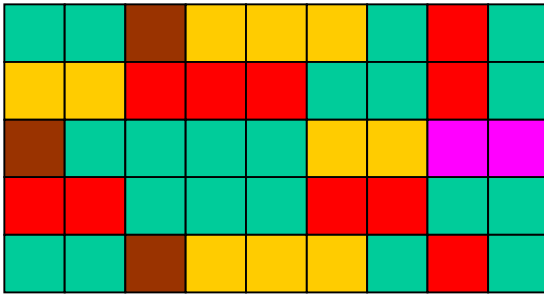
$d=1$: 2 perechi de puncte
 $d=2$: 0 perechi de puncte

	1	2
2	2	0

C. VERTAN



Auto-corelograma

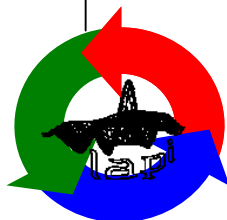


d=1 : 12 perechi de puncte
d=2 : 10 perechi de puncte

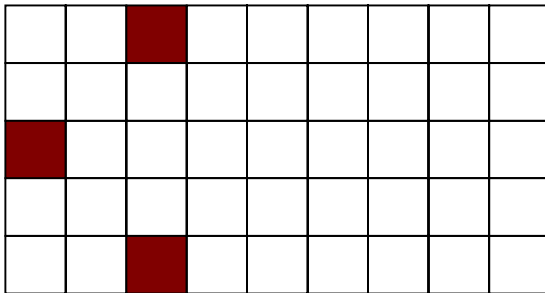
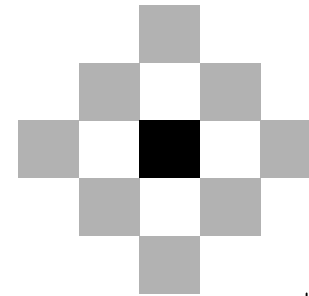
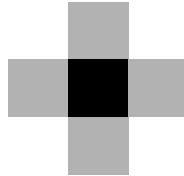
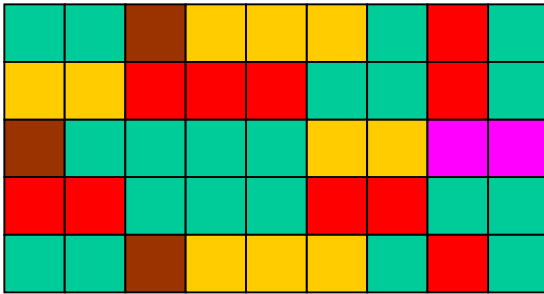
	1	2
2	2	0
1		
0		
12	12	10
10		
0		

C. VERTAN

LABORATORUL DE ANALIZA ȘI PRELUCRAREA IMAGINILOR



Auto-corelograma

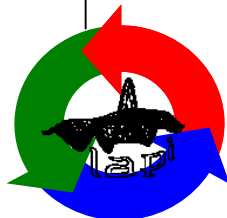


d=1 : 0 perechi de puncte
d=2 : 0 perechi de puncte

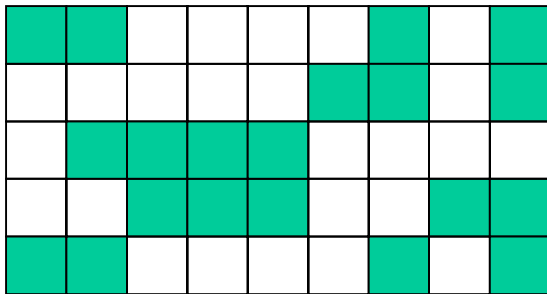
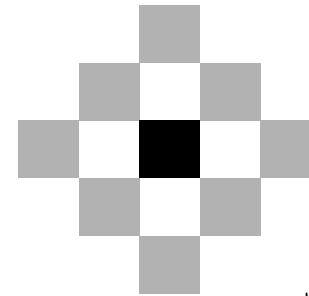
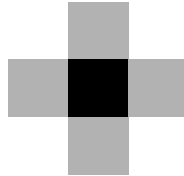
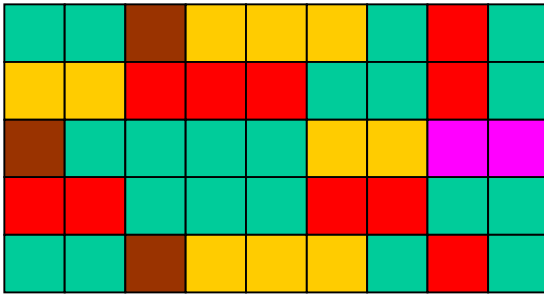
	1	2
2	2	0
0		
0	0	0
12	12	10

C. VERTAN

LABORATORUL DE ANALIZA ȘI PRELUCRAREA IMAGINILOR



Auto-corelograma

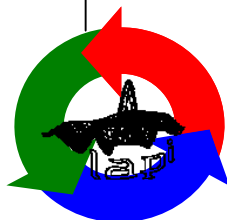


d=1 : 30 perechi de puncte
d=2 : 34 perechi de puncte

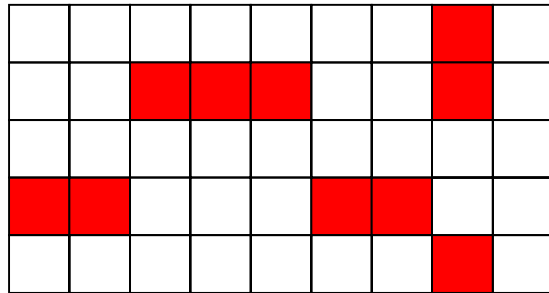
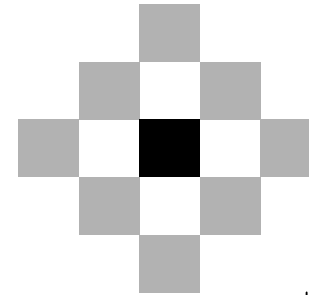
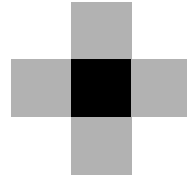
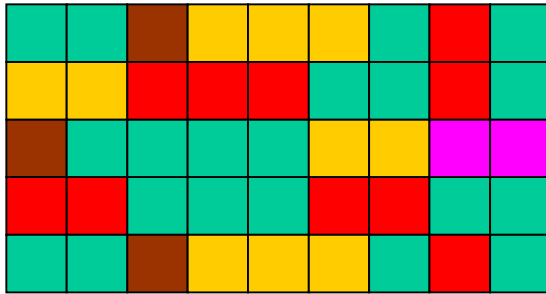
	1	2
1	2	0
2	30	34
3	0	0
4	12	10
5		

C. VERTAN

LABORATORUL DE ANALIZA ȘI PRELUCRAREA IMAGINILOR



Auto-corelograma



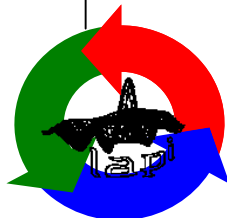
$d=1$: 10 perechi de puncte

$d=2$: 4 perechi de puncte

	1	2
<div></div>		
<div></div>	2	0
<div></div>	30	34
<div></div>	0	0
<div></div>	12	10
<div></div>	10	4

C. VERTAN

LABORATORUL DE ANALIZA ȘI PRELUCRAREA IMAGINILOR



Matricea de izosegmente

Izosegment (*runlength*) = grup de pixeli formand o componenta conexa, formand un segment de dreapta orientat pe o directie impusa

Matricea de izosegmente grupeaza (pentru o zona data si o directie impusa) probabilitatea de aparitie a unui izosegment de diferite lungimi posibile si diferite valori.

Matricea are un numar de linii egal cu numarul de valori diferite ale valorilor posibile ale pixelilor din regiune si un numar de coloane egal cu dimensiunea maxima a regiunii pe directia specificata.

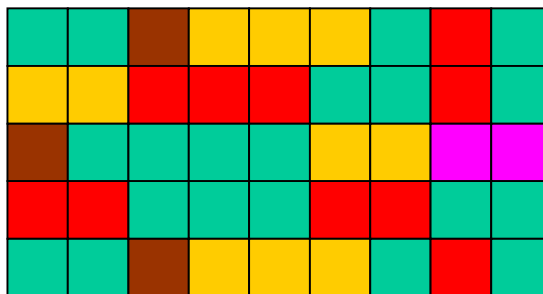
$M_{\theta}(a, l)$ probabilitatea de a avea un izosegment de lungime l si valoare a pe directia θ

C. VERTAN

LABORATORUL DE ANALIZA ȘI PRELUCRAREA IMAGINILOR



Exemplu :



Matricea de izosegmente

Culorile sunt coduri vizuale pentru numere :

 1  2  3  4  5

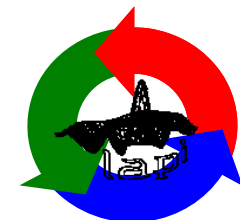
Valorile pixelilor sunt deci cuprinse in $[1, 5]$, matricea de izosegmente va avea 5 linii.

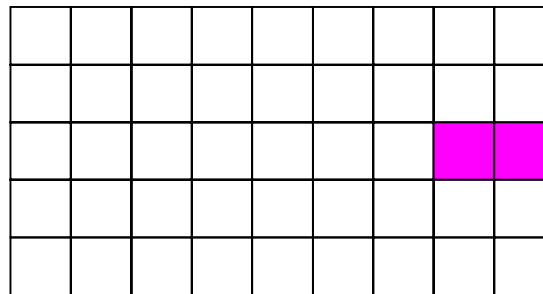
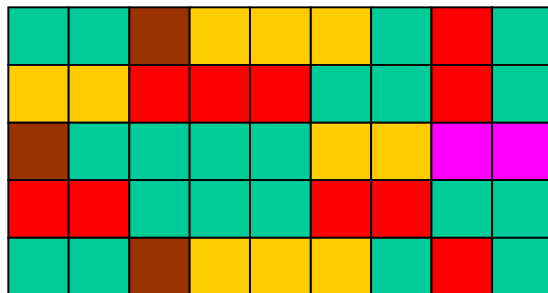
Sa consideram orientarea orizontala; dimensiunea maxim posibila a unui izosegment este dimensiunea orizontala a regiunii, deci 9.

In practica se considera imaginile binare obtinute prin extragerea fiecărei valori posibile, pe care se numara izosegmentele corespunzatoare

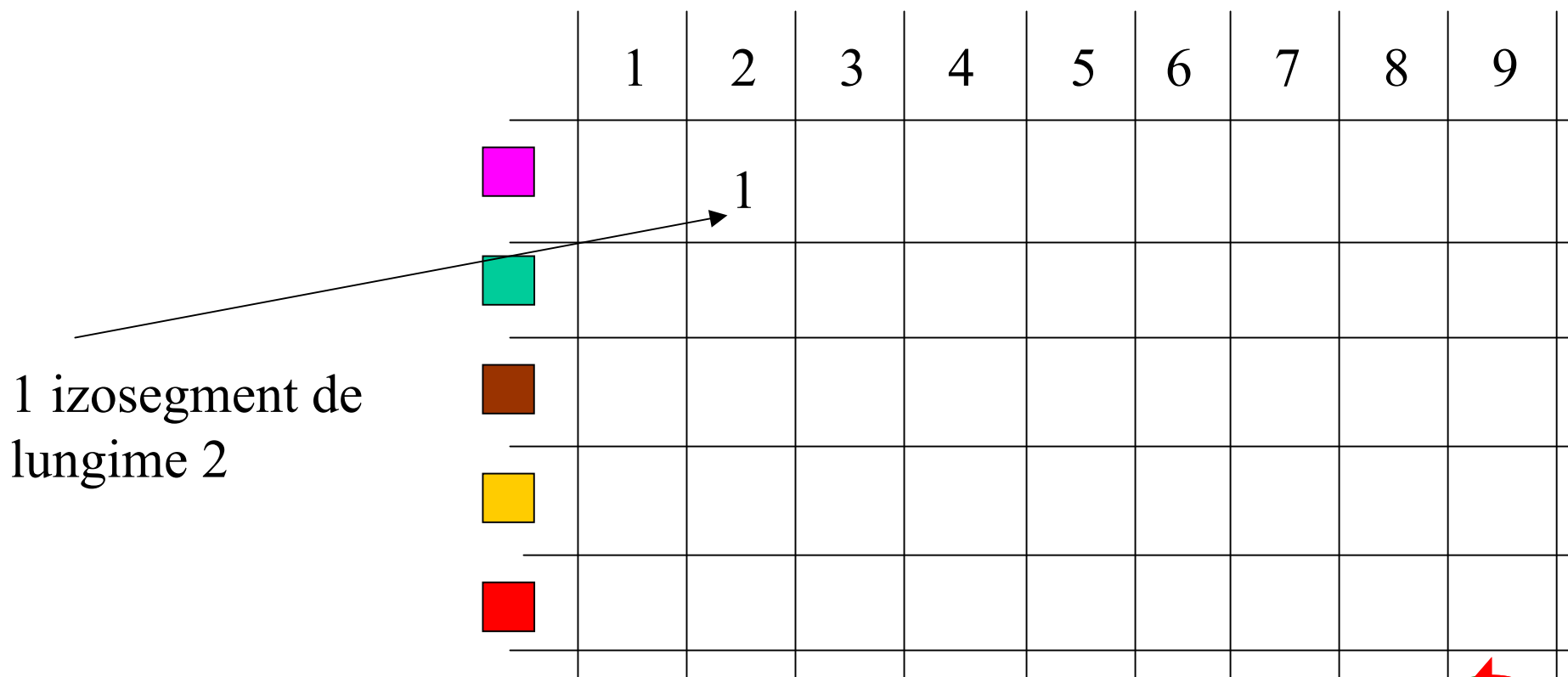
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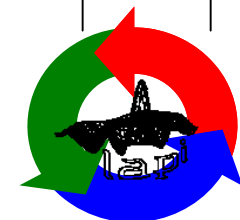


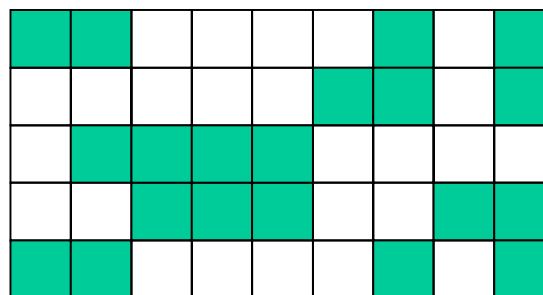
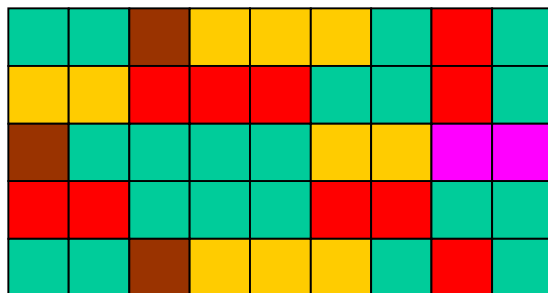
Matricea de izosegmente



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Matricea de izosegmente

5 izosegmente de lungime 1



4 izosegmente de lungime 2



1 izosegment de lungime 3

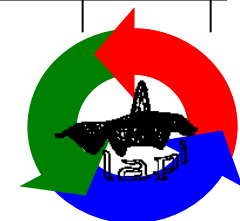


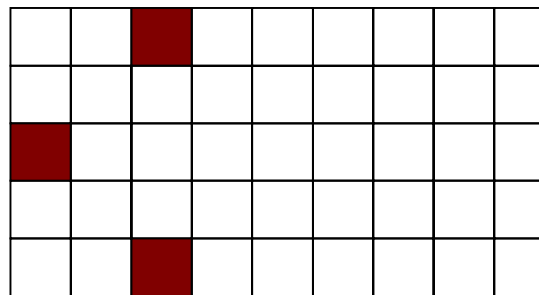
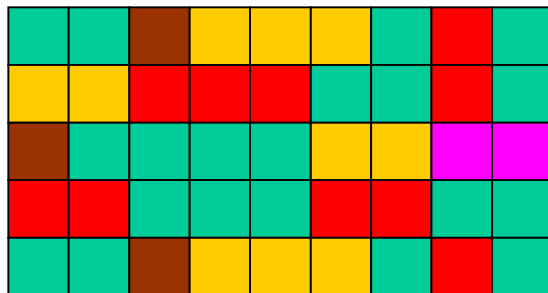
1 izosegment de lungime 4



	1	2	3	4	5	6	7	8	9
Magenta	0	1	0	0	0	0	0	0	0
Cyan	5	4	1	1	0	0	0	0	0
Brown									
Yellow									
Red									






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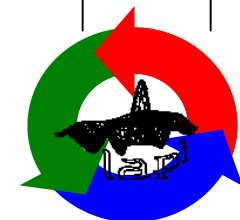


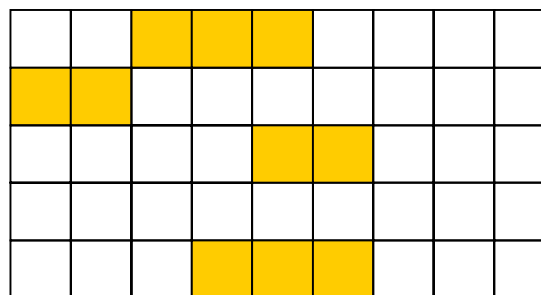
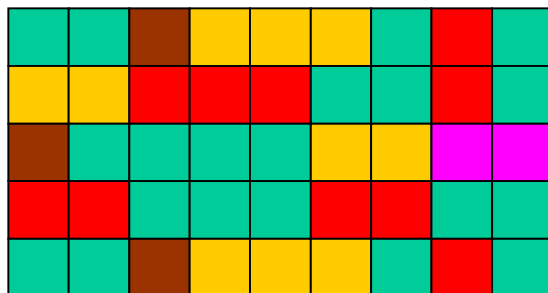
Matricea de izosegmente

3 izosegmente de lungime 1

	1	2	3	4	5	6	7	8	9
	0	1	0	0	0	0	0	0	0
	5	4	1	1	0	0	0	0	0
	3	0	0	0	0	0	0	0	0
									
									

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Matricea de izosegmente

2 izosegmente de lungime 2



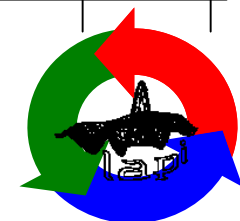
2 izosegmente de lungime 3

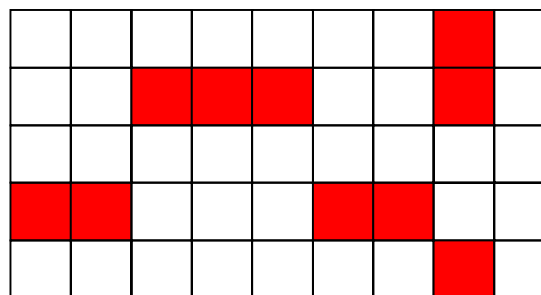
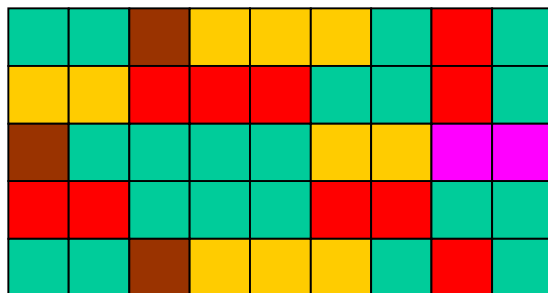


	1	2	3	4	5	6	7	8	9
Magenta	0	1	0	0	0	0	0	0	0
Teal	5	4	1	1	0	0	0	0	0
Brown	3	0	0	0	0	0	0	0	0
Yellow	0	2	2	0	0	0	0	0	0
Red									

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Matricea de izosegmente

3 izosegmente de lungime 1



2 izosegmente de lungime 2



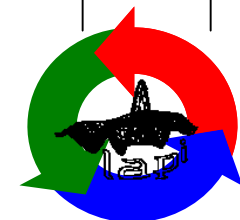
1 izosegment de lungime 3



	1	2	3	4	5	6	7	8	9
	0	1	0	0	0	0	0	0	0
	5	4	1	1	0	0	0	0	0
	3	0	0	0	0	0	0	0	0
	0	2	2	0	0	0	0	0	0
	3	2	1	0	0	0	0	0	0

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numarul / proportia de izosegmente

$$N_{iz} = \sum_{a=0}^{L-1} \sum_{b=1}^{n_{\theta}} M_{\theta}(\mathbf{a}, b)$$

$$RF5 = \frac{N_{iz}}{N_{reg}}$$

proportia de izosegmente scurte / lungi

$$RF1 = \frac{1}{N_{iz}} \sum_{a=0}^{L-1} \sum_{b=1}^{n_{\theta}} \frac{M_{\theta}(\mathbf{a}, b)}{b^2}$$

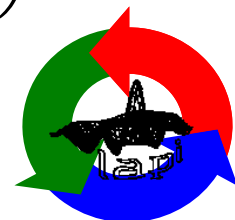
$$RF2 = \frac{1}{N_{iz}} \sum_{a=0}^{L-1} \sum_{b=1}^{n_{\theta}} b^2 M_{\theta}(\mathbf{a}, b)$$

heterogenitatea valorilor / lungimilor

$$RF3 = \frac{1}{N_{iz}} \sum_{a=0}^{L-1} \left(\sum_{b=1}^{n_{\theta}} M_{\theta}(\mathbf{a}, b) \right)^2$$

$$RF4 = \frac{1}{N_{iz}} \sum_{b=1}^{n_{\theta}} \left(\sum_{a=0}^{L-1} M_{\theta}(\mathbf{a}, b) \right)^2$$

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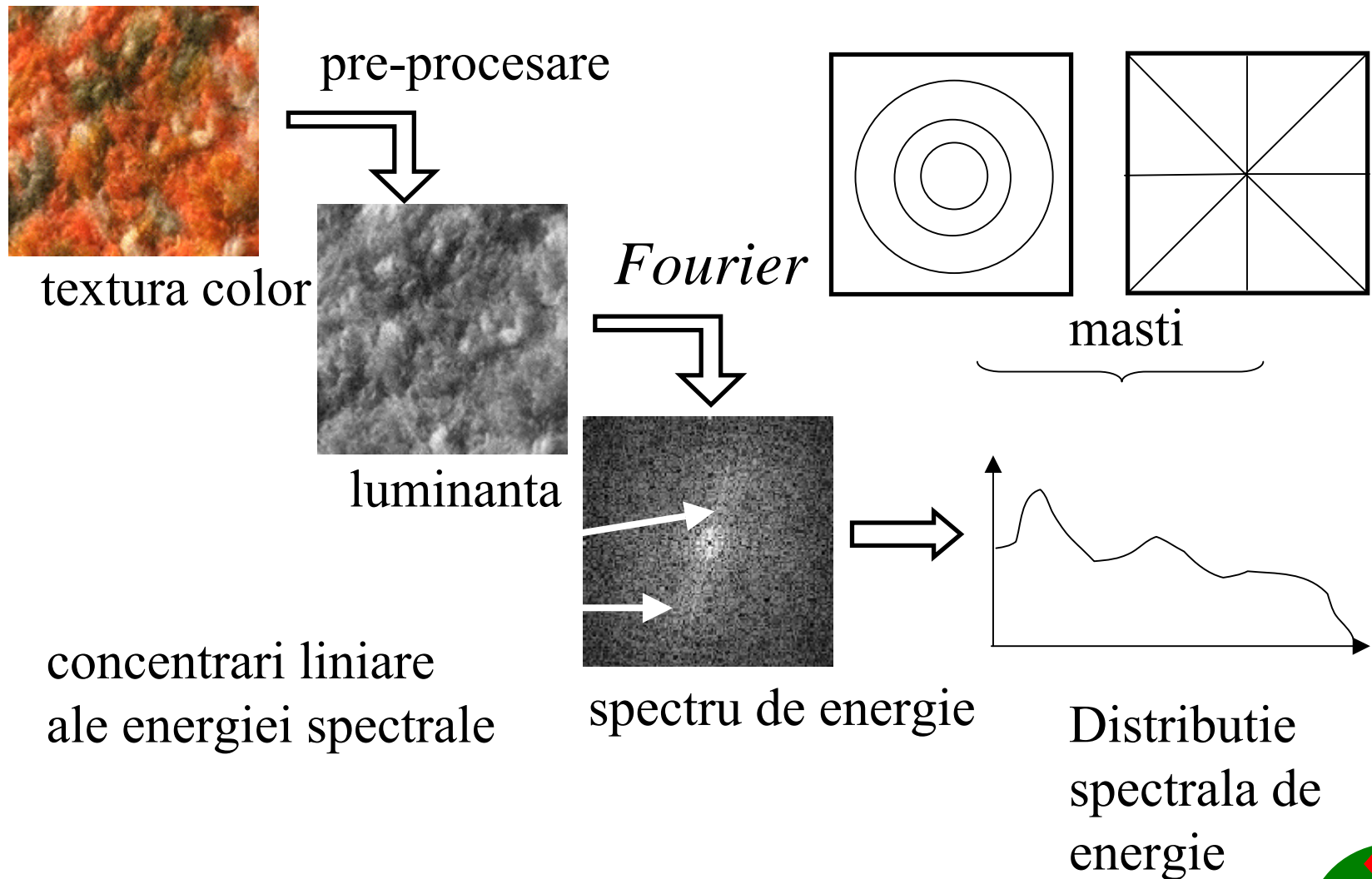
Distributii in domeniul spectral (Fourier)

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Descrierea spectrala a texturilor

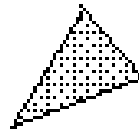
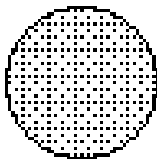
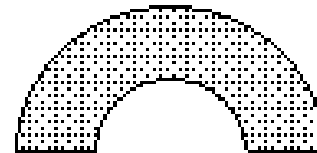
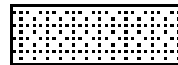
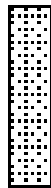
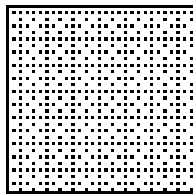


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Ce proprietati ale transformatei Fourier se folosesc ?

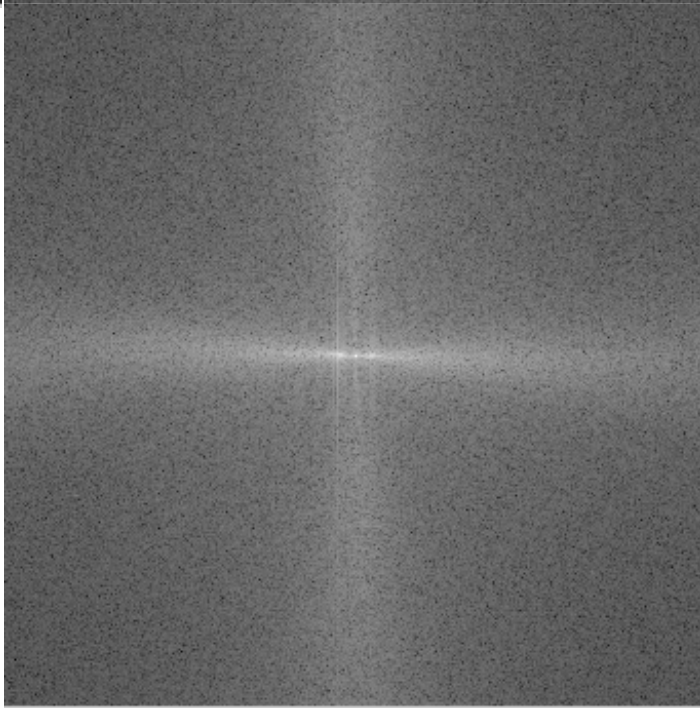
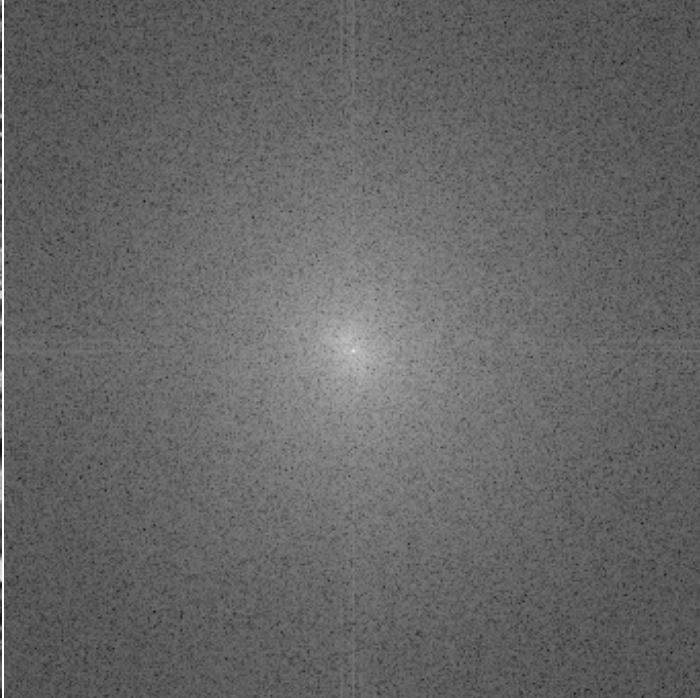
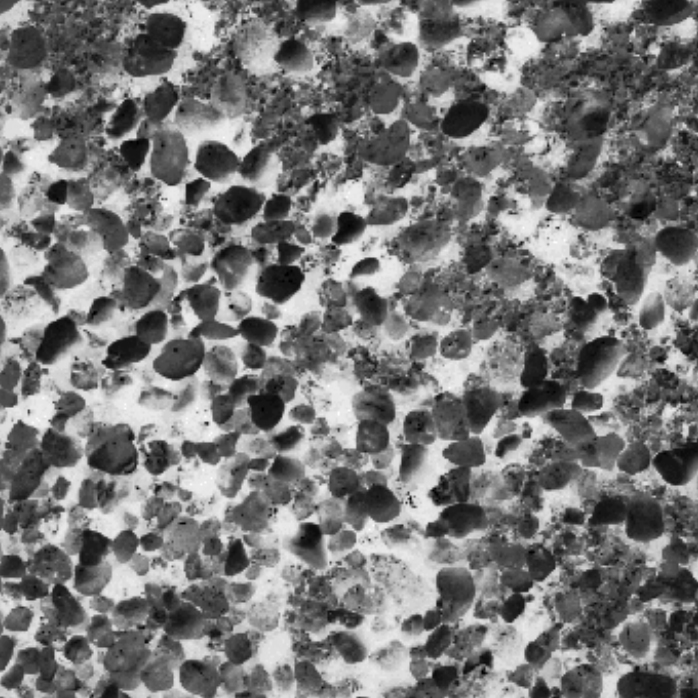
Cum se aleg mastile de decupare a spectrului ?

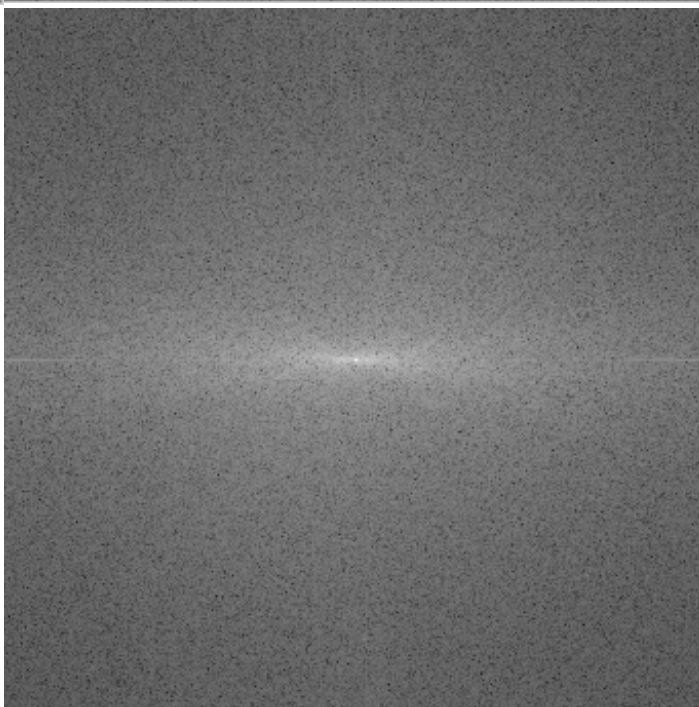
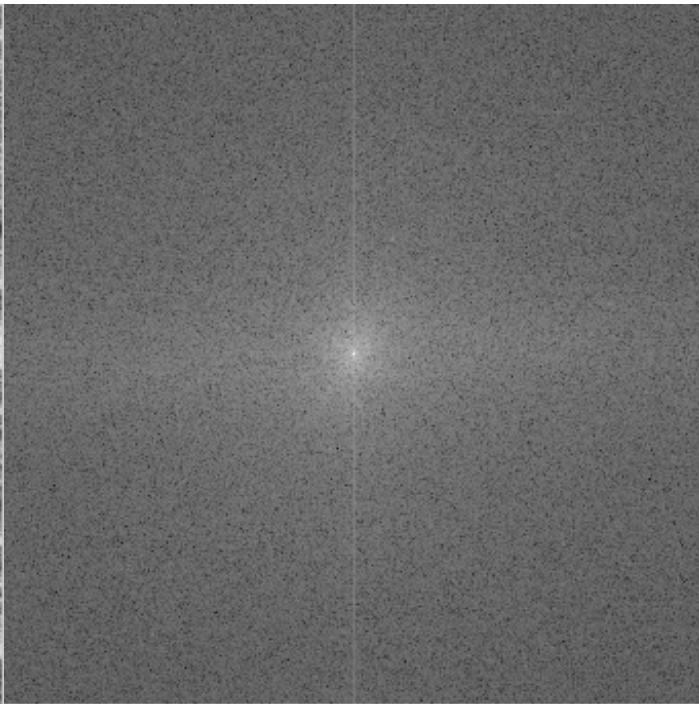


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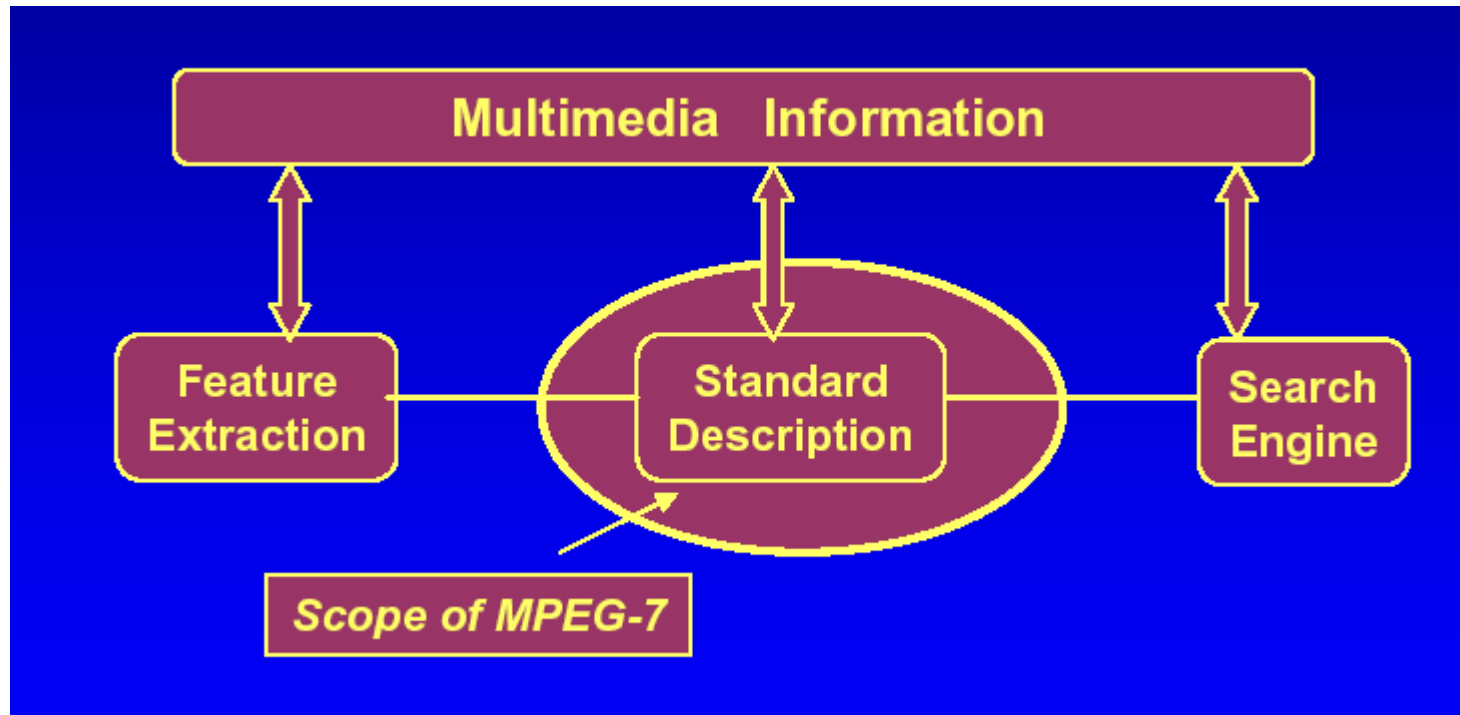




Descriptori MPEG - 7

MPEG - *Motion Picture Experts Group*

✓ Multimedia Content Descriptor Interface



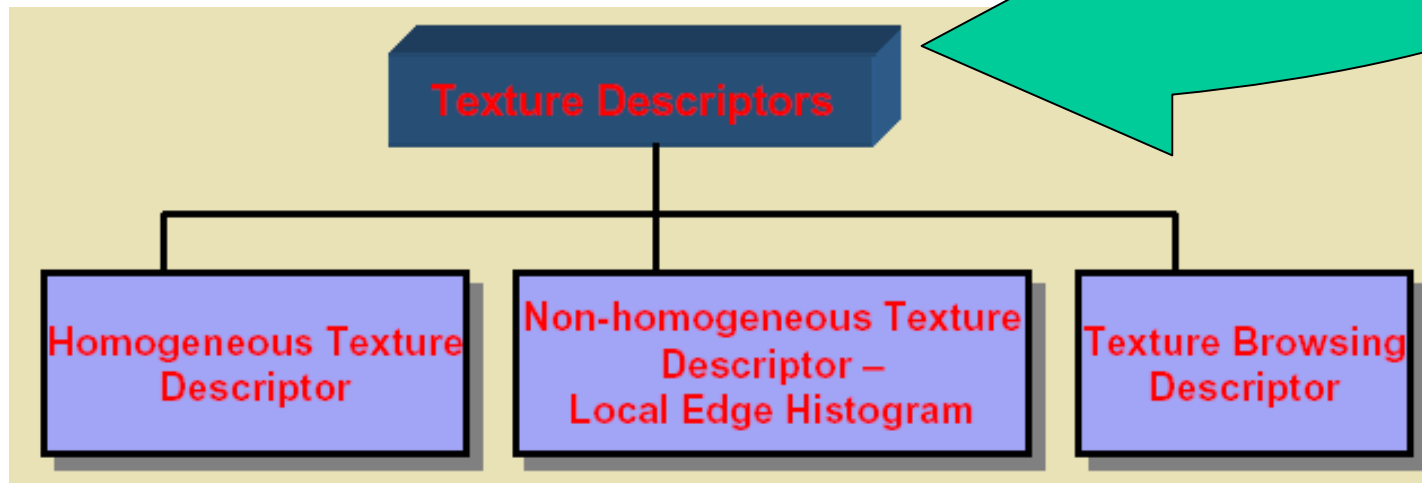
descriptors (D)

description schemes (DS)

description definition language (DDL) se fol. XML

Visual Descriptors

- Color Descriptors
- Texture Descriptors
- Shape Descriptors
- Motion Descriptors for Video



MPEG-7: descriptori de texturi omogene

Filtre Gabor

- sinusoida ponderata cu gaussiană
- modelează canale individuale
- fiecare canal răspunde la un anumit fel de textură

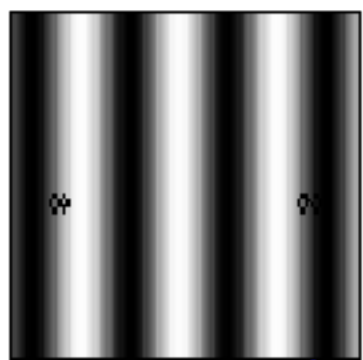
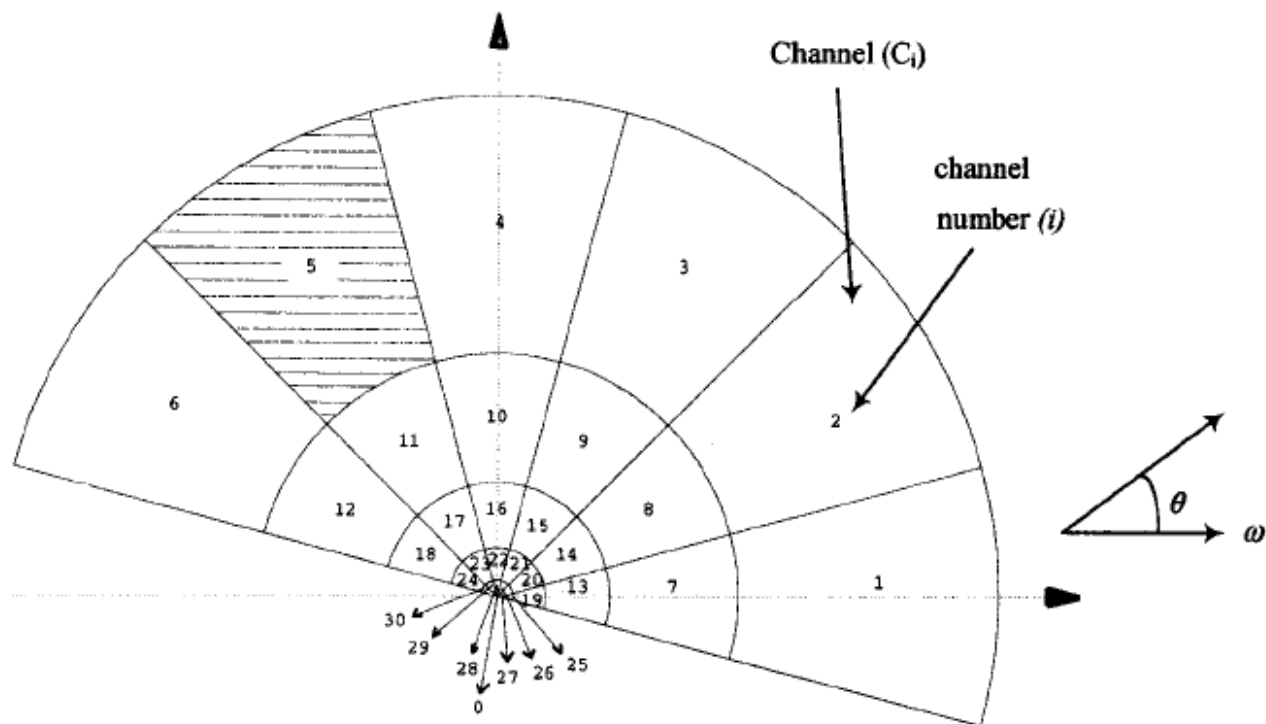
$$p_i = \sum_{\omega=0^+}^1 \sum_{\theta=0^+}^{360^\circ} [G_{P_{s,r}}(\omega, \theta) \cdot P(\omega, \theta)]^2$$

$P(\omega, \theta)$ is the Fourier transform of an image represented in the polar frequency domain

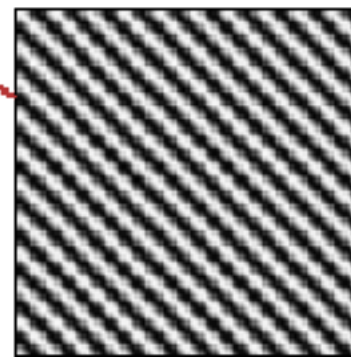
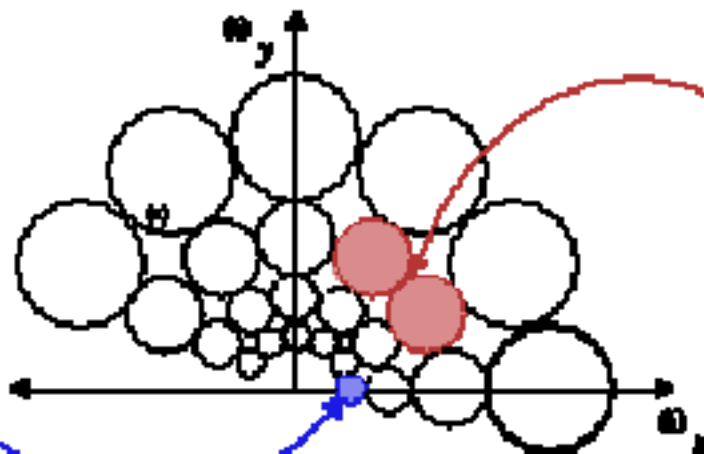
$$G_{P_{s,r}}(\omega, \theta) = \exp\left[\frac{-(\omega - \omega_s)^2}{2\sigma_{\rho_s}^2}\right] \cdot \exp\left[\frac{-(\theta - \theta_r)^2}{2\sigma_{\theta_r}^2}\right]$$

$$e_i = \log_{10}[1 + p_i]$$





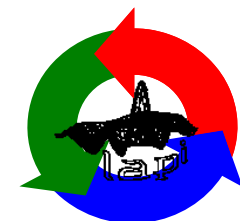
$\theta = 0^\circ$
 $\omega = 30 \text{ Hz}$

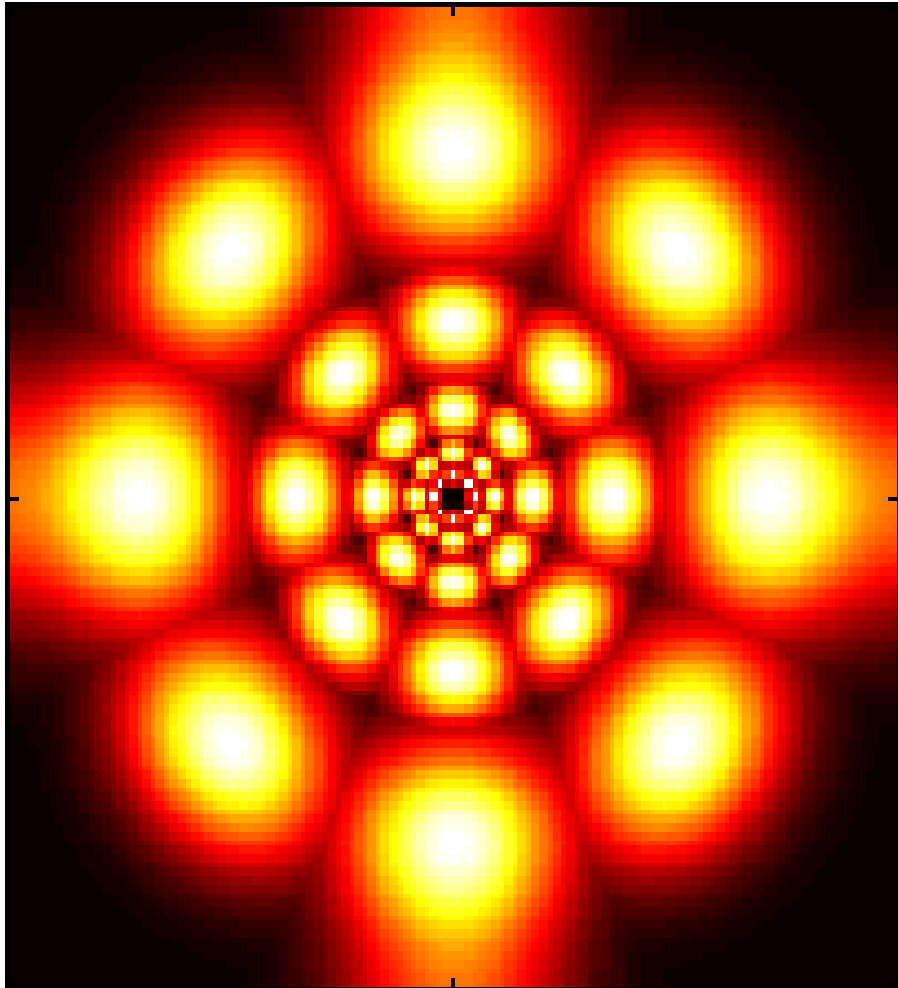


$\theta = 45^\circ$
 $\omega = 120 \text{ Hz}$

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Functia de transfer in frecventa
e unui banc de filtre Gabor cu
5 scale si 8 orientari

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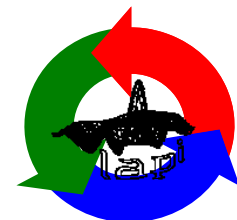


MPEG-7: descriptori de texturi neomogene

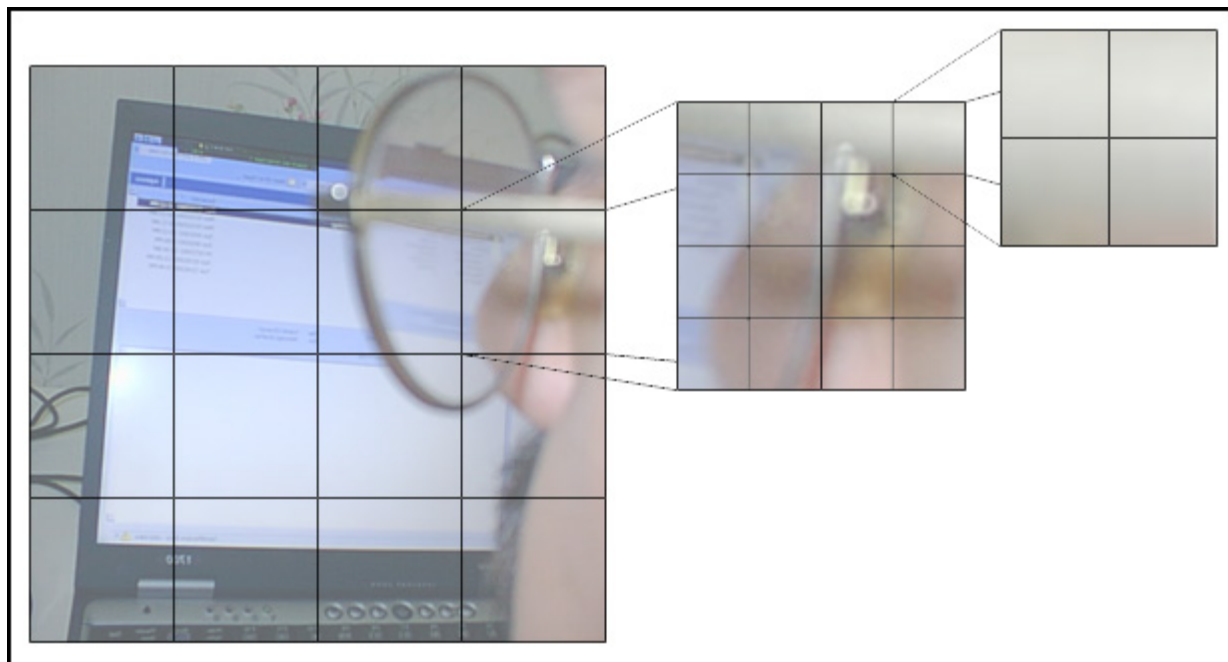
- Distribuția spațială a 5 tipuri de muchii
 - vertical, orizontal, 45° , 135° , non-directional
- imaginea împartită în 16 (4x4) blocuri
- pt fiecare bloc se generează o histogramă cu 5 bini
- invariantă la scală

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MPEG-7: descriptori de texturi neomogene



descompunere
multirezolucie
a imaginii

1	-1
1	-1

1	1
-1	-1

$\sqrt{2}$	0
0	$-\sqrt{2}$

0	$\sqrt{2}$
$-\sqrt{2}$	0

2	-2
-2	2

masti de gradient orientat

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