

Περιγραφή υφής

Περιγραφείς στατιστικής



(a)



(b)

Φασματικοί περιγραφείς



(c)



(d)

Ανάλυση χώρου / κλίμακας



(e)



(f)

Απλοί περιγραφείς υφής

Ιστόγραμμα

$$p(i), \quad i=0, \dots, L-1$$

Μέση τιμή

Ροπές

Διακύμανση

Βαθμός διακύμανσης
(κανονικοποίηση)

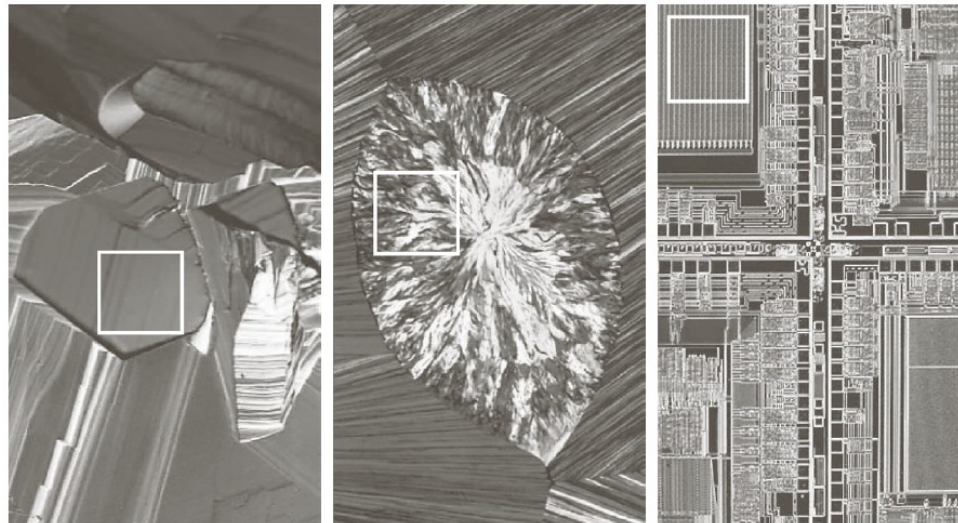
$$R = 1 - \frac{1}{1 + \sigma^2}$$

Ομοιομορφία

$$U = \sum_{i=0}^{L-1} p^2(i)$$

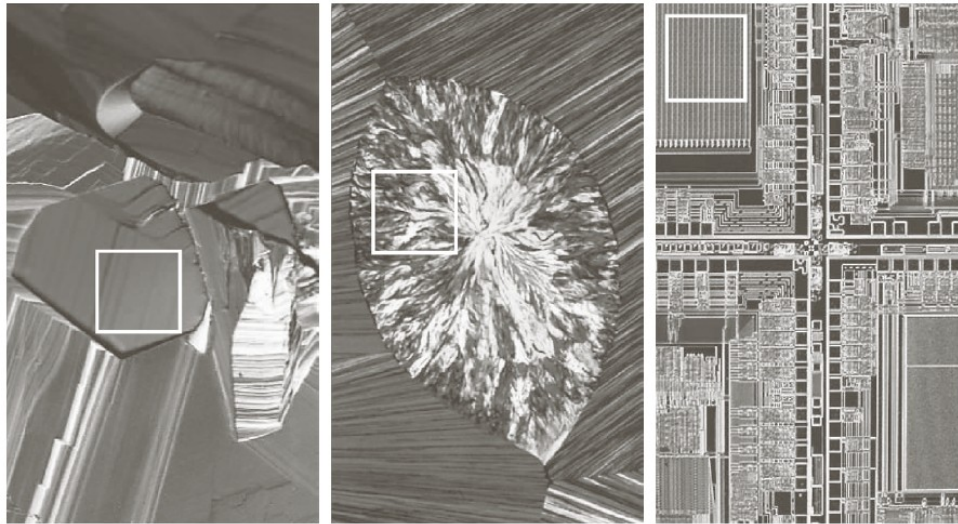
Εντροπία

$$H = - \sum_{i=0}^{L-1} p(i) \log_2 p(i)$$



Gonzalez & Woods, Digital Image Processing

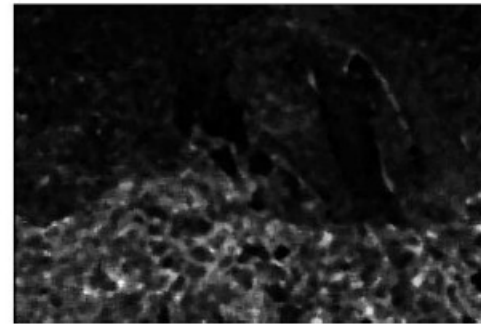
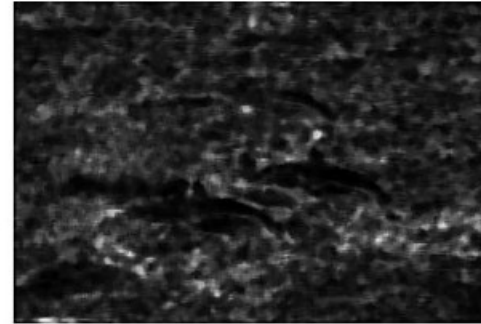
Απλοί περιγραφείς υφής



Texture	Mean	Standard deviation	R (normalized)	Third moment	Uniformity	Entropy
Smooth	82.64	11.79	0.002	-0.105	0.026	5.434
Coarse	143.56	74.63	0.079	-0.151	0.005	7.783
Regular	99.72	33.73	0.017	0.750	0.013	6.674

Gonzalez & Woods, Digital Image Processing

Απλοί περιγραφείς υφής



Τοπική απόκλιση με μεσαία τιμή

Αναλλοίωτες ροπές

$$m_{pq} = \sum_{m=1}^M \sum_{n=1}^N x^p y^q f(x, y)$$

$$\bar{x} = \frac{m_{10}}{m_{00}}, \quad \bar{y} = \frac{m_{01}}{m_{00}}$$

$$\mu_{pq} = \sum_{m=1}^M \sum_{n=1}^N (x - \bar{x})^p (y - \bar{y})^q f(x, y)$$

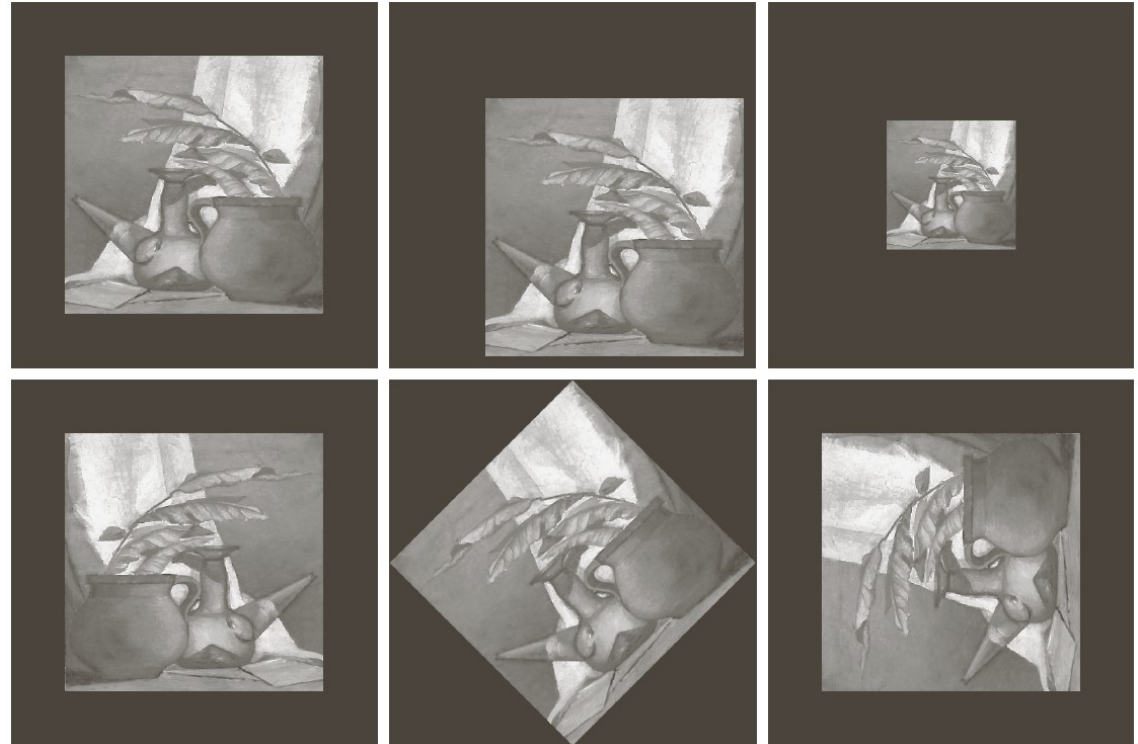
$$\eta_{pq} = \frac{\mu_{pq}}{(\mu_{00})^{\gamma}}, \quad \gamma = \frac{p+q}{2} + 1$$

$$\varphi_1 = \eta_{20} + \eta_{02}$$

$$\varphi_2 = (\eta_{20} - \eta_{02})^2 + 4\eta_{11}^2$$

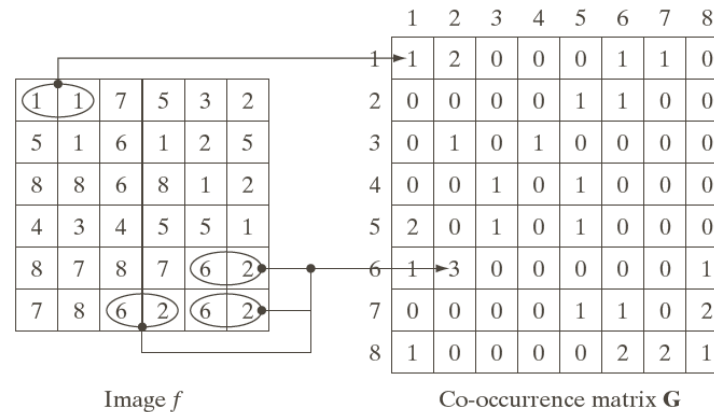
$$\varphi_3 = (\eta_{30} - 3\eta_{12})^2 + (\eta_{03} - 3\eta_{21})^2$$

$$\varphi_4 = (\eta_{30} + \eta_{12})^2 + (\eta_{03} + \eta_{21})^2$$



Moment Invariant	Original Image	Translated	Half Size	Mirrored	Rotated 45°	Rotated 90°
ϕ_1	2.8662	2.8662	2.8664	2.8662	2.8661	2.8662
ϕ_2	7.1265	7.1265	7.1257	7.1265	7.1266	7.1265
ϕ_3	10.4109	10.4109	10.4047	10.4109	10.4115	10.4109
ϕ_4	10.3742	10.3742	10.3719	10.3742	10.3742	10.3742
ϕ_5	21.3674	21.3674	21.3924	21.3674	21.3663	21.3674
ϕ_6	13.9417	13.9417	13.9383	13.9417	13.9417	13.9417
ϕ_7	-20.7809	-20.7809	-20.7724	20.7809	-20.7813	-20.7809

Πίνακας συνύπαρξης



Gonzalez & Woods, Digital Image Processing

Μέγιστη πιθανότητα

Συσχέτιση

$$\frac{1}{\sigma^2} \sum_{i=1}^K \sum_{j=1}^K (i-\mu)(j-\mu) p_{ij}$$

Αντίθεση

$$\sum_{i=1}^K \sum_{j=1}^K (i-j)^2 p_{ij}$$

Ομοιομορφία

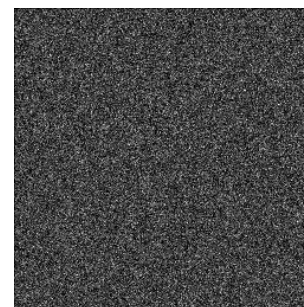
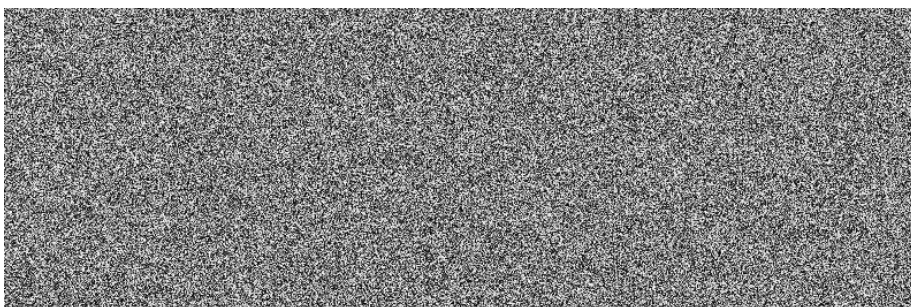
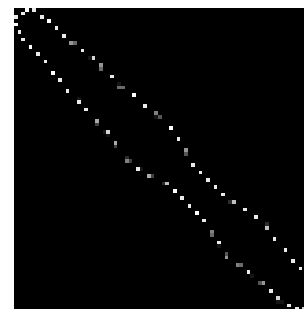
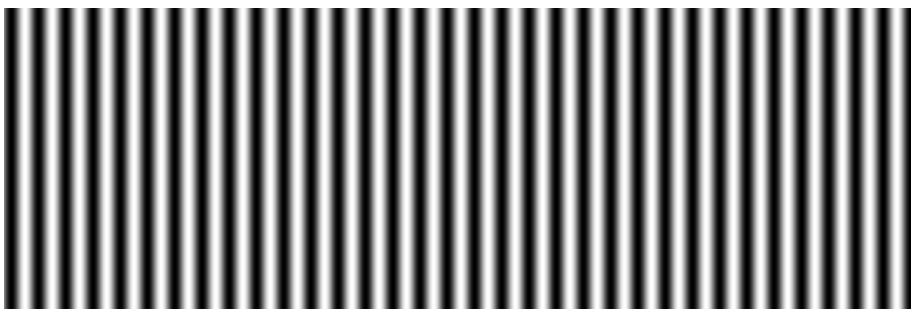
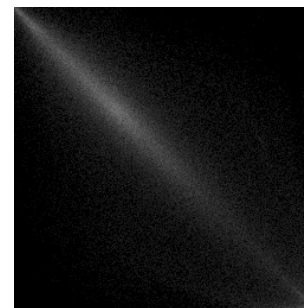
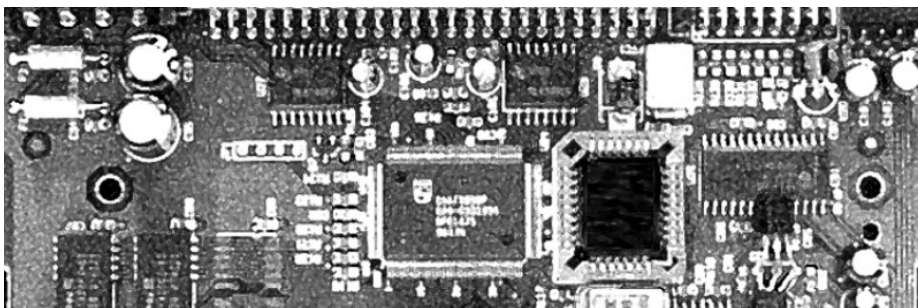
$$\sum_{i=1}^K \sum_{j=1}^K p_{ij}^2$$

Ομογένεια

$$\sum_{i=1}^K \sum_{j=1}^K \frac{p_{ij}}{1+|i-j|}$$

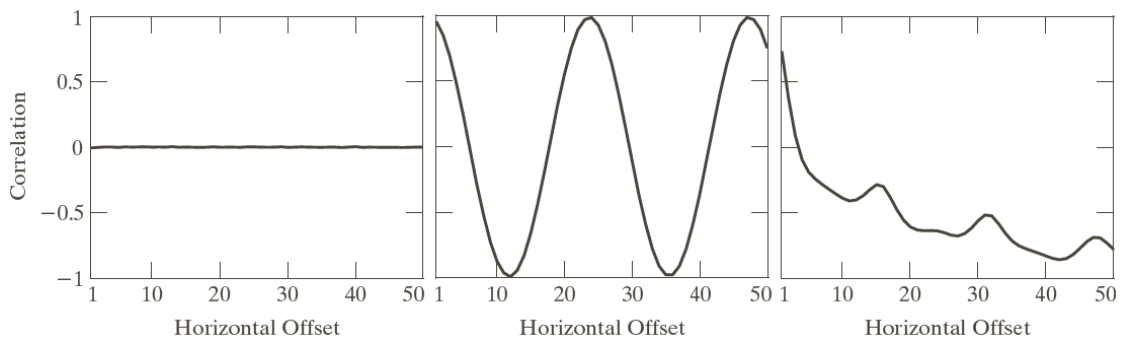
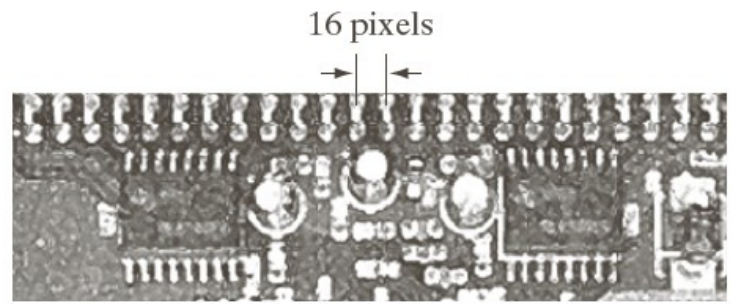
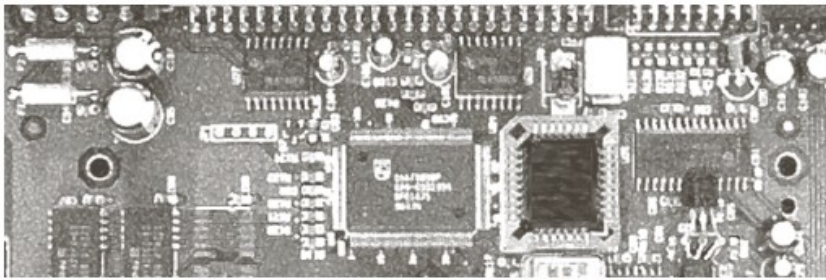
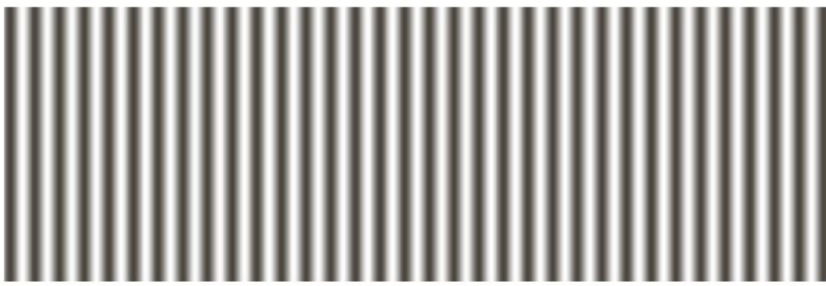
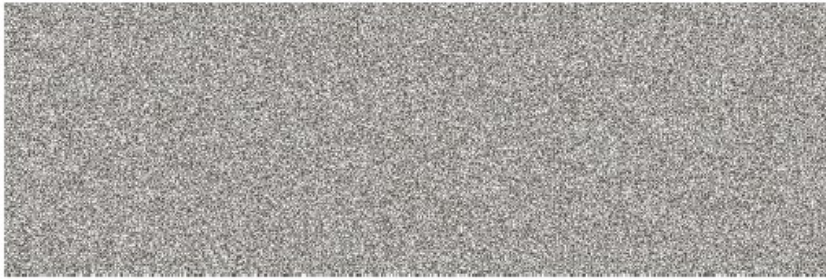
Εντροπία

Πίνακας συνύπαρξης

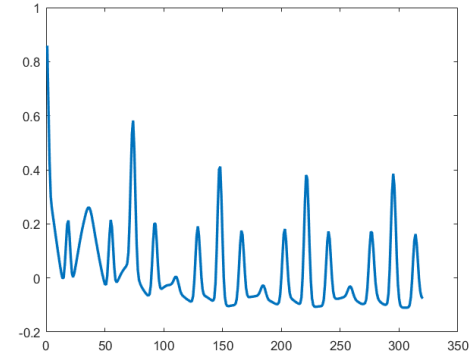
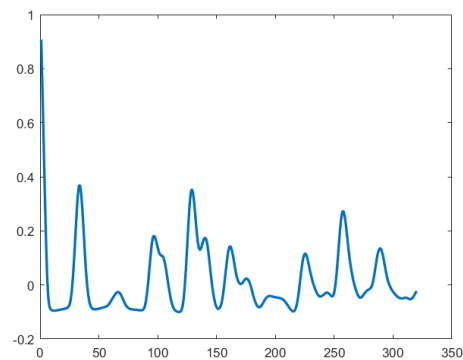
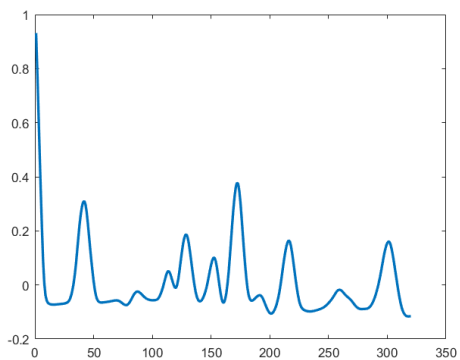
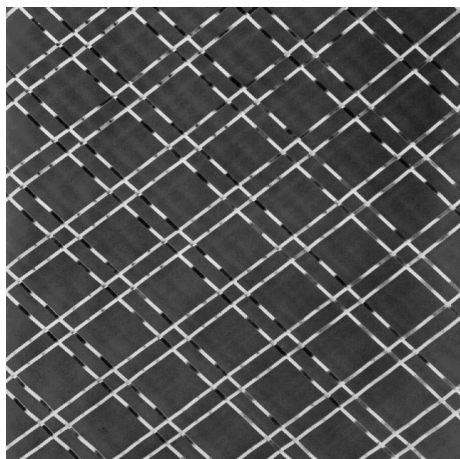
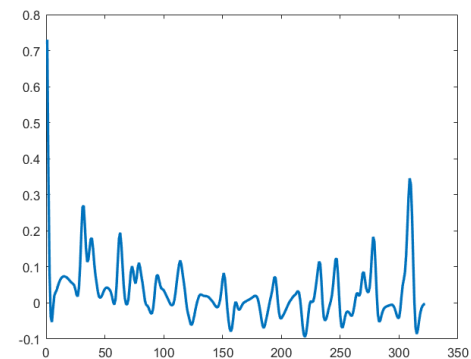
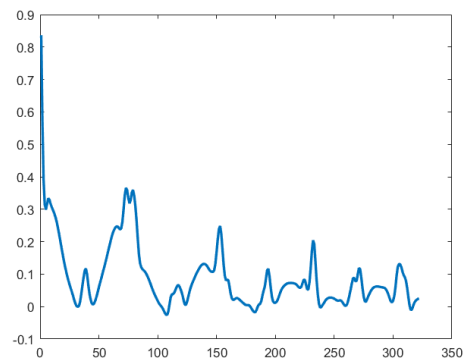
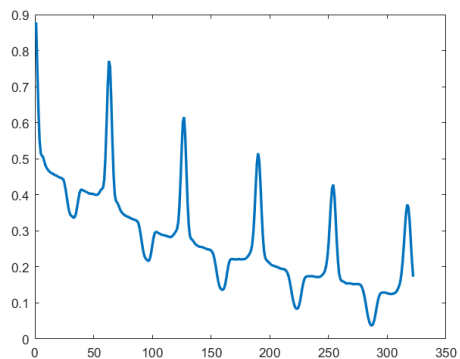
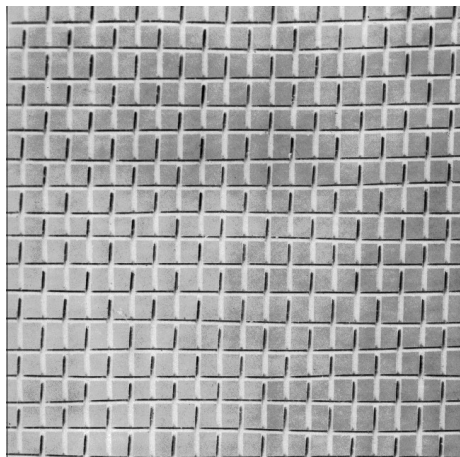


Normalized Co-occurrence Matrix	Descriptor					
	Max Probability	Correlation	Contrast	Uniformity	Homogeneity	Entropy
G_1/n_1	0.00006	-0.0005	10838	0.00002	0.0366	15.75
G_2/n_2	0.01500	0.9650	570	0.01230	0.0824	6.43
G_3/n_3	0.06860	0.8798	1356	0.00480	0.2048	13.58

Πίνακας συνύπαρξης



Συντελεστής συσχέτισης

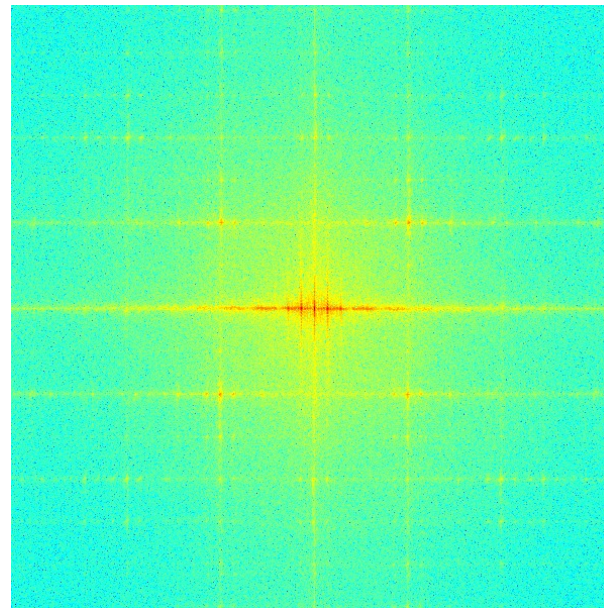
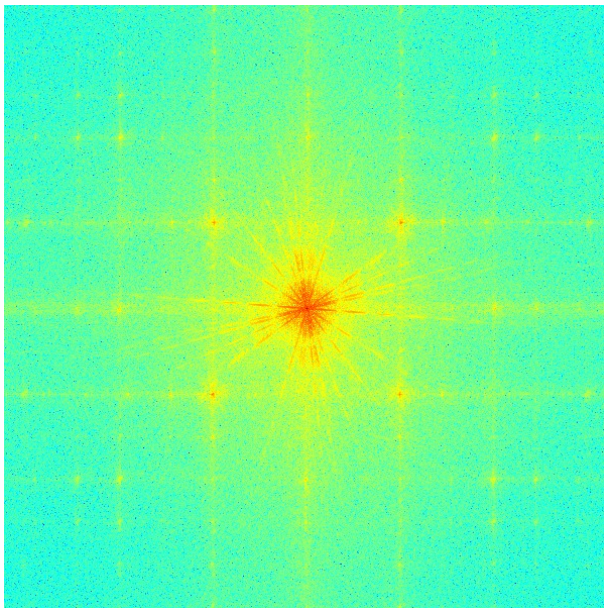
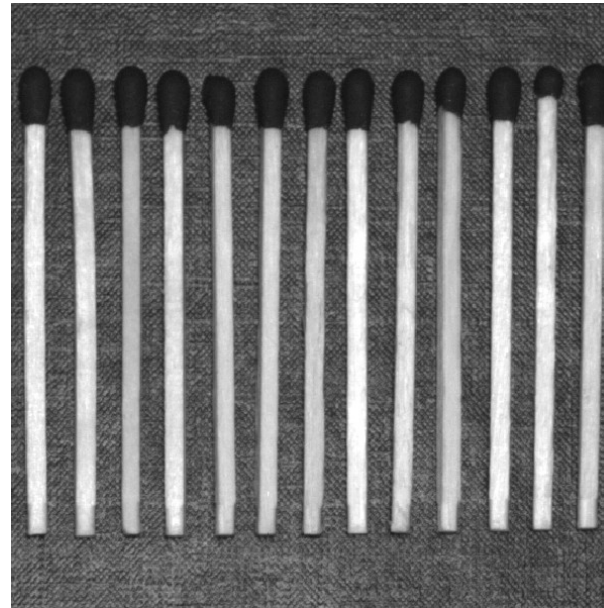
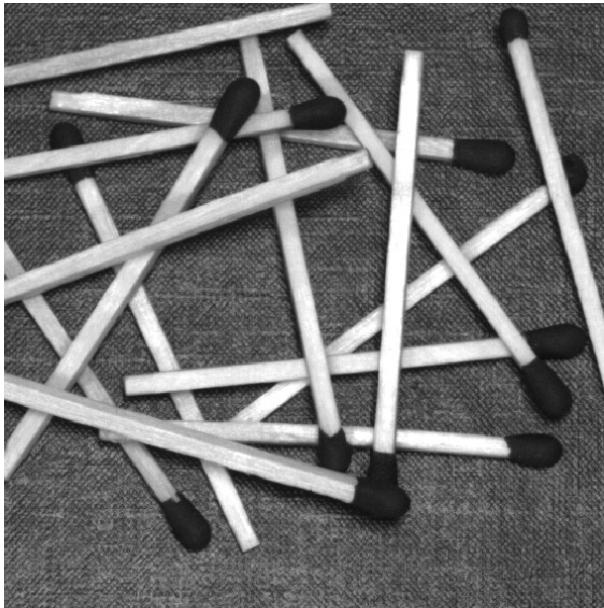


Οριζόντια

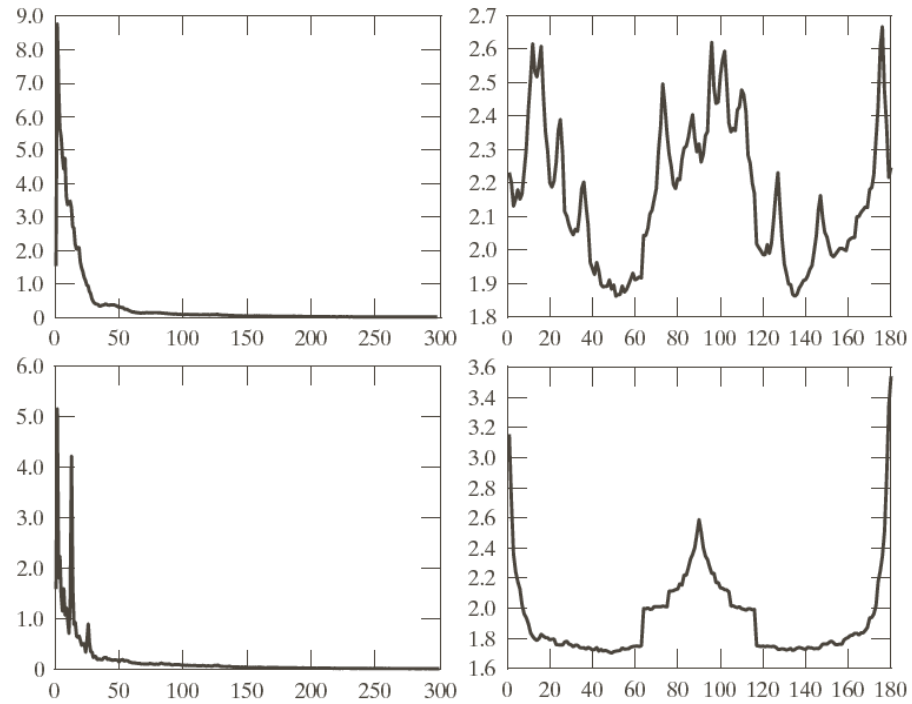
Κατακόρυφα

Διαγώνια

Φασματικές προσεγγίσεις



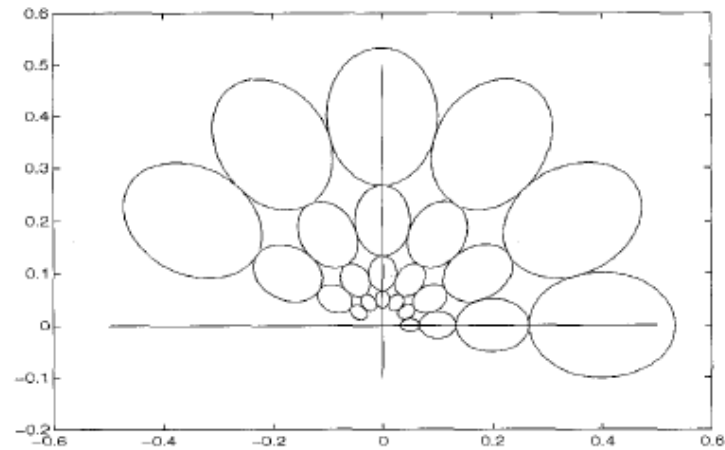
Φασματικές προσεγγίσεις



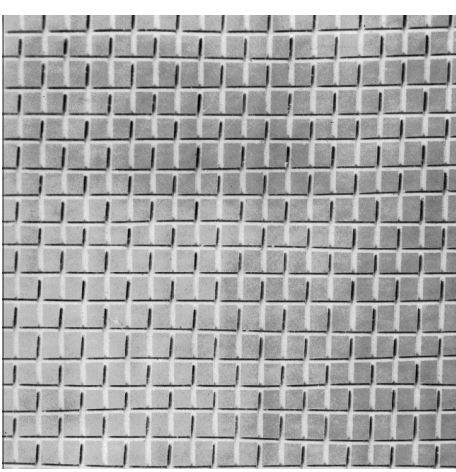
$S(r)$

$S(\theta)$

Ανάλυση Gabor

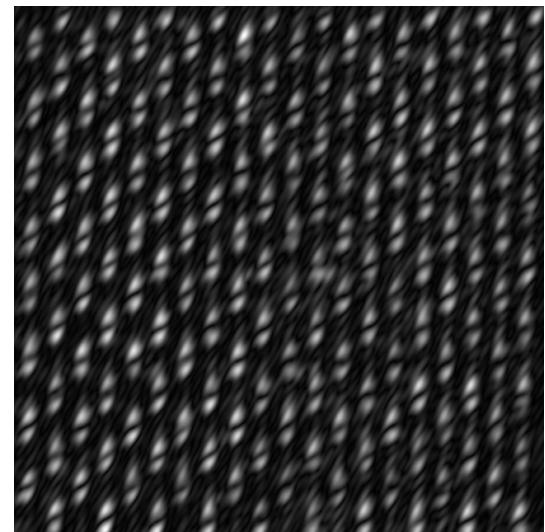
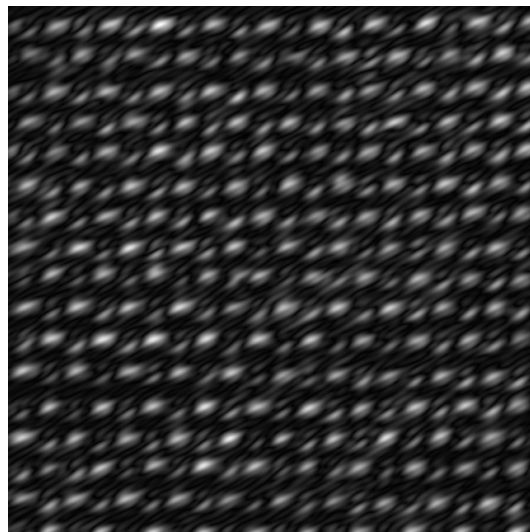
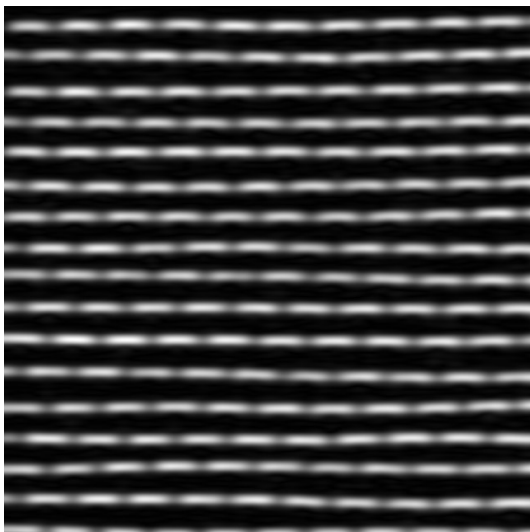
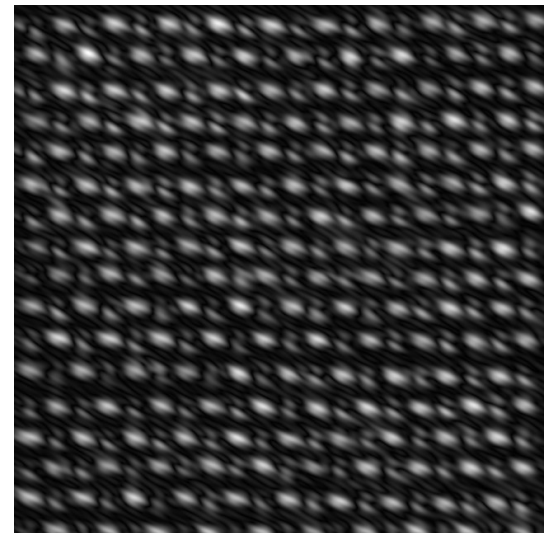
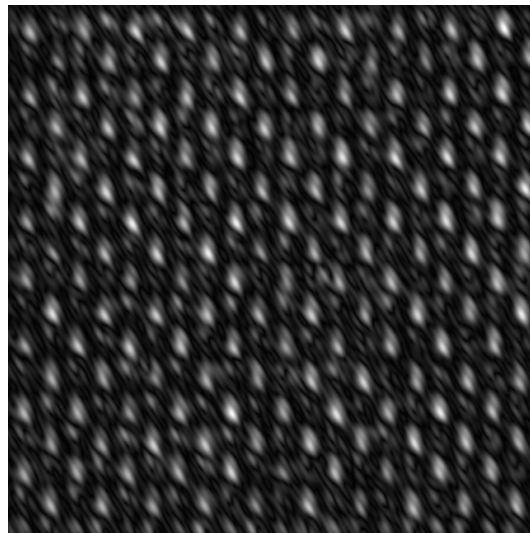
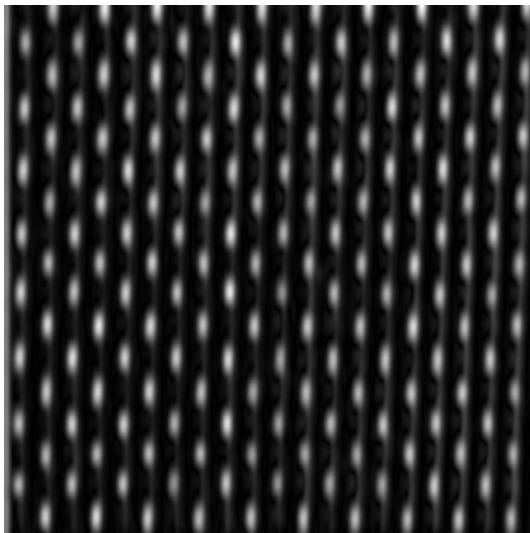


$$G_{P_s, r}(W, q) = \exp\left[\frac{-(W - W_s)^2}{2S_{r_s}^2}\right] \cdot \exp\left[\frac{-(q - q_r)^2}{2S_{q_r}^2}\right]$$



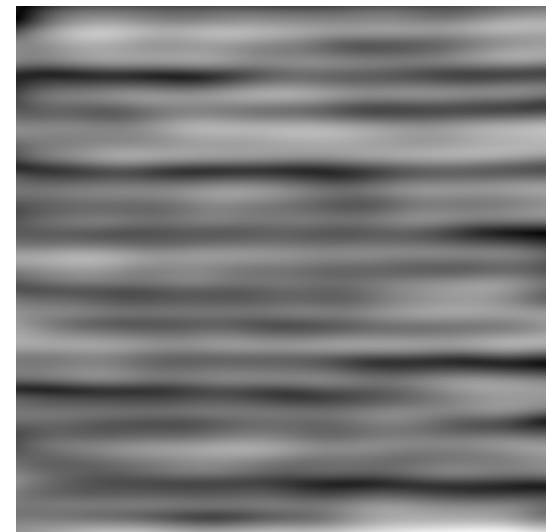
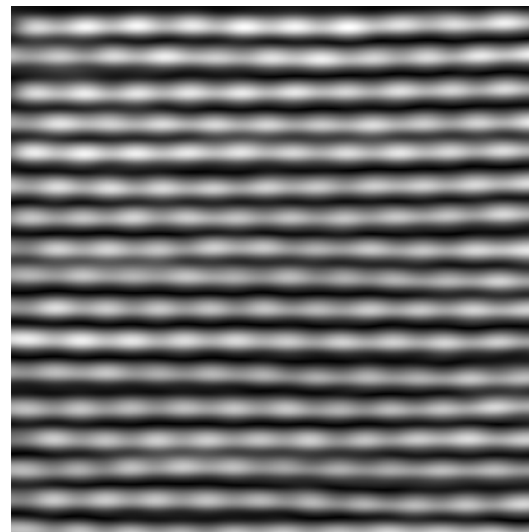
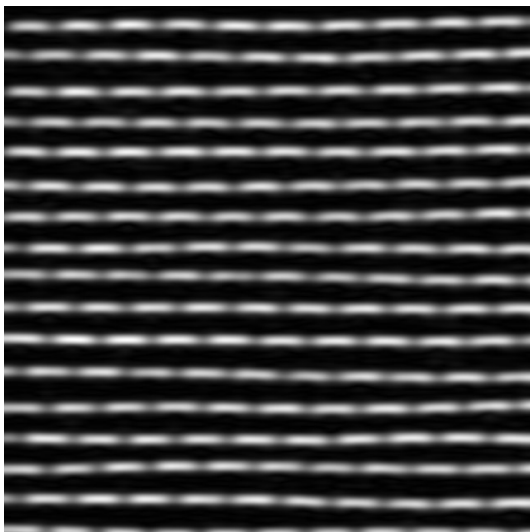
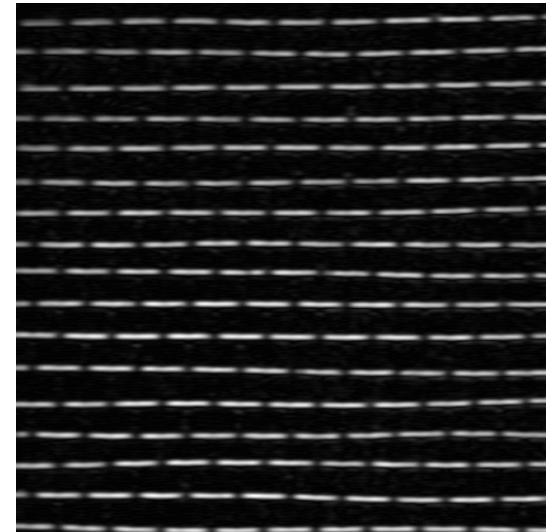
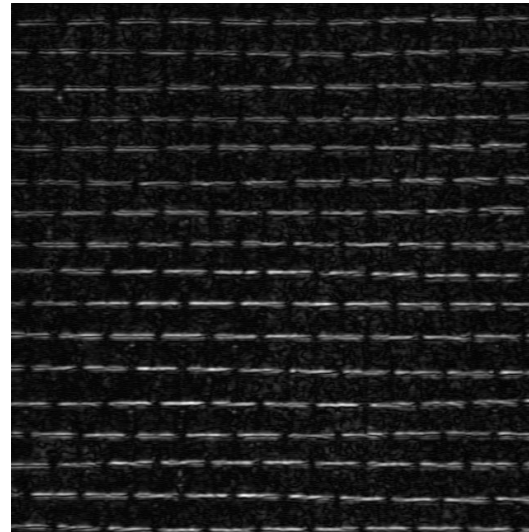
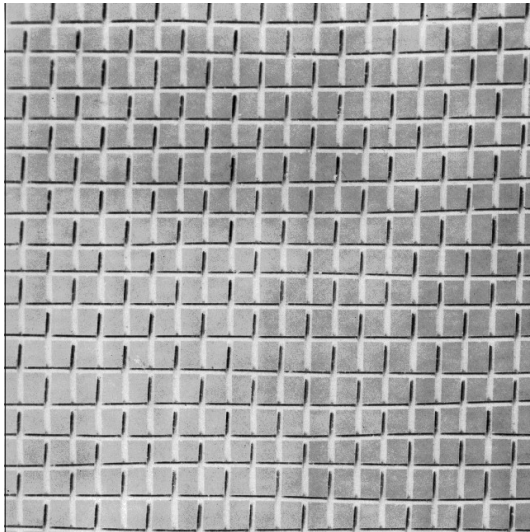
Ανάλυση Gabor

Κατεύθυνση : 0 30 60 90 120 150
Ισχύς : 1216 337 394 1941 356 358



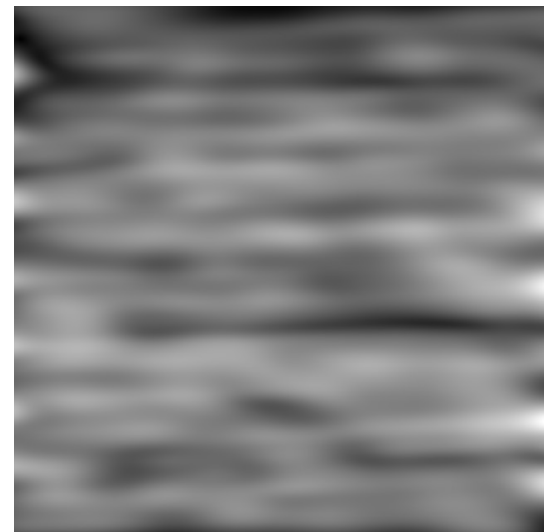
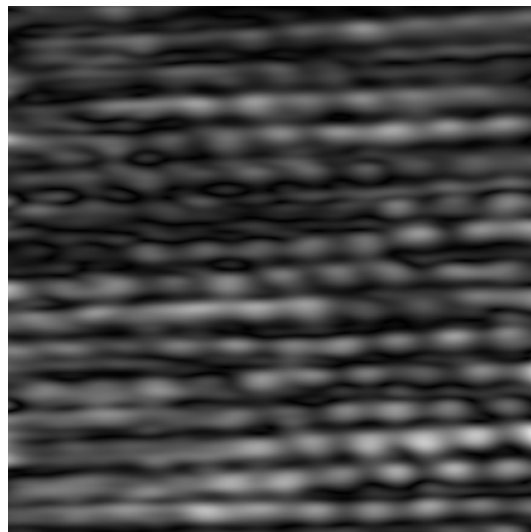
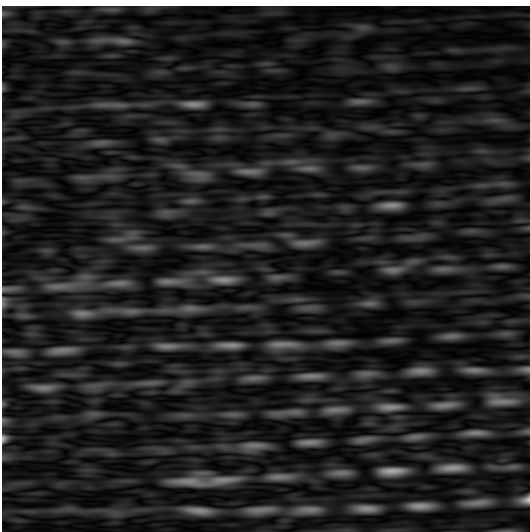
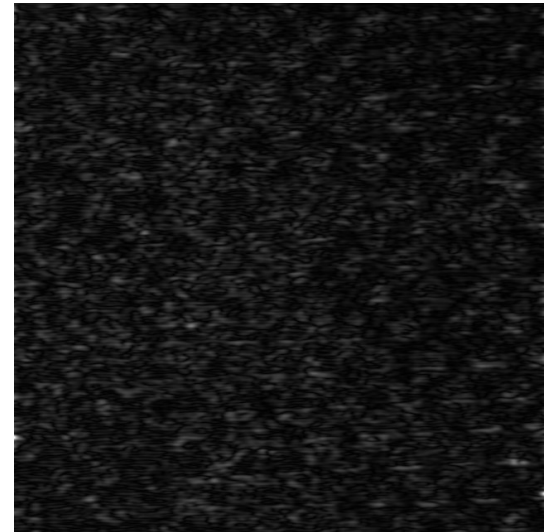
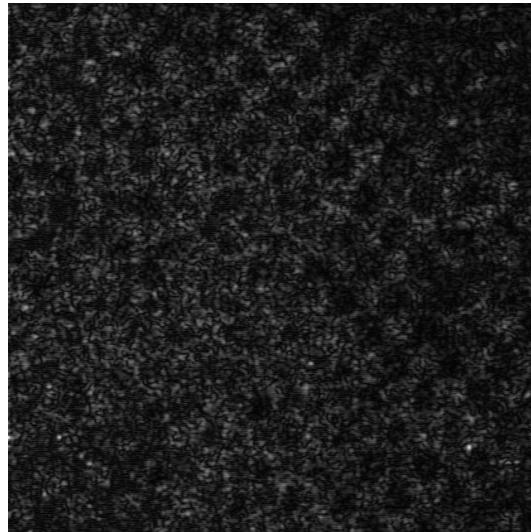
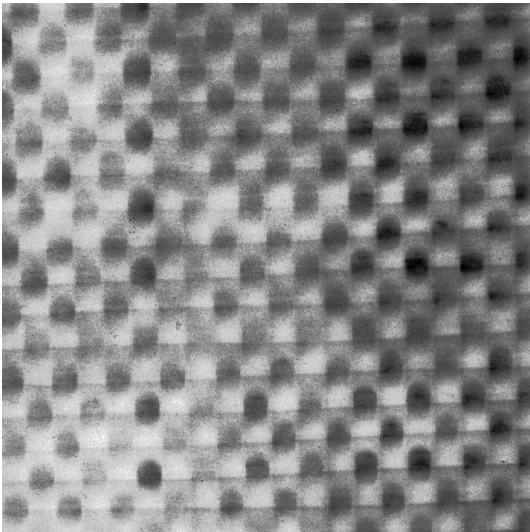
Ανάλυση Gabor

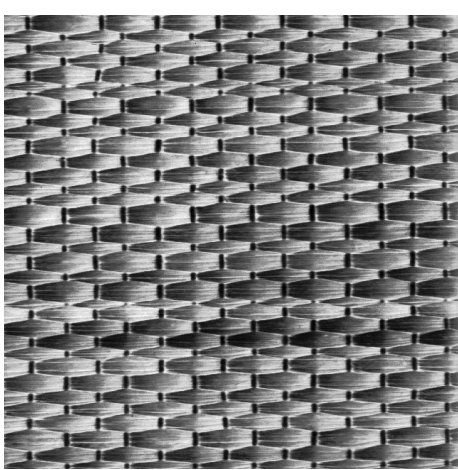
Κλίμακα : 1 2 3 4 5



Ανάλυση Gabor

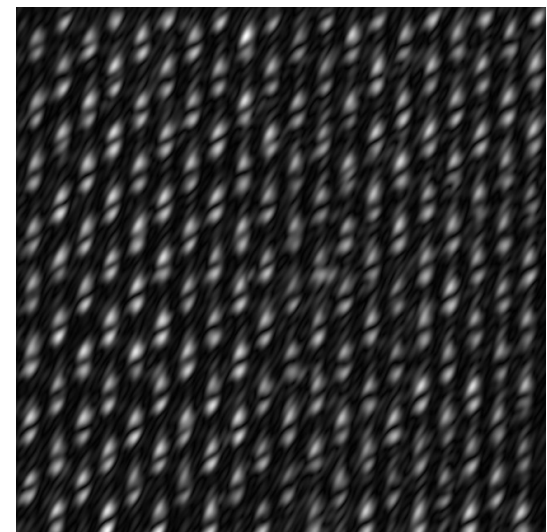
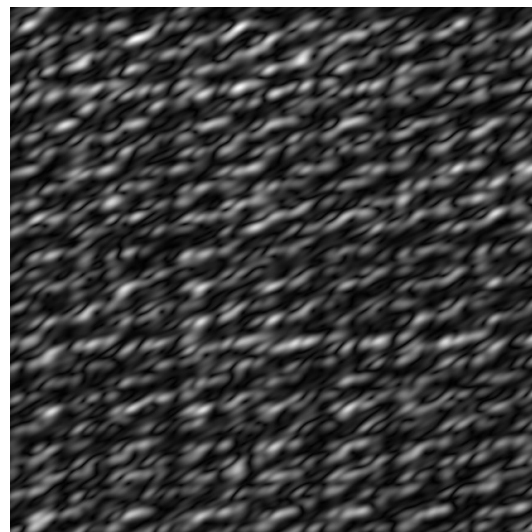
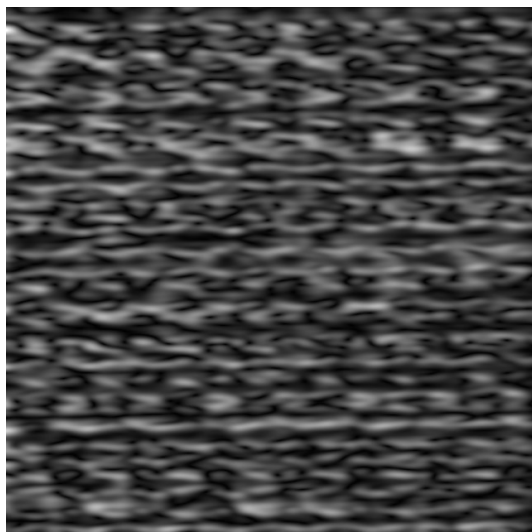
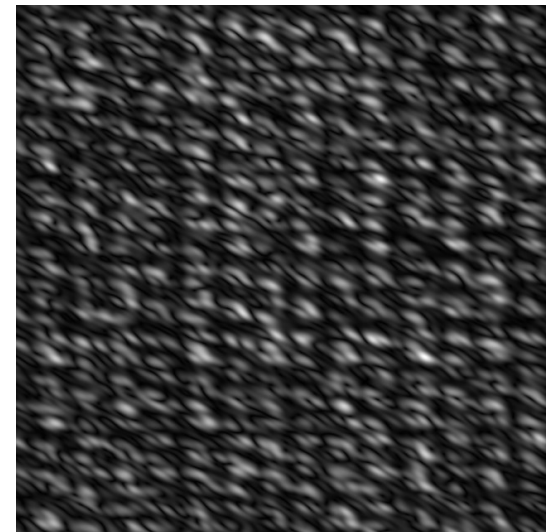
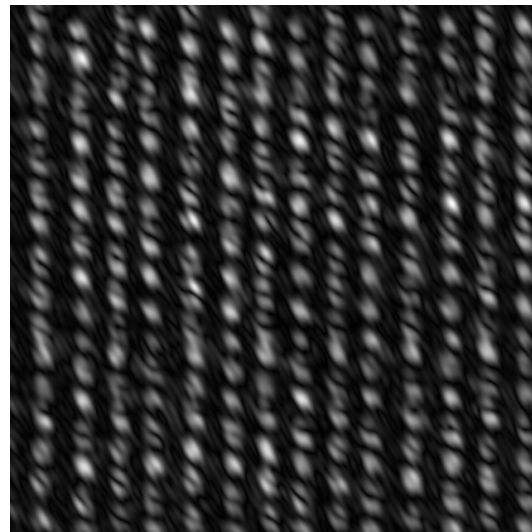
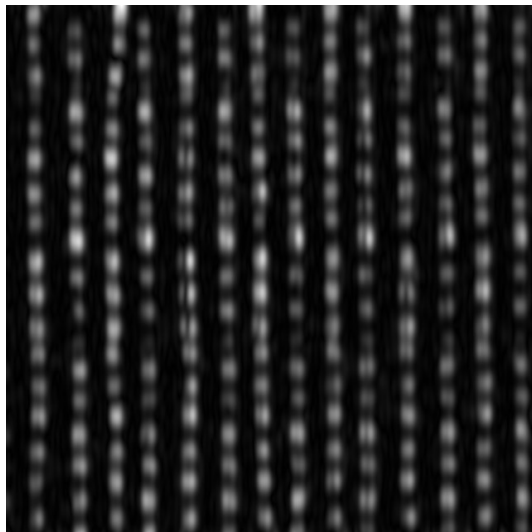
Κλίμακα : 1 2 3 4 5



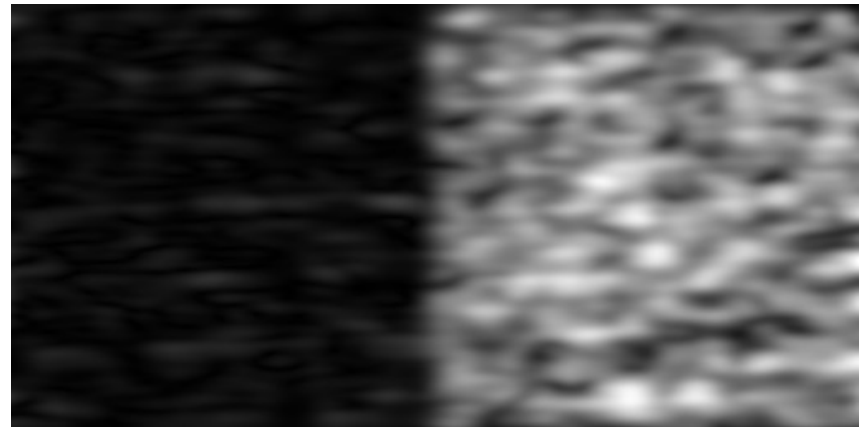
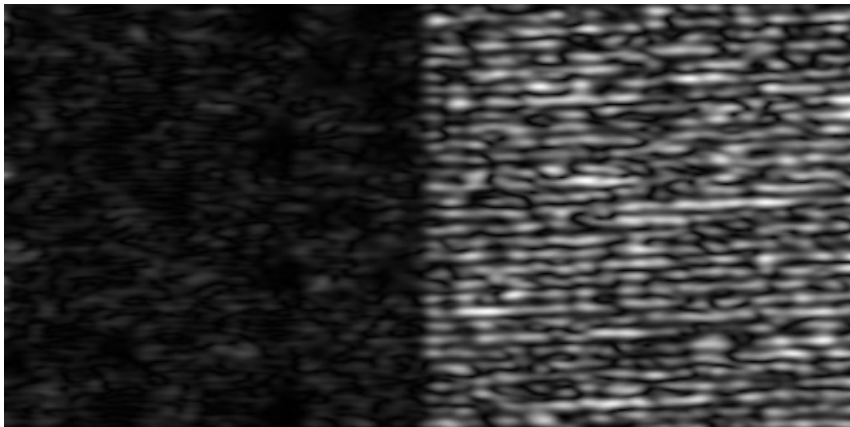
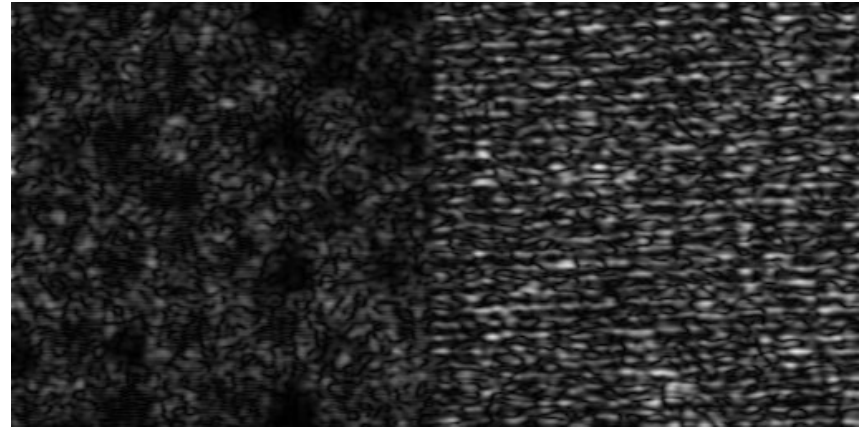
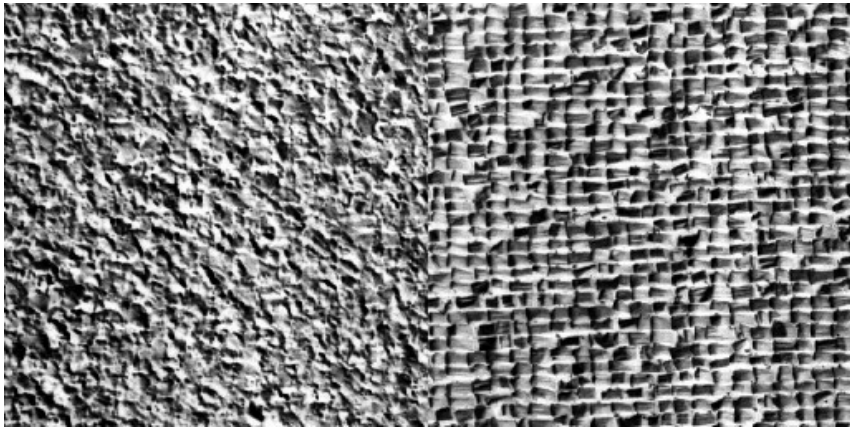


Ανάλυση Gabor

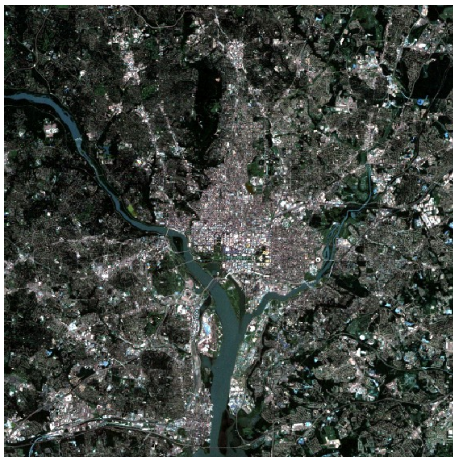
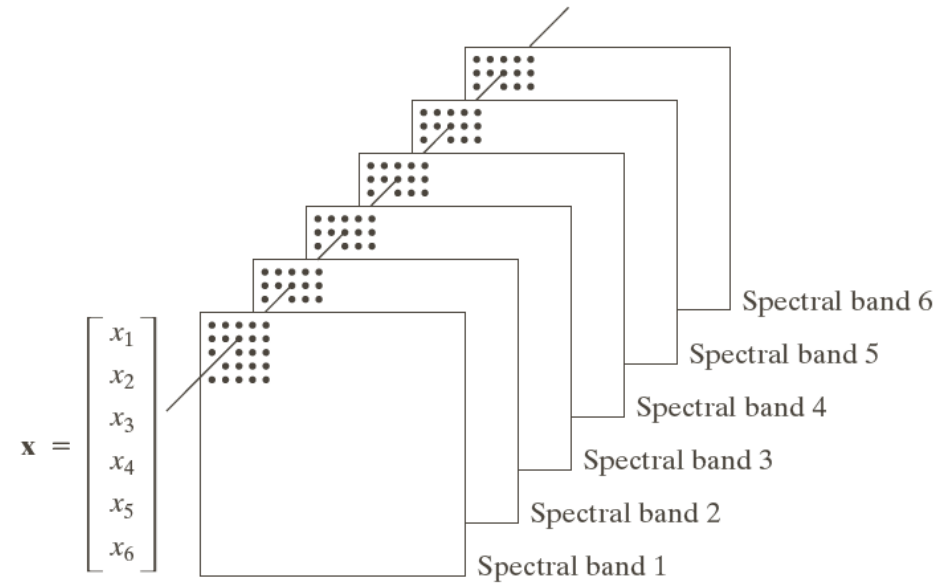
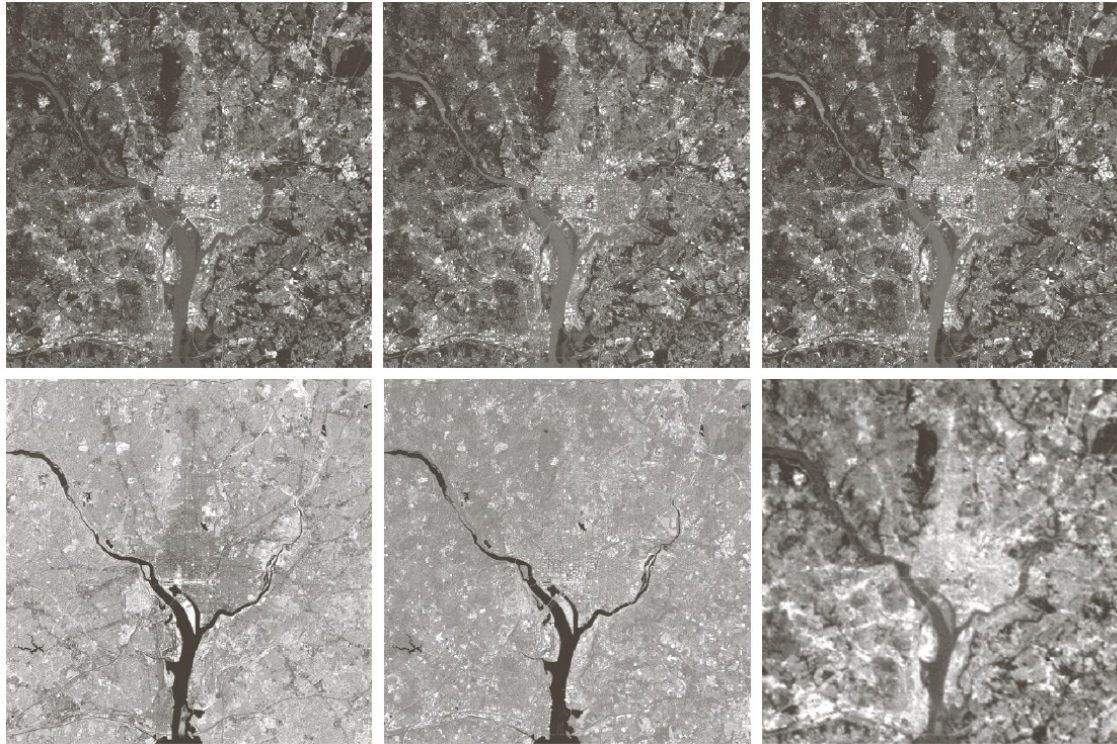
Κατεύθυνση : 0 30 60 90 120 150
Ισχύς : 705 410 441 1924 571 428



Ανάλυση Gabor

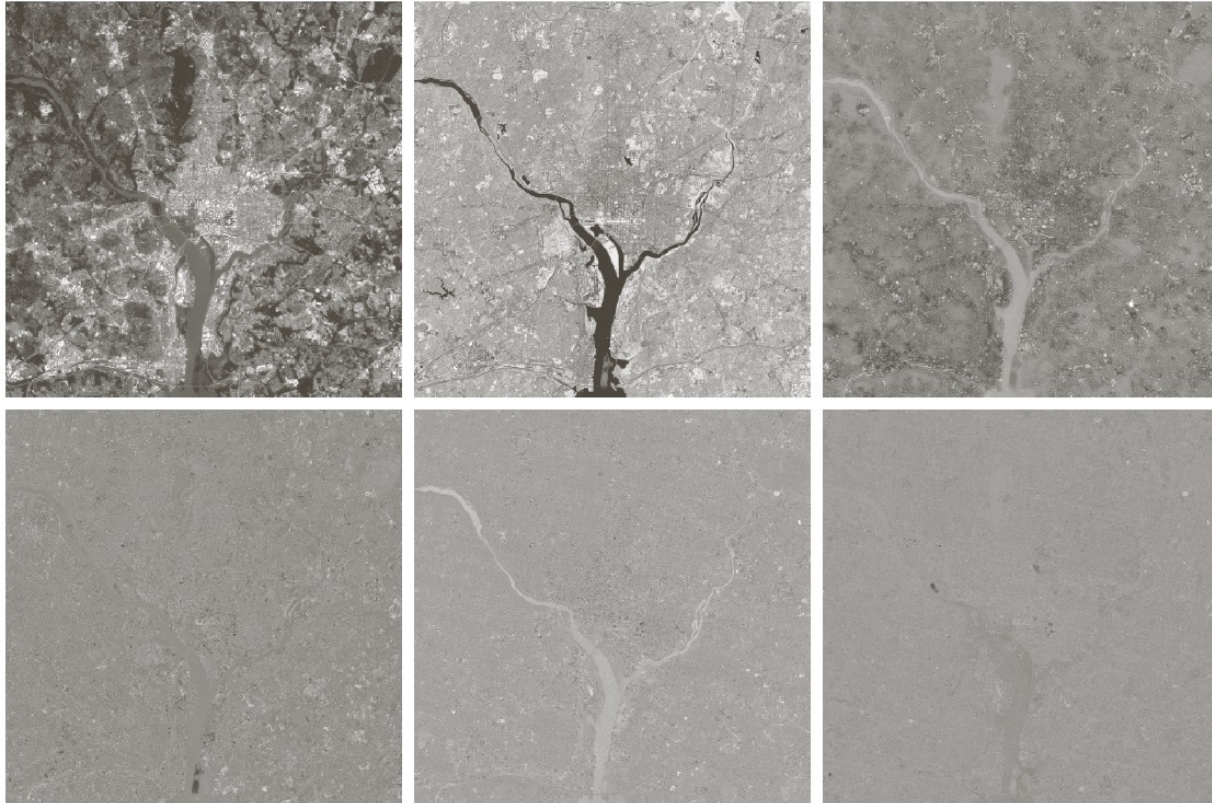


Κύριες συνιστώσες



λ_1	λ_2	λ_3	λ_4	λ_5	λ_6
10344	2966	1401	203	94	31

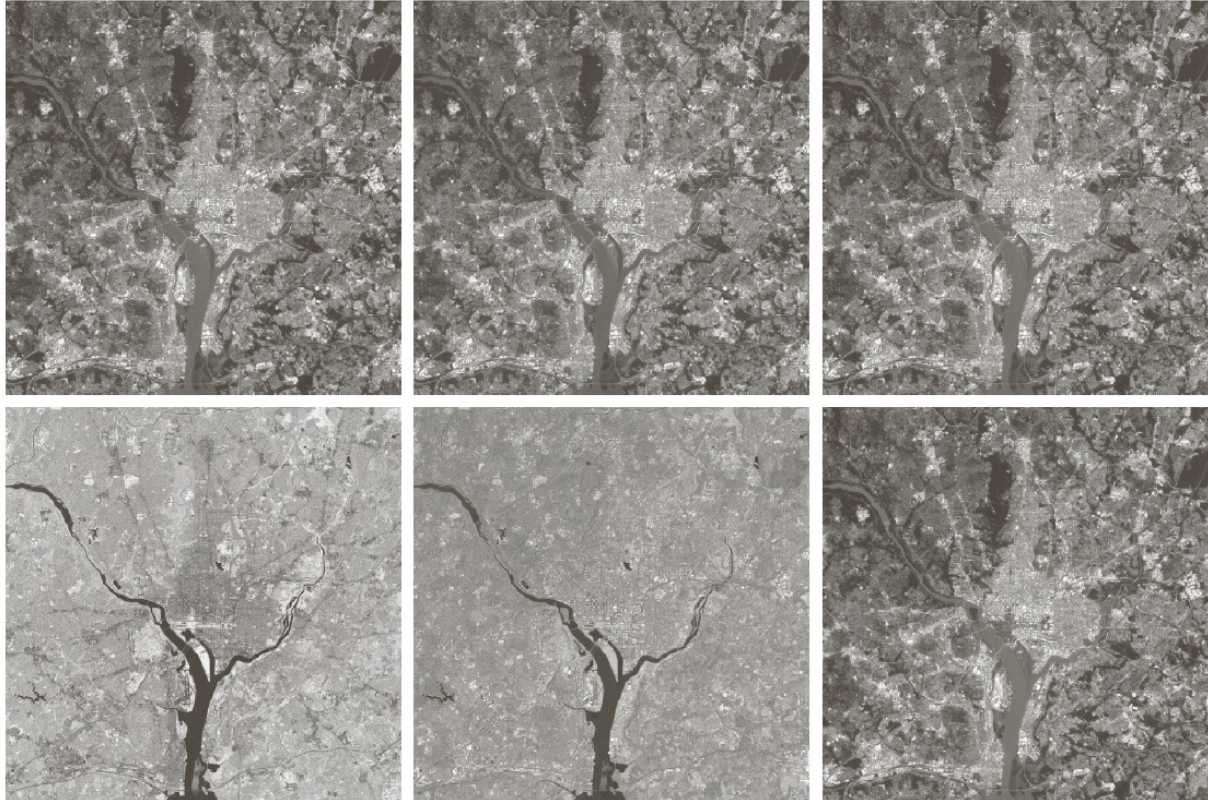
Κύριες συνιστώσες



V

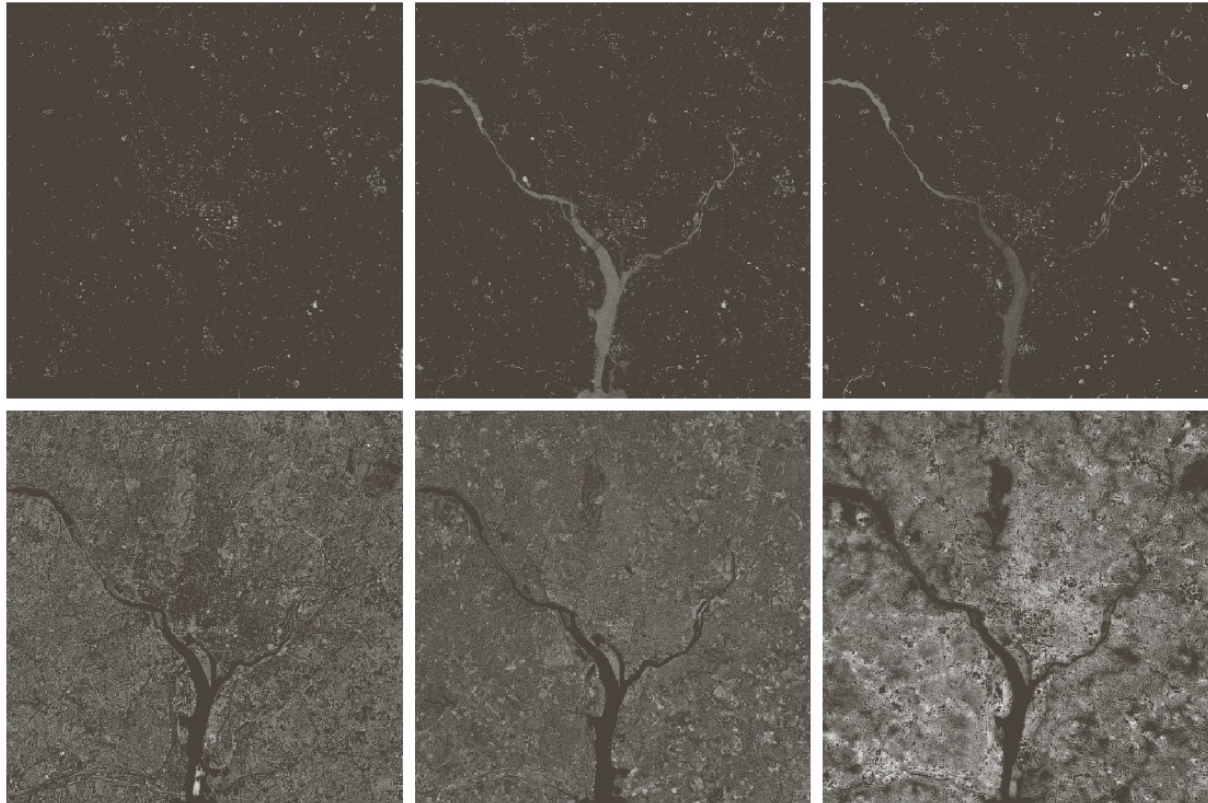
0.4890	-0.0124	0.2301	-0.3066	-0.7777	0.0947
0.4777	0.0394	0.3012	-0.1391	0.3547	-0.7310
0.4899	-0.0220	0.3150	0.0462	0.4644	0.6652
-0.1375	0.7986	-0.0431	-0.5624	0.1222	0.1018
0.2188	0.5981	-0.0165	0.7473	-0.1788	-0.0606
0.4753	-0.0486	-0.8689	-0.0990	0.0826	0.0090

Κύριες συνιστώσες



Ανακατασκευή

Κύριες συνιστώσες



Διαφορές

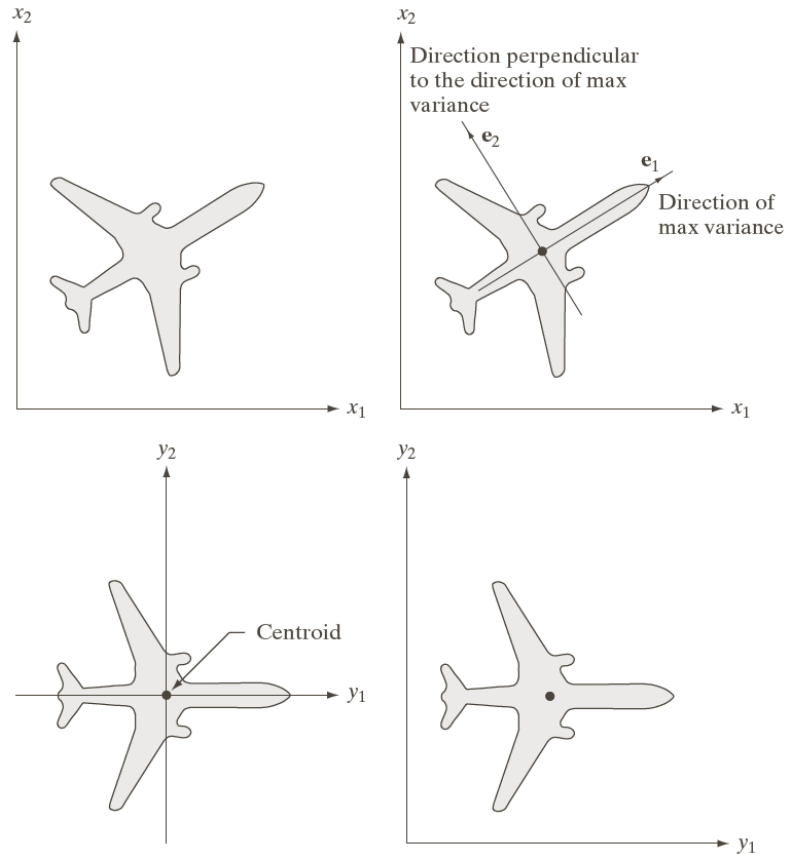
Κύριες συνιστώσες

$$\mathbf{m}_x = \begin{bmatrix} 3 \\ 3 \end{bmatrix}$$

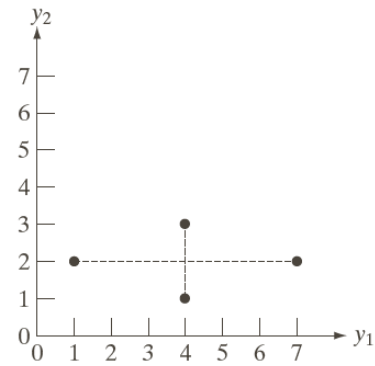
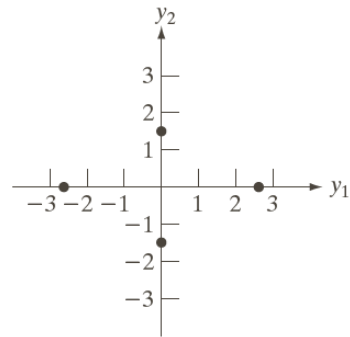
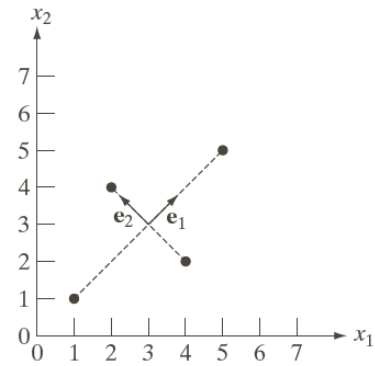
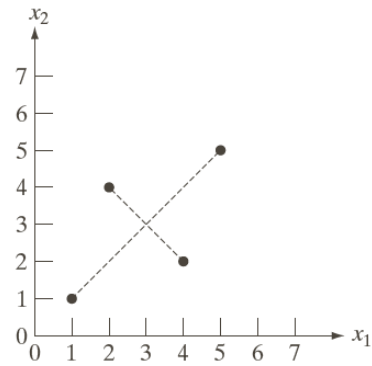
$$\mathbf{C}_x = \begin{bmatrix} 3.333 & 2.00 \\ 2.00 & 3.333 \end{bmatrix}$$

$$\mathbf{e}_1 = \begin{bmatrix} 0.707 \\ 0.707 \end{bmatrix}$$

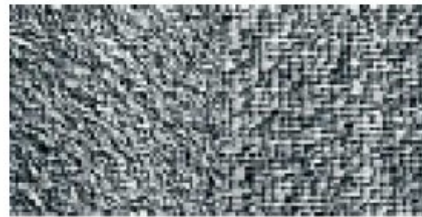
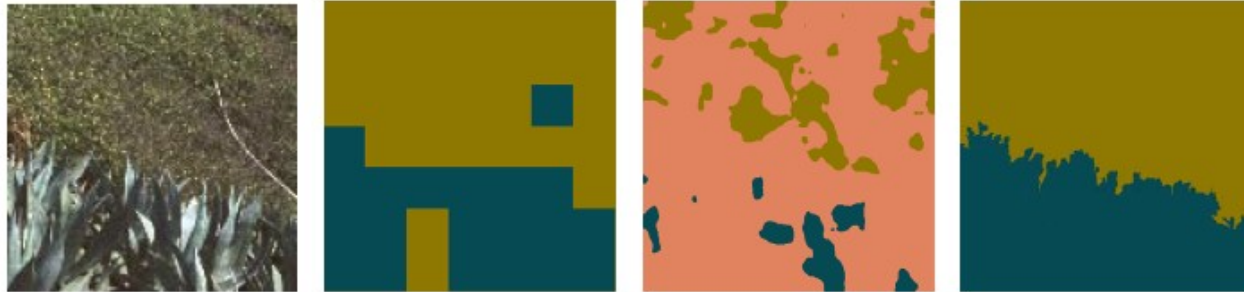
$$\mathbf{e}_2 = \begin{bmatrix} -0.707 \\ 0.707 \end{bmatrix}$$



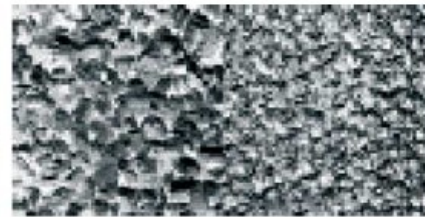
Κύριες συνιστώσες



Τμηματοποίηση με χρήση υφής



(a)



(b)



(c)



(d)

Τμηματοποίηση με χρήση υφής

