Tratamiento Digital de la Señal

Tema 4

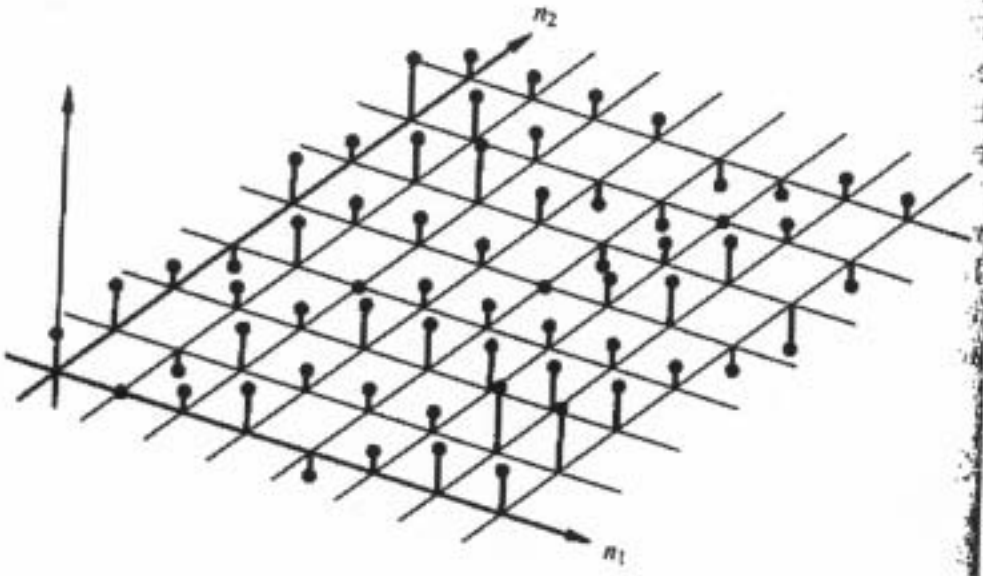
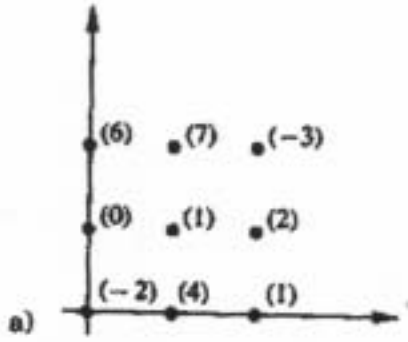


Figure 3-6 *2D discrete-variable sequence.*



2	6	7	−3
1	0	1	2
0	−2	4	1
b)	0	1	2

Figure 3-7 *(a) 2D sequence represented as values on a grid; (b) 2D sequence represented as an array.*

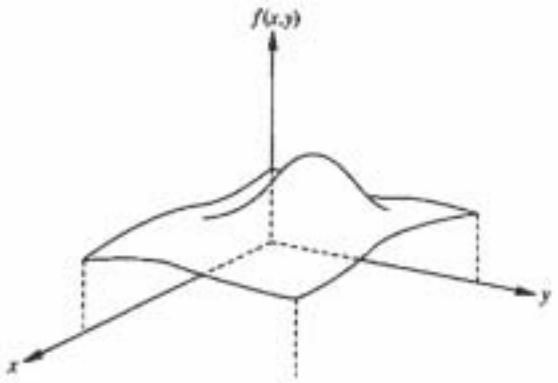
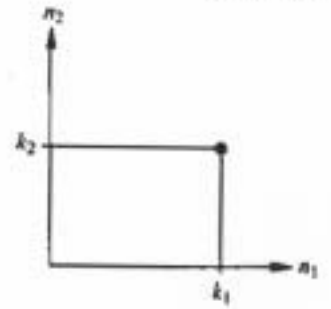


Figure 3-1 *A 2D analog signal.*

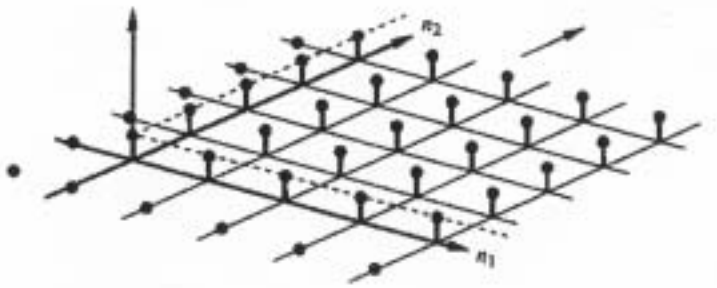


$\delta(n_1-k_1, n_2-k_2)$

a)

$\delta(n_1-k_1)$

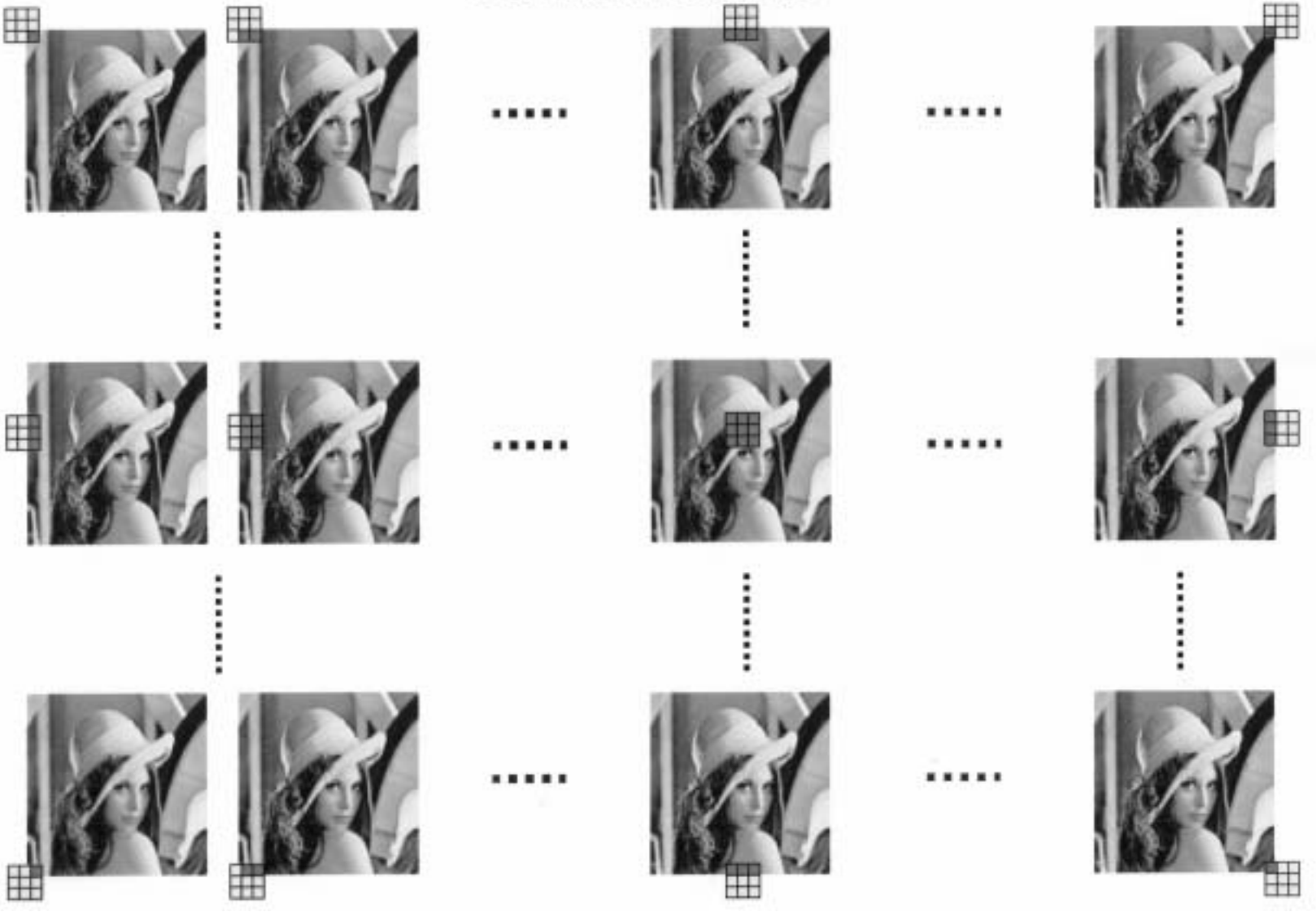
b)



c)

Figure 3-8 *(a) Impulse $\delta(n_1 - k_1, n_2 - k_2)$; (b) line impulse $\delta(n_1 - k_1)$; (c) unit step function $u(n_1, n_2)$.*

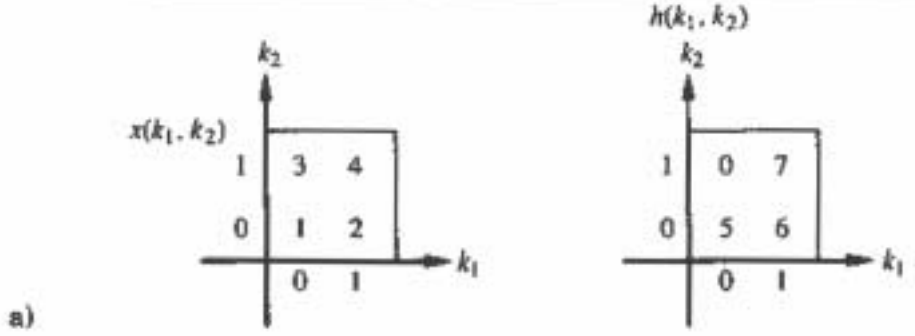
Convolución 2D



Efecto de los bordes

Bordes Negros

Bordes con repetición (periódicos)



$$y(n_1, n_2) = \sum_{k_1} \sum_{k_2} h(n_1 - k_1, n_2 - k_2)\, x(k_1, k_2)$$

First Column

$$y(0, n_2) = \sum_{k_1} \sum_{k_2} h(-k_1, n_2 - k_2)\, h(k_1, k_2)$$

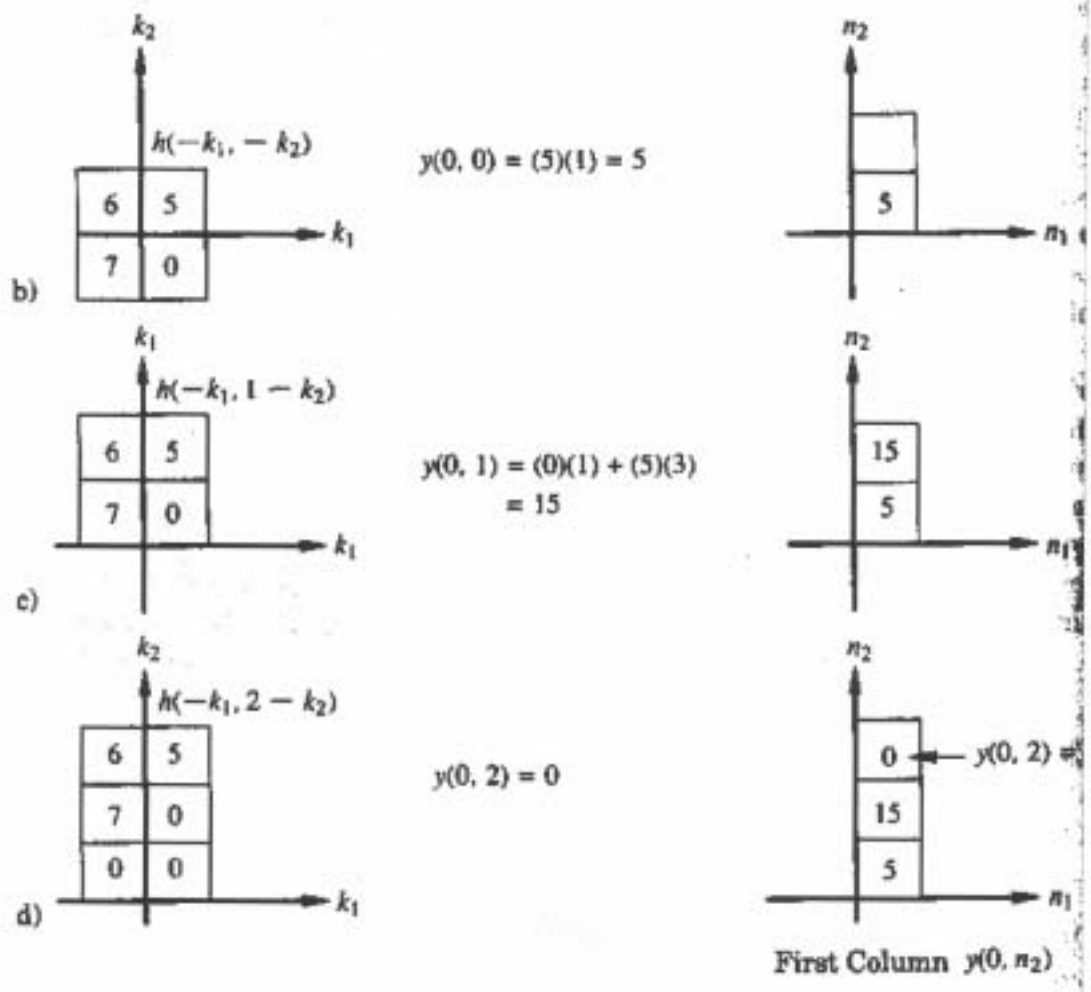
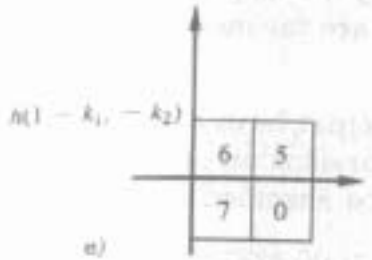


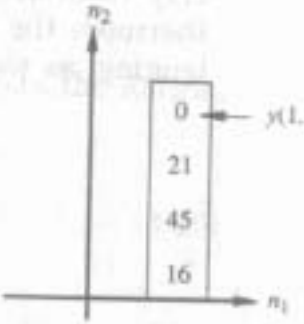
Figure 3-17 *Steps in 2D convolution.*

Second column $y(1, n_2) = \sum_{k_2} \sum_{k_1} h(1 - k_1, n_2 - k_2)\, x(k_1, k_2)$

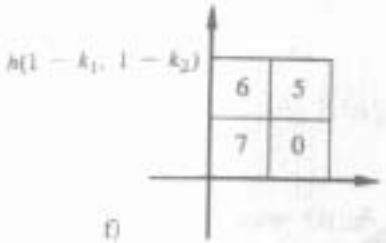


e)

$y(1, 0) = (6)(1) + (5)(2) = 16$

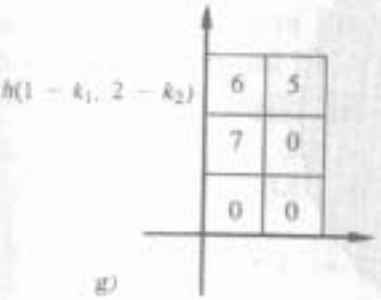


Second column $y(1, n_2)$



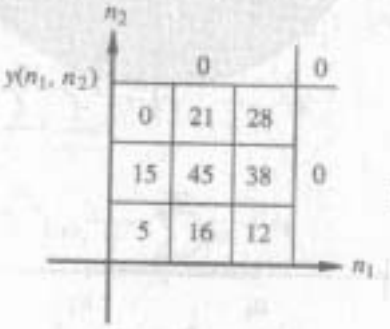
f)

$y(1, 1) = (7)(1) + (6)(3) + (5)(4) = 45$



g)

$y(1, 2) = (7)(3) = 21$



h)

Final array

Figure 3-17 *(continued)*

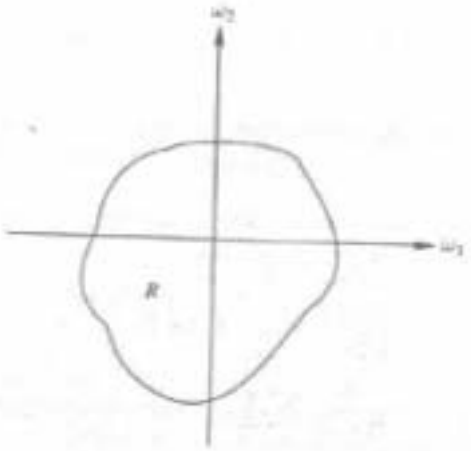


Figure 3-3 Band-limited spectrum: outside region R, $F(\omega_1, \omega_2) = 0$.

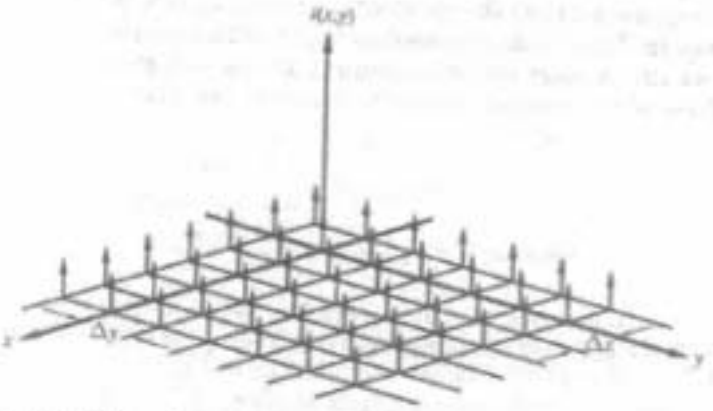


Figure 3-4 2D impulse sampling function (the "bed-of-nails" function).

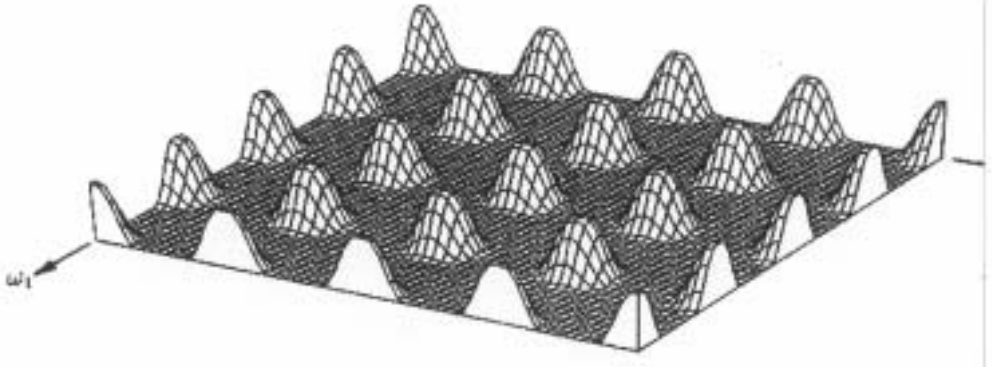


***Figure 3-5** Spectrum of sampled band-limited signal.*

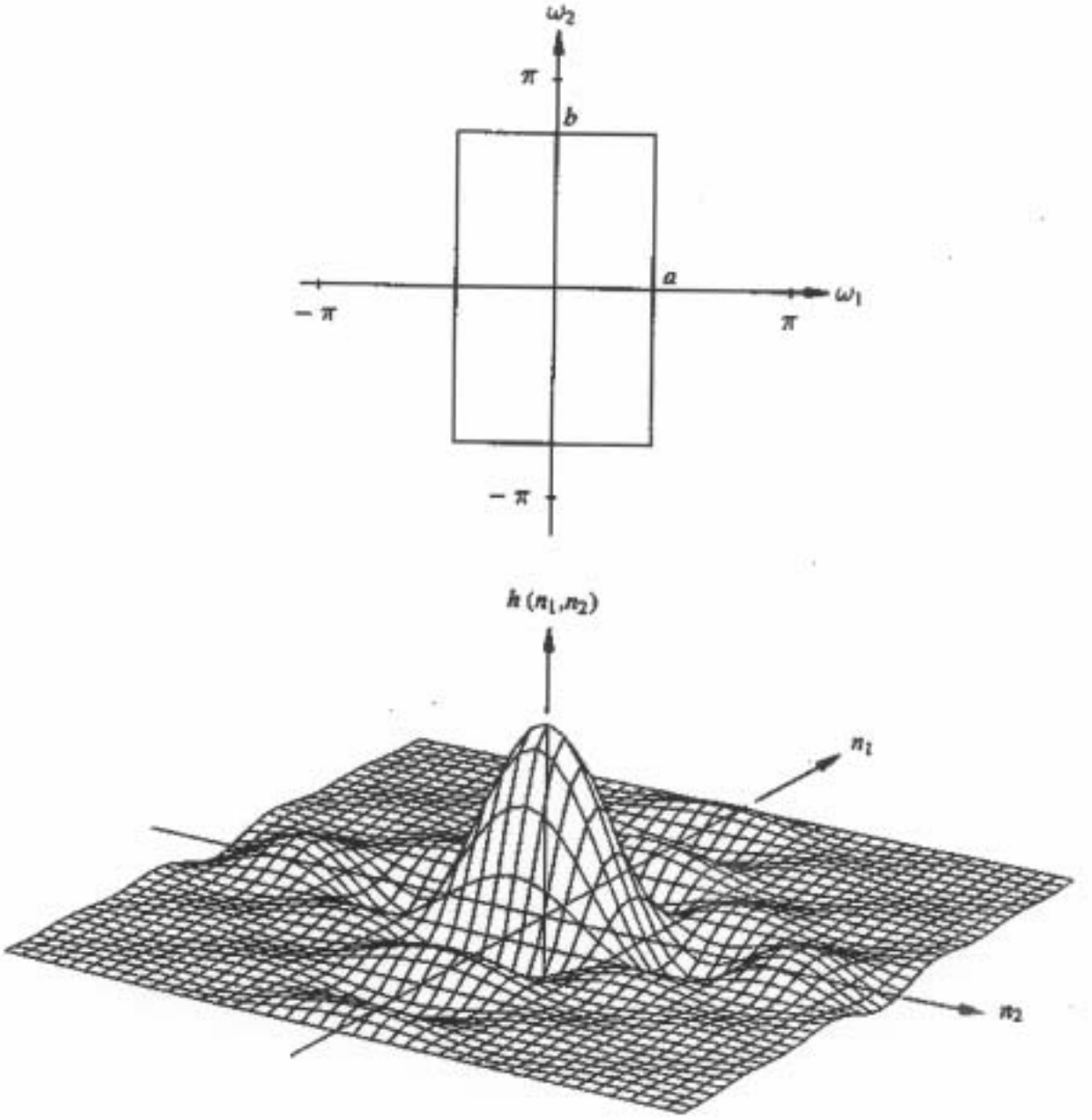
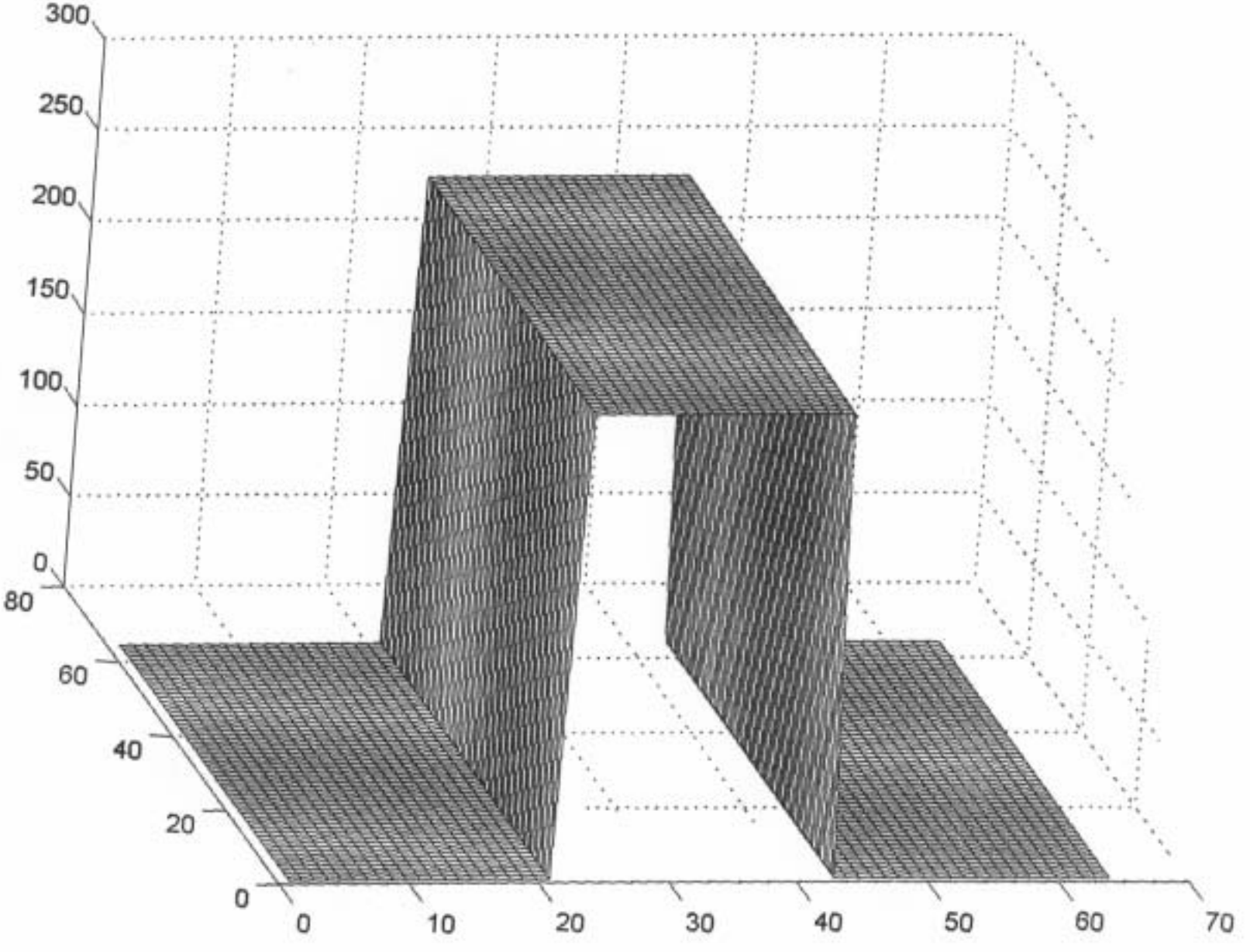


Figure 3-13 *Ideal low-pass filter, rectangular symmetry: (a) frequency response, (b) impulse response.*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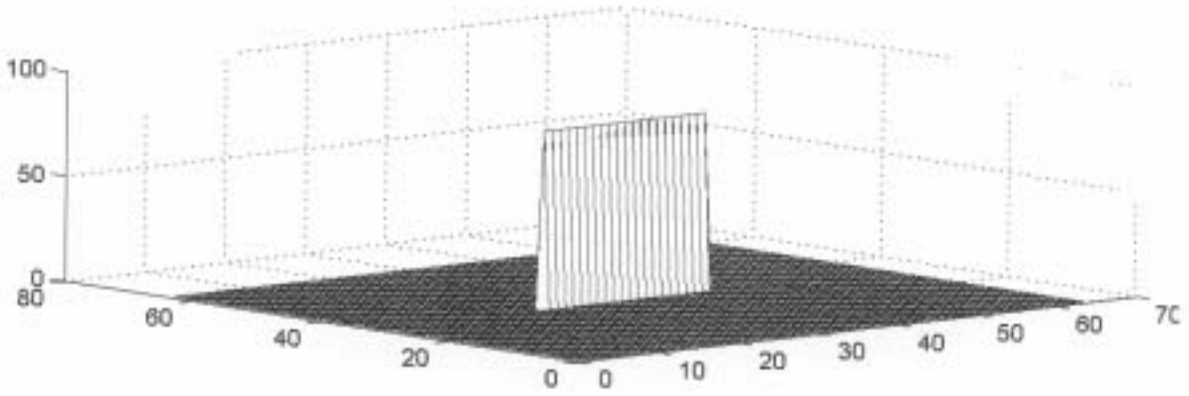
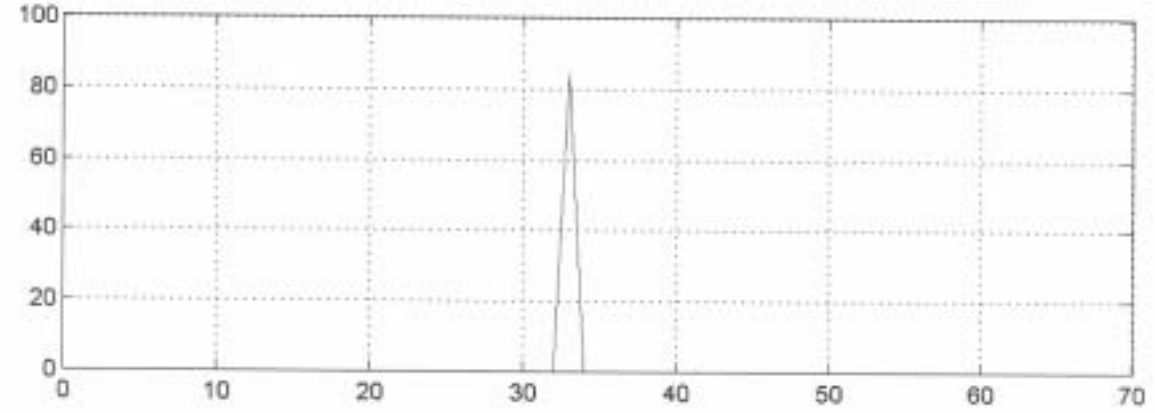
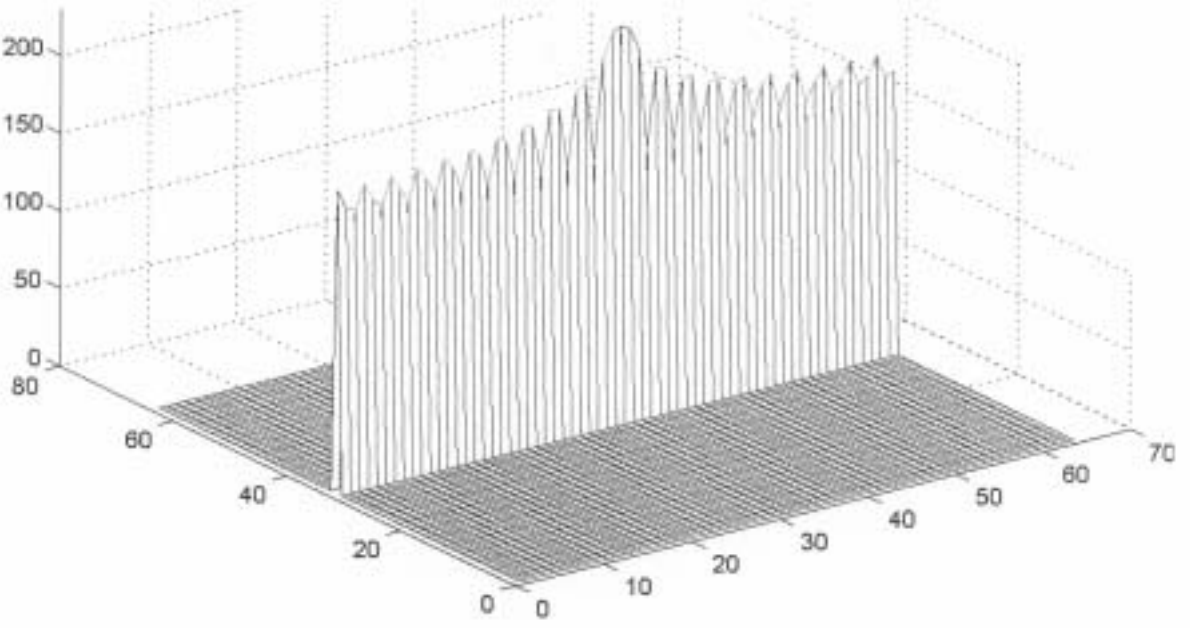
250
200
150
100
50
0
80
60
40
20
0
0
10
20
30
40
50
60
70


100
50
0
80
60
40
20
0
0
10
20
30
40
50
60
70


100
80
60
40
20
0
0
10
20
30
40
50
60
70


200
150
100
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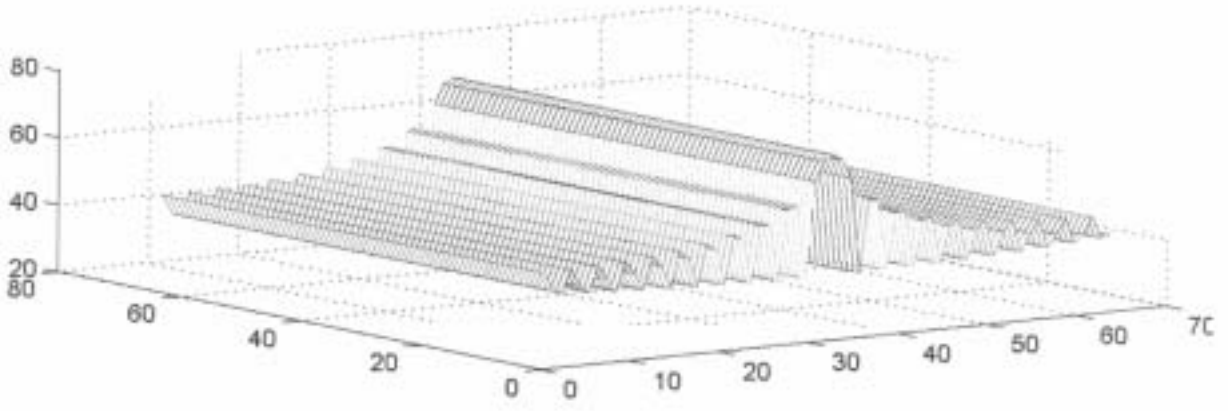
0
80
60
40
20
0
0
10
20
30
40
50
60
70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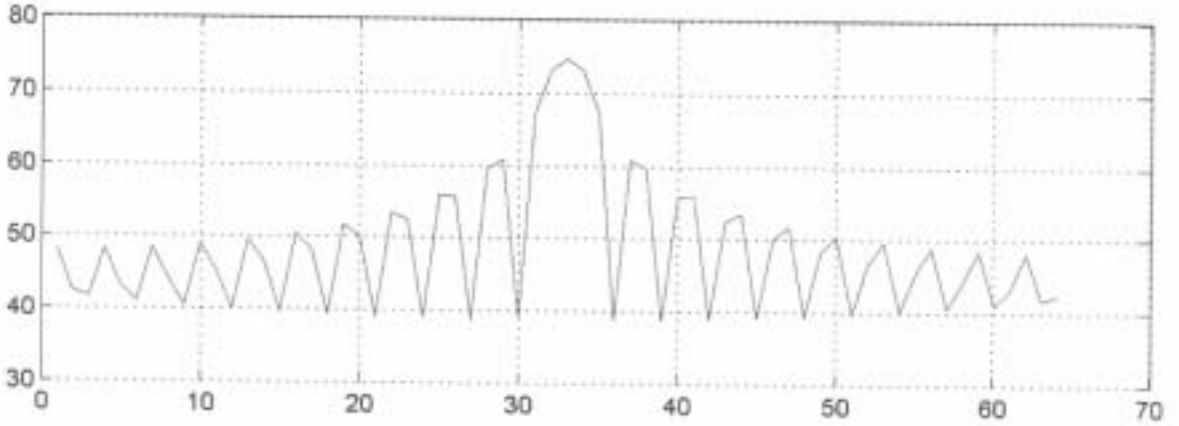
60
40
20
80
60
40
20
0
0
10
20
30
40
50
60
70


80
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30
0
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60
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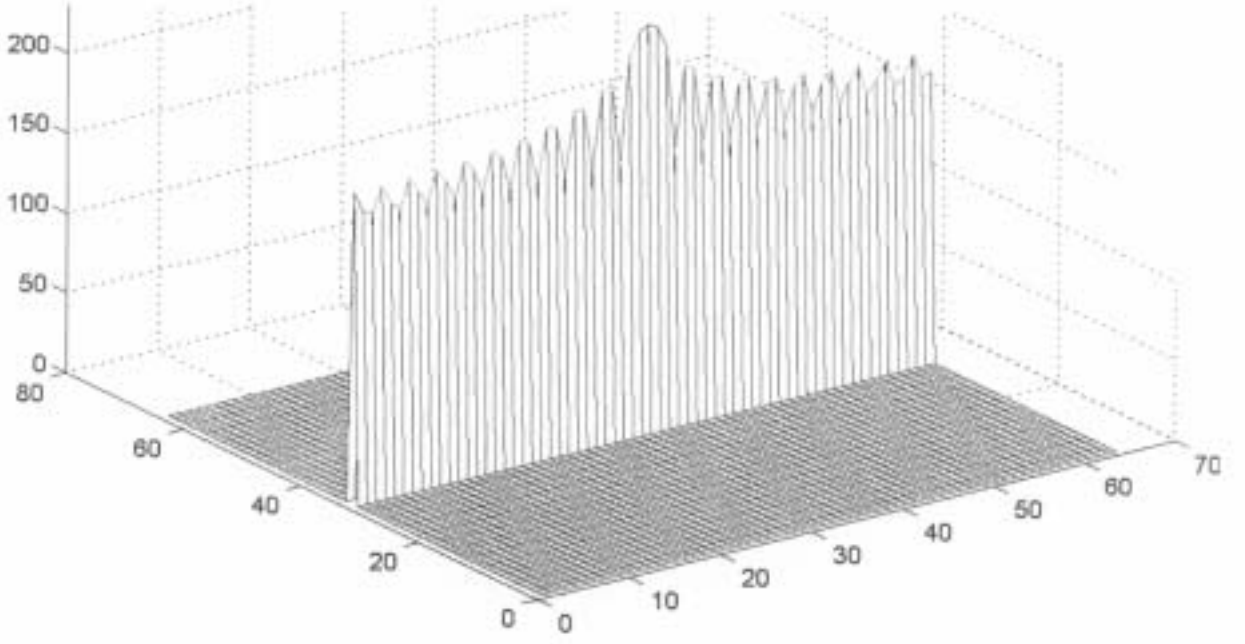
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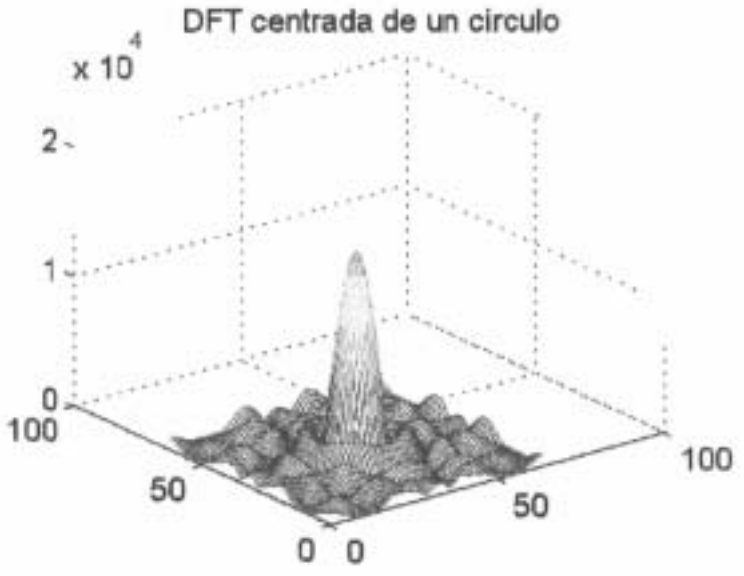
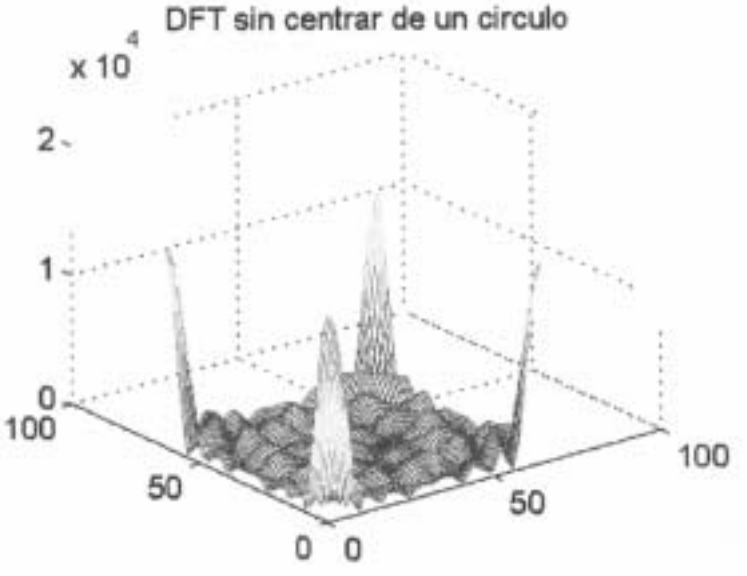
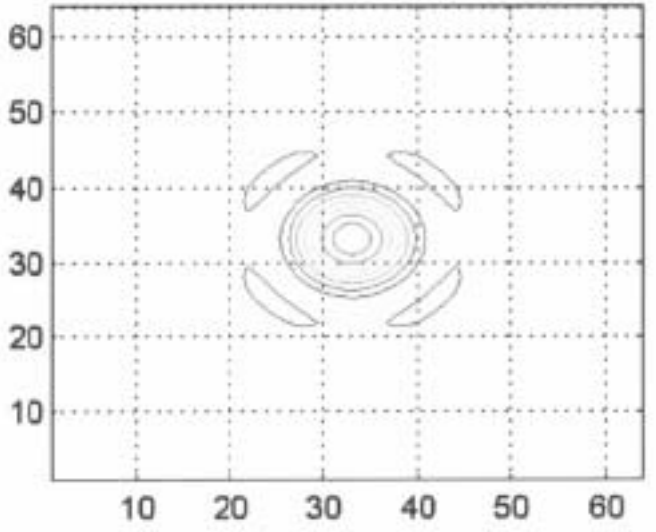
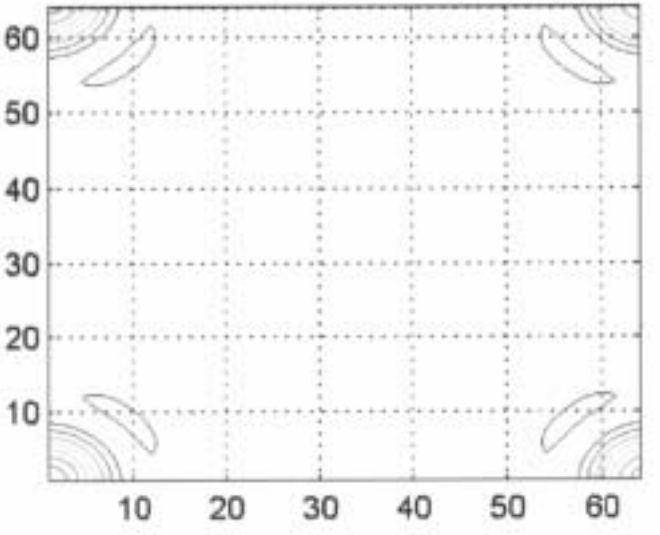
100
50
0
80
60
40
20
0
0
10
20
30
40
50
60
70


DFT centrada de un circulo
x 10^4
2
1
0
100
50
0
0
50
100

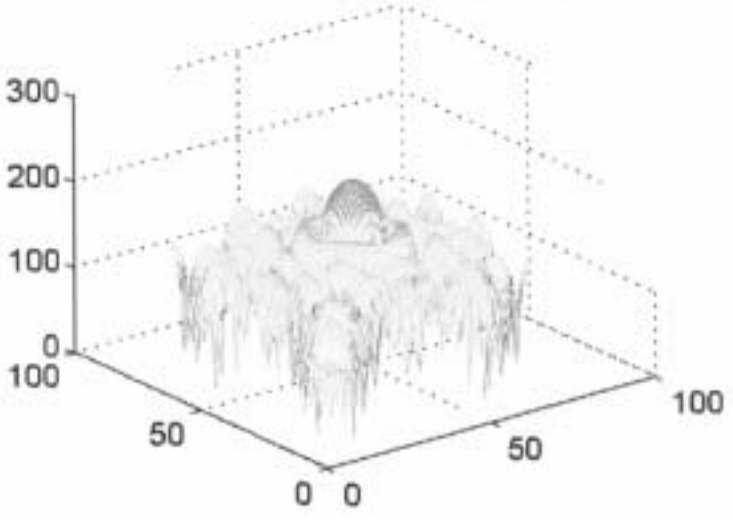

DFT sin centrar de un circulo
x 10^4
2
1
0
100
50
0
0
50
100


60
50
40
30
20
10
10
20
30
40
50
60


60
50
40
30
20
10
10
20
30
40
50
60

escalada

DFT centrada de un circulo



escala

DFT sin centrar de un circulo