

SEL-5886

Visão Computacional

Aula 2

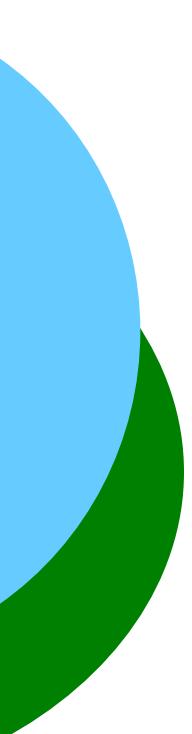
Processamento Espacial

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Processamento Espacial

- Transformações ponto a ponto
 - Histograma
 - Transformações lineares
 - Transformações não-lineares



Transformações Ponto a Ponto

Operadores Ponto a Ponto

(Transformações de níveis de Cinza ou Mapeamento)

Cada ponto na Imagem de Entrada gera um só ponto na Imagem de Saída

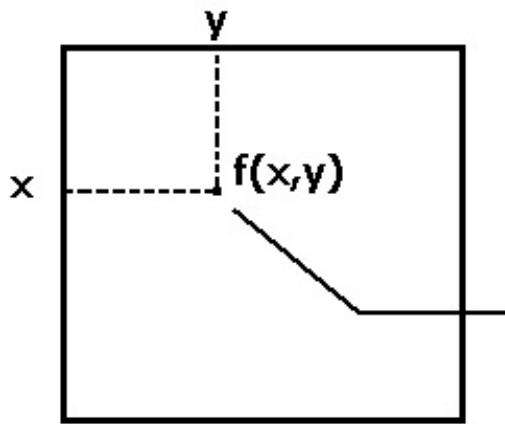


Imagen de Entrada

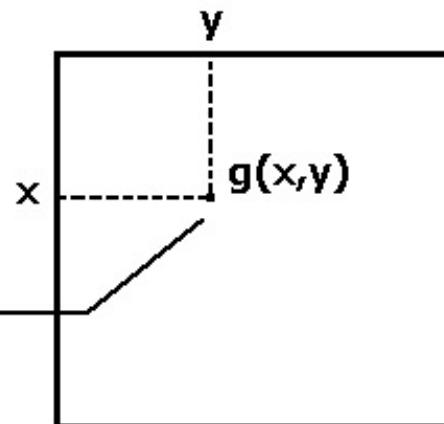
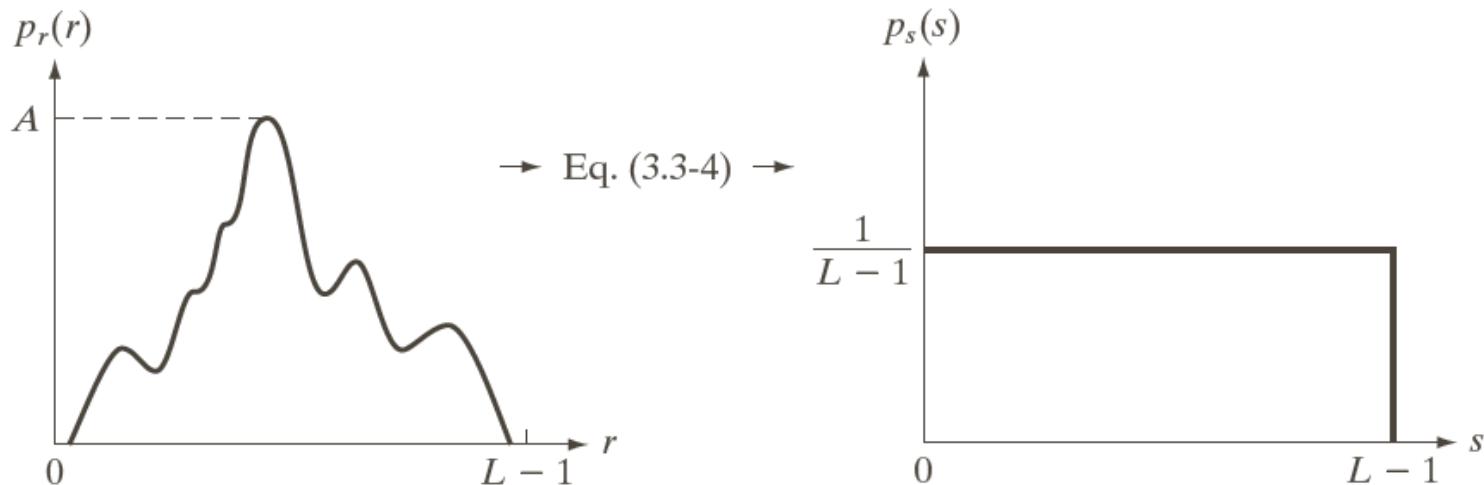


Imagen de Saída

$T[f(x,y)] \implies$ Operação sobre cada ponto (cada Pixel) da Imagem de Entrada

Equalização do histograma:



a | b

FIGURE 3.18 (a) An arbitrary PDF. (b) Result of applying the transformation in Eq. (3.3-4) to all intensity levels, r . The resulting intensities, s , have a uniform PDF, independently of the form of the PDF of the r 's.

Equalização do histograma:

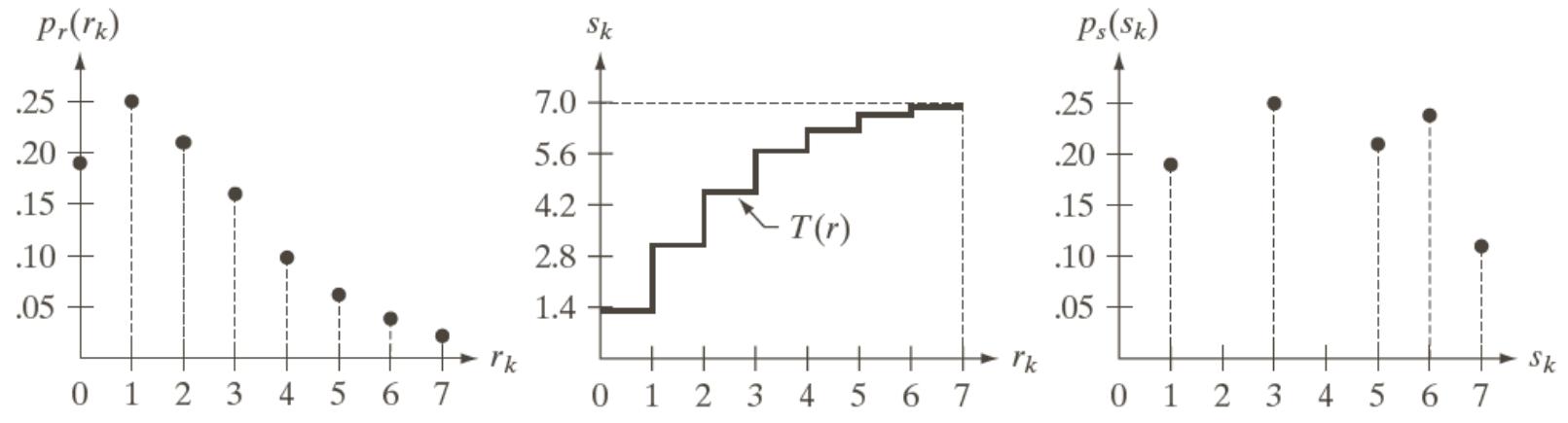
- ❑ Aumentar o contraste geral na Imagem espalhando a distribuição de níveis de cinza.

Exemplo:

Dada uma Imagem de $n \times m$ Pixels e “g” níveis de cinza.

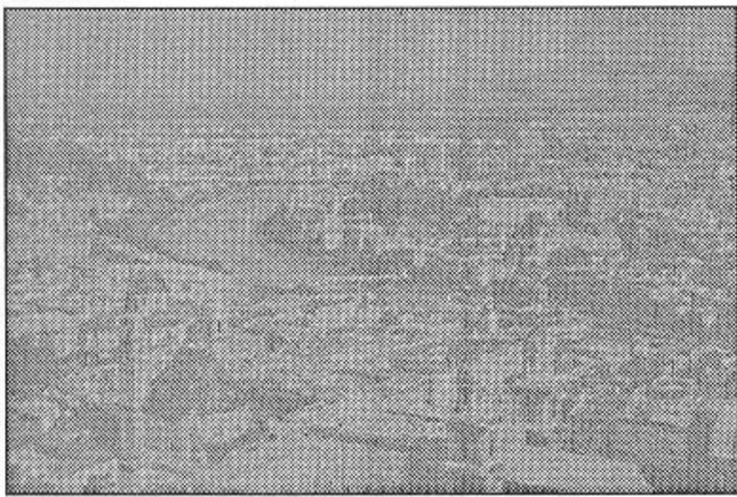
No. Ideal de pixels em cada nível $\Rightarrow I = (n \times m)/g$

Exemplo:



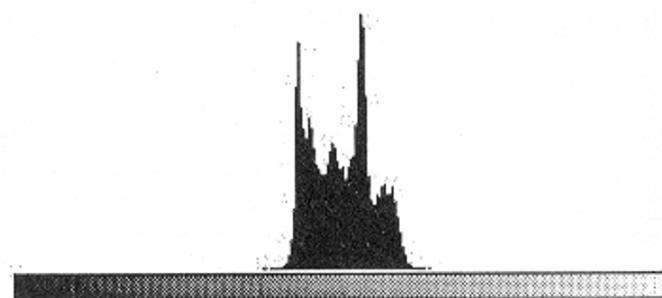
a b c

FIGURE 3.19 Illustration of histogram equalization of a 3-bit (8 intensity levels) image. (a) Original histogram. (b) Transformation function. (c) Equalized histogram.



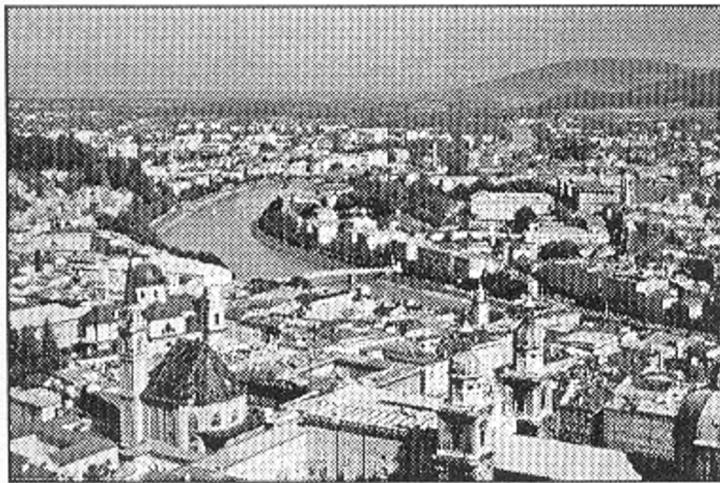
(a)

a) Imagem Original



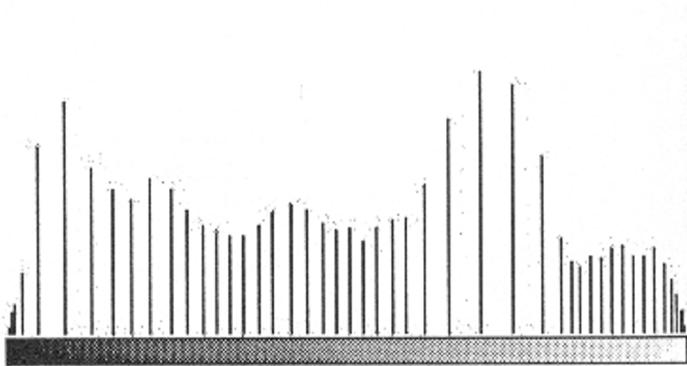
(b)

b) Histograma original



(c)

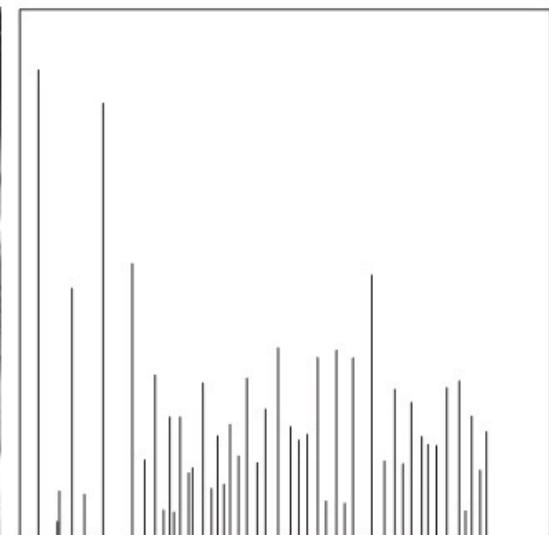
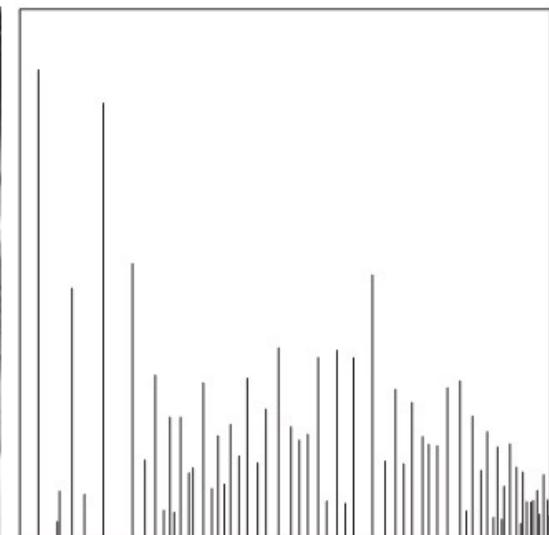
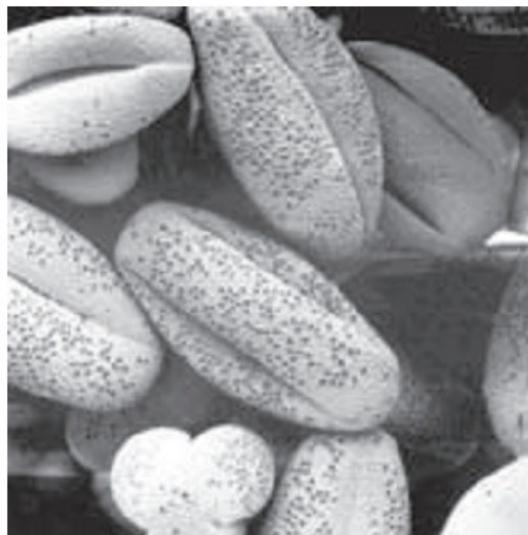
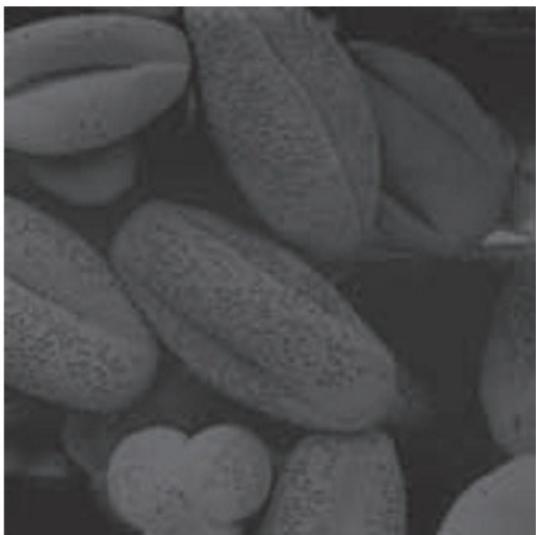
c) Imagem Equalizada



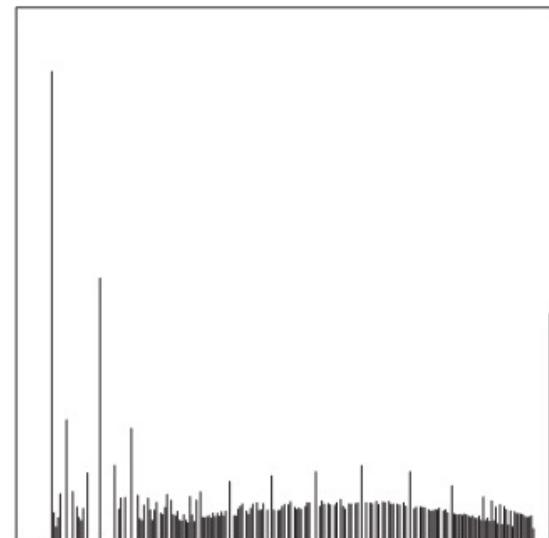
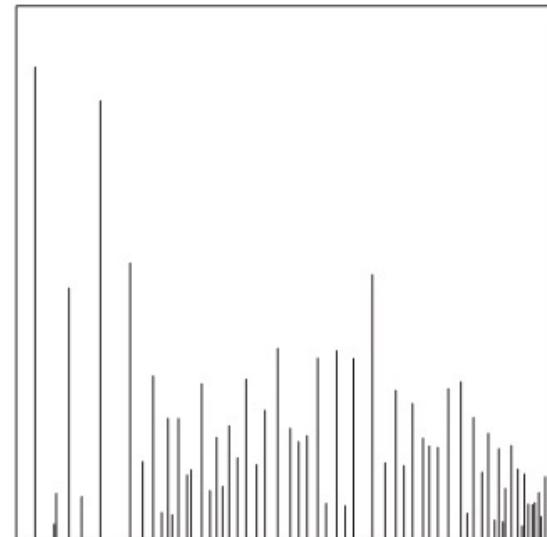
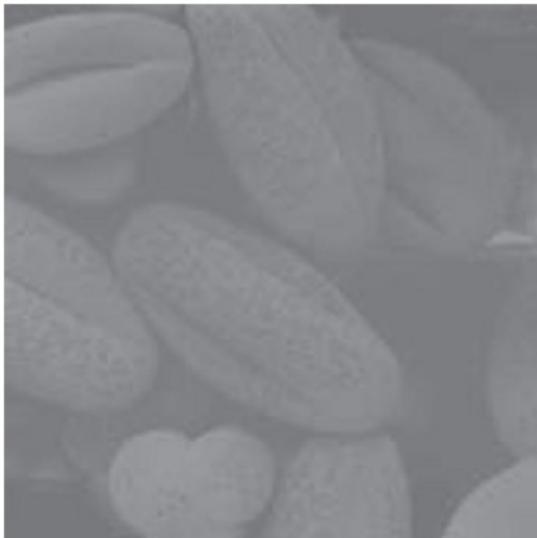
(d)

d) Histograma Equalizado

Equalização de Histograma



Equalização de Histograma



Equalização do histograma:

A equalização pode ser obtida fazendo:

$$q = \max \left\{ 0, ARRED. \left(\frac{\sum_{j=0}^k n_j}{I} \right) - 1 \right\} \quad 0 \leq k \leq g$$

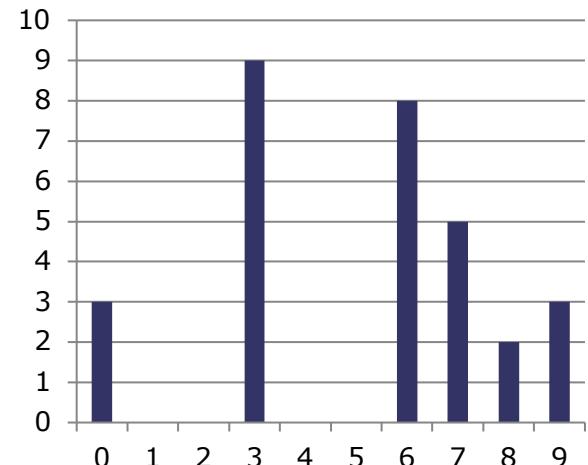
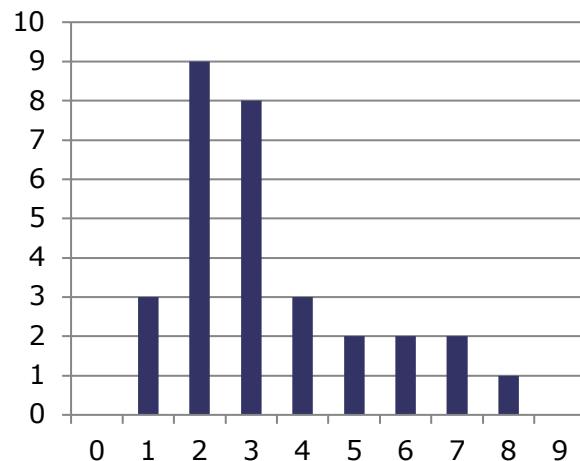
Onde: g = níveis de cinza da Imagem Original

q = níveis de cinza da Imagem Equalizada

$$n \times m = 30 \text{ pixels} \rightarrow g = 10 \text{ níveis de cinza}$$

Exemplo:

$$I = 30/10 = 3$$



g	n	Σn	q
0	0	0	0
1	3	3	0
2	9	12	3
3	8	20	6
4	3	23	7
5	2	25	7
6	2	27	8
7	2	29	9
8	1	30	9
9	0	30	9

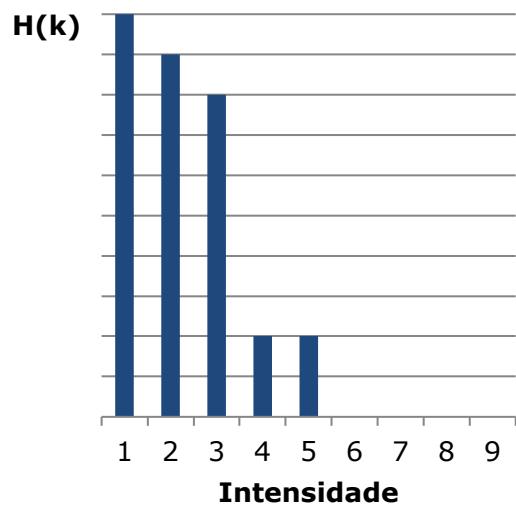
$\Rightarrow (6,66) \uparrow 7$
 $\Rightarrow (7,33) \downarrow 7$

$$q = \max \left\{ 0, \text{ARRED.} \left(\frac{\sum_{j=0}^k n_j}{I} \right) - 1 \right\} \quad 0 \leq k \leq g$$

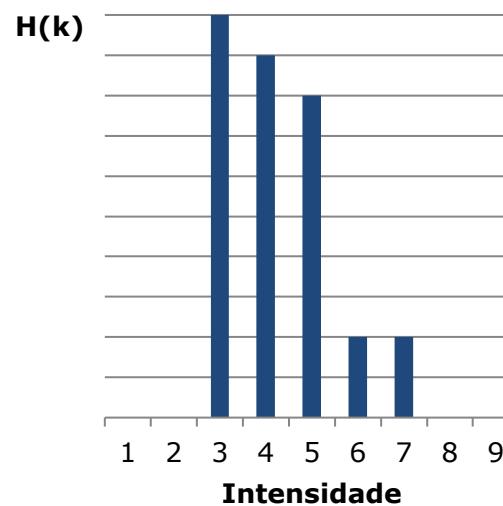
Visualização das Transformações nos Níveis de Cinza através dos Histogramas

1) Alterações Globais no Brilho

Clarear ou escurecer uma Imagem.



+2



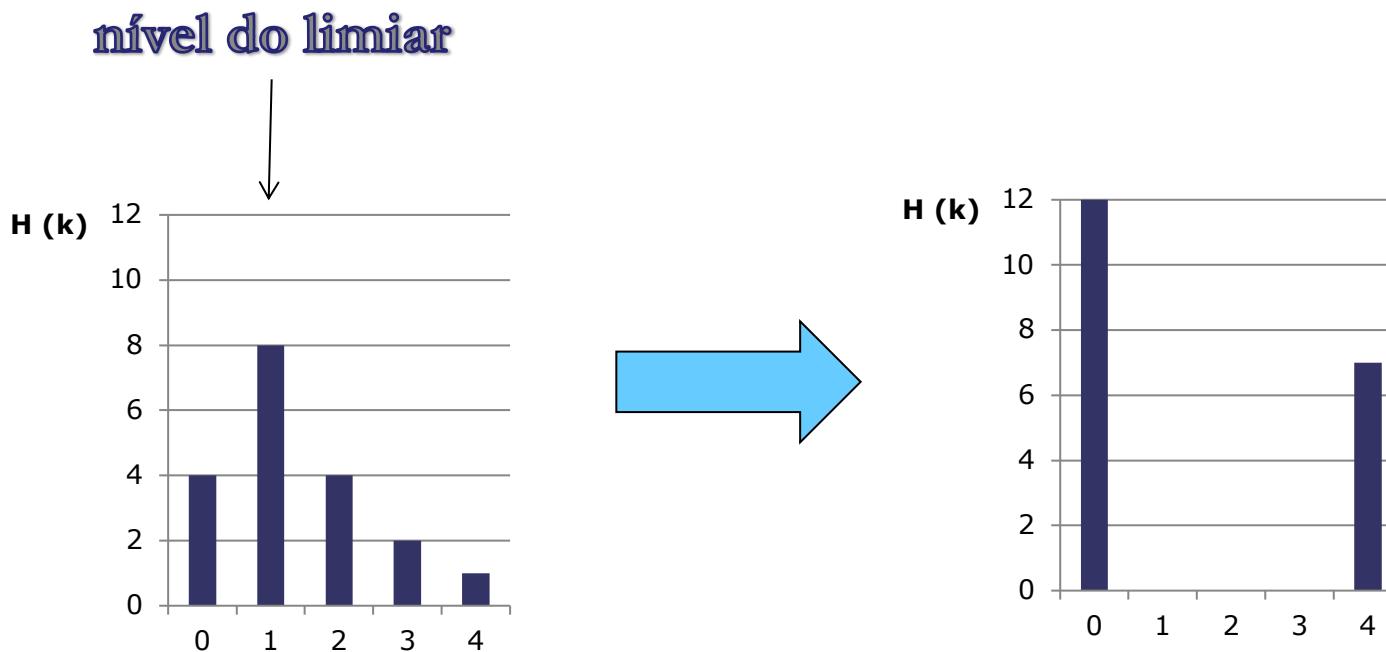
Somar ou
Subtrair uma
constante em
todos os pixels
da Imagem.

0 → Preto

Max → Branco

2) Binarização (“Threshold”):

- Determinação de um limiar abaixo do qual os pixels são transformados em zero, e acima são transformados no máximo de intensidade.

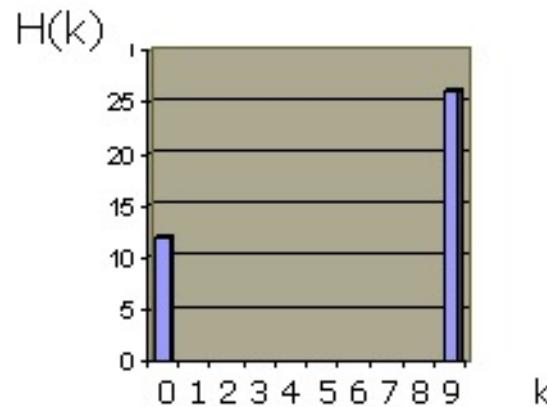
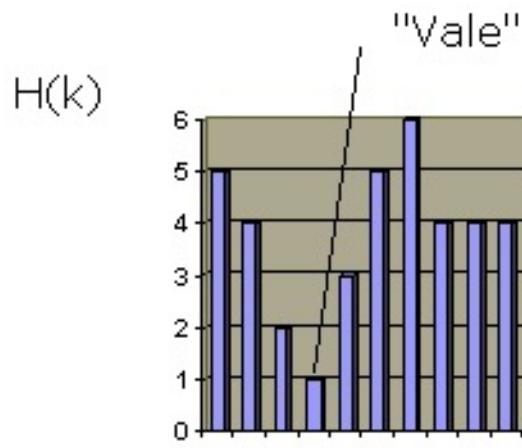


Determinação do Limiar:

Uma das dificuldades da “limiarização” de uma imagem é a melhor determinação do valor de “thresholding”, ou seja, do ponto de separação dos pixels.

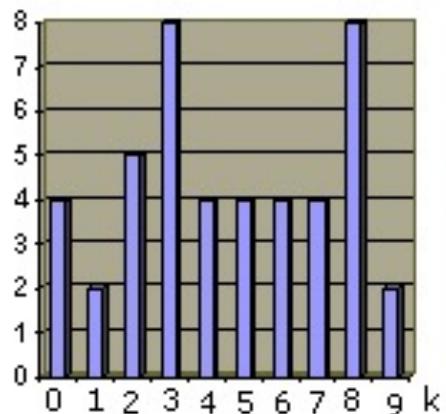
Método do vale:

Através da análise do histograma estabelecer T (valor de “Threshold”) na região de “vale” mais próxima ao meio de escala dos níveis de cinza.

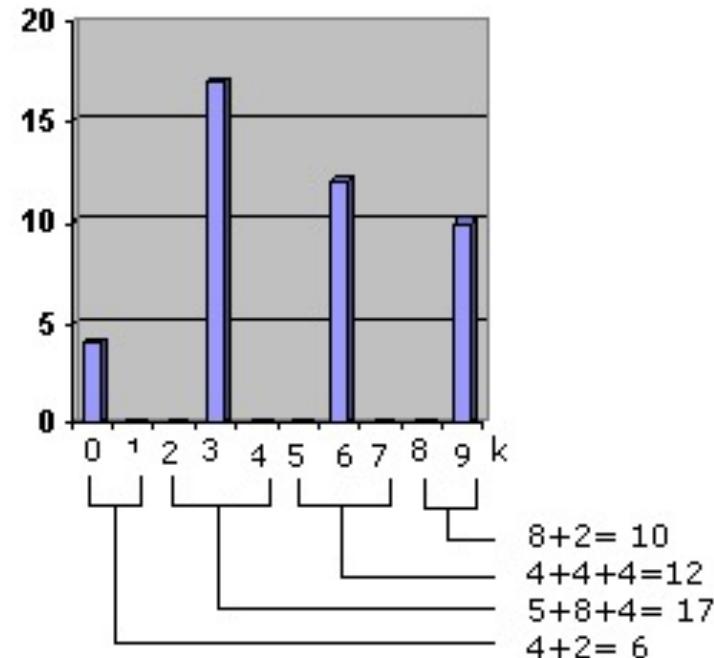


3) Agrupamento ou quantização do histograma:

- Reduzir o número de níveis de cinza na imagem.

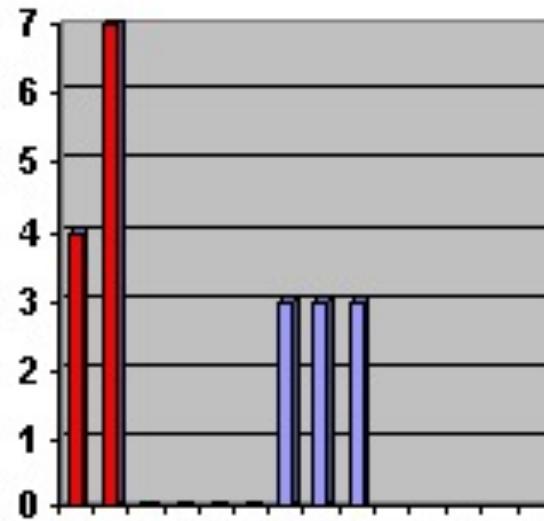
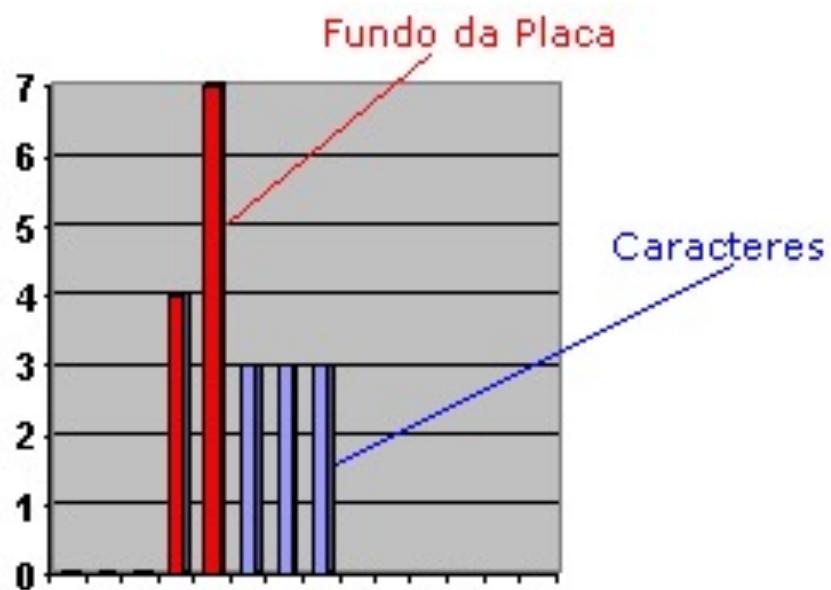


0, 3, 6 e 9
→



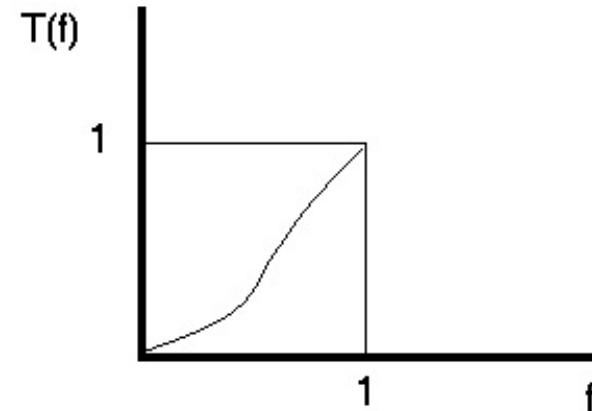
4) “Splitting”.

Aumentar a diferença entre dois grupos de nível de cinza para melhorar o contraste.



Exemplo: Digitalização de placas de automóveis.

1) Contraste e Brilho



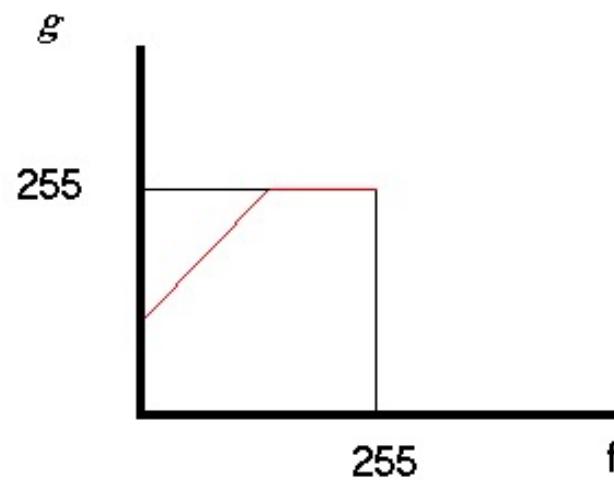
As Transformações de Intensidade podem ser:

1) Lineares :

$$g = c.f + b$$

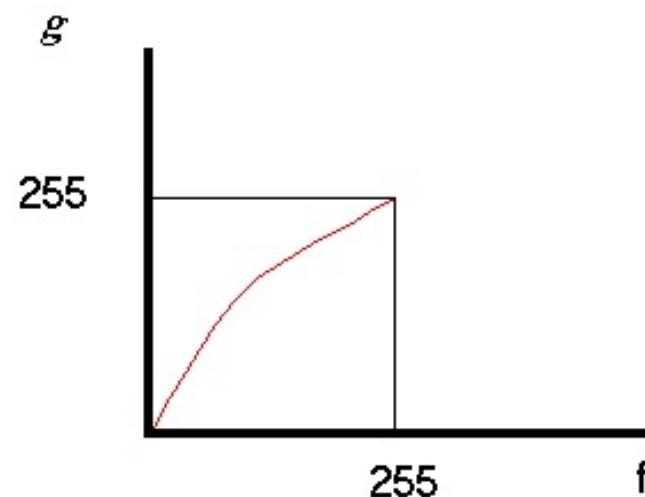
onde : c (Contraste),
 b (Brilho)

Exemplo: $g = 2f + 32$



2) Não Lineares:

Exemplo: $g = 31,875 \cdot \log_2(f+1)$



2) Negativo

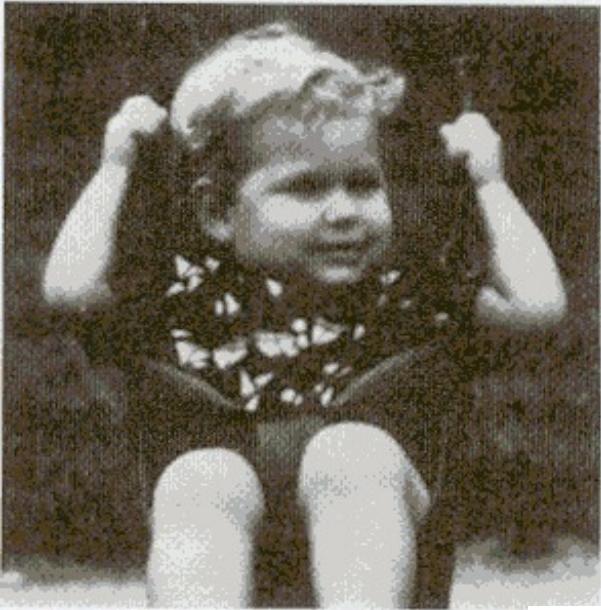


Imagen de Entrada

$$T[f(x,y)] = \\ g(x,y) = W - f(x,y)$$

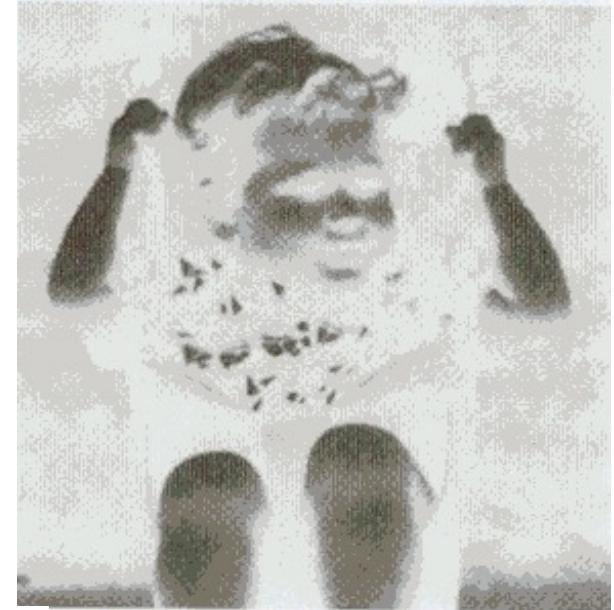
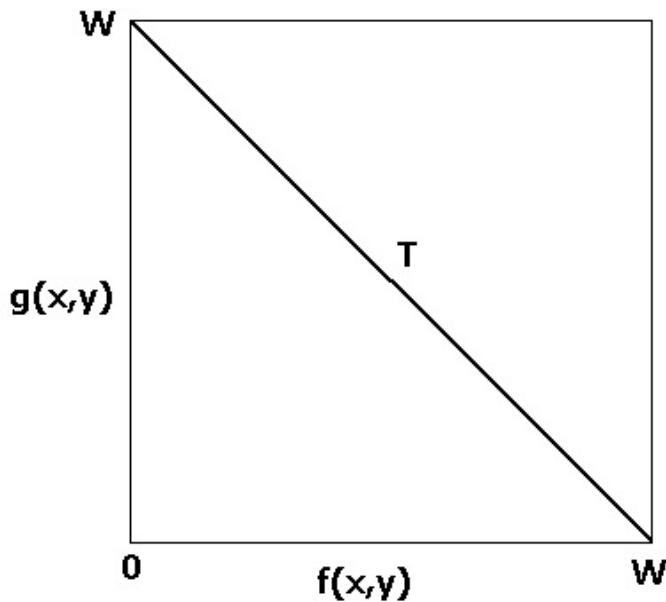
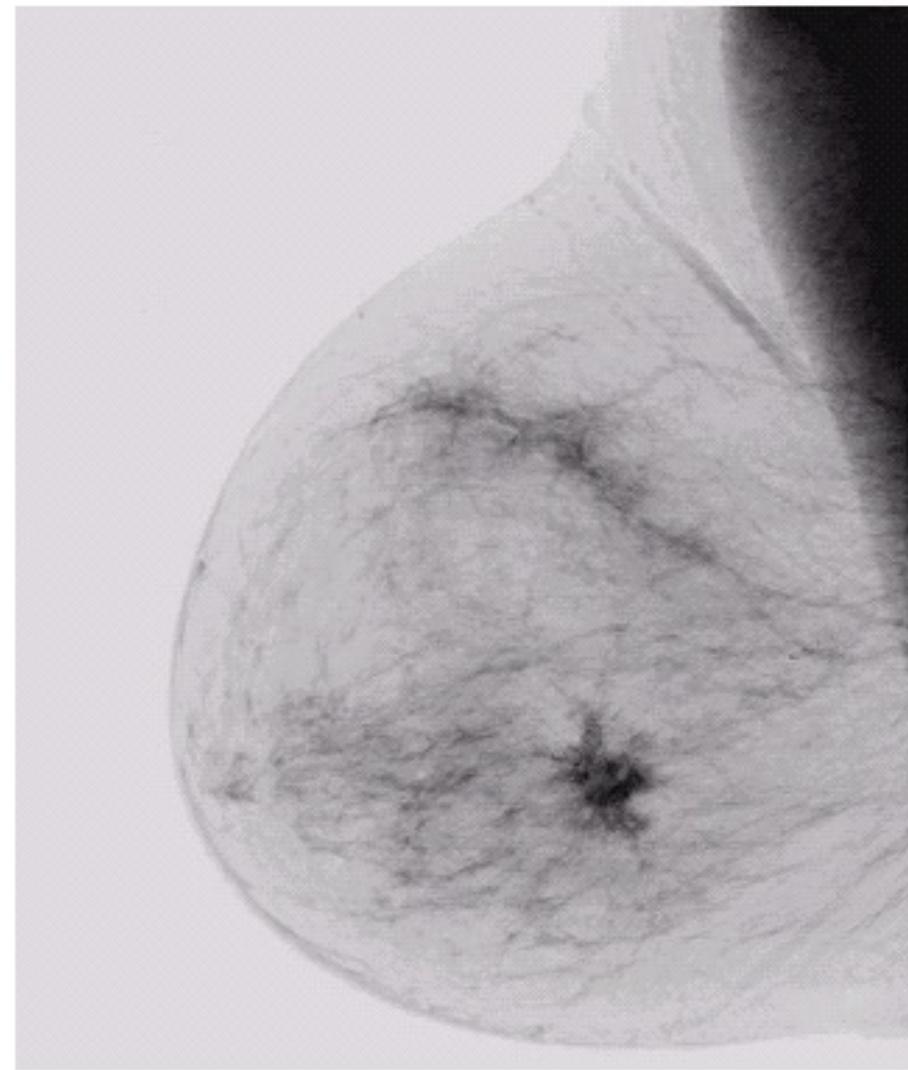
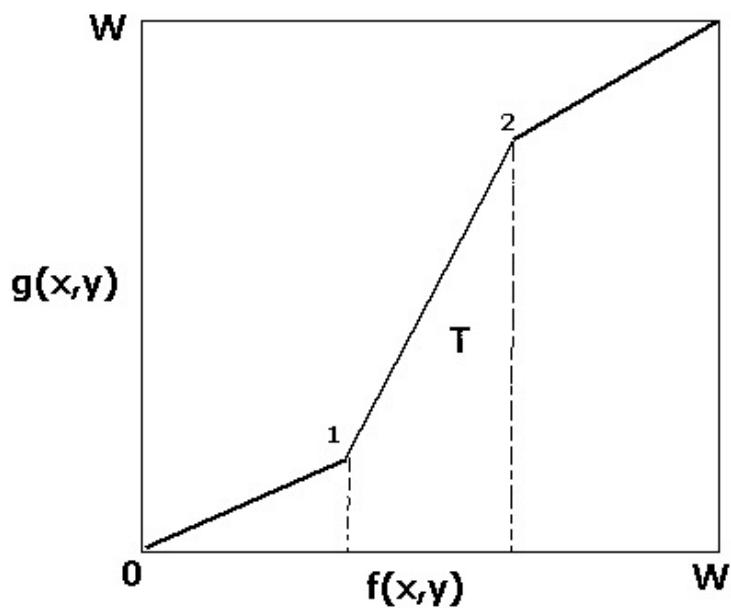


Imagen de Saída





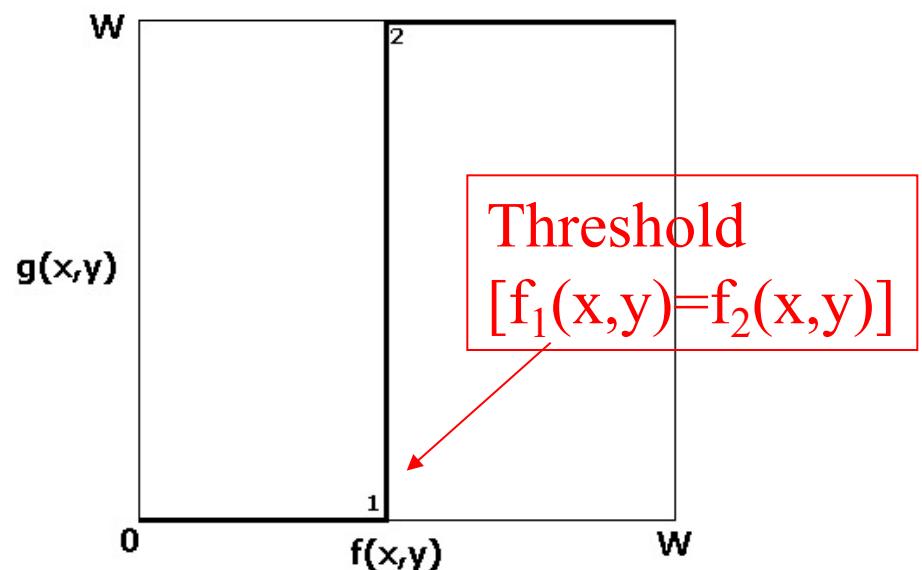
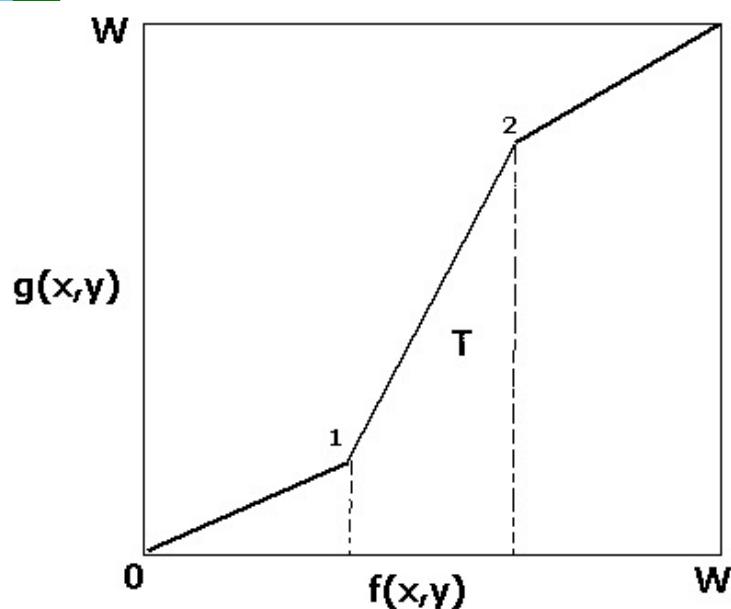
3) Contraste Seletivo



$$g(x,y) = \begin{cases} k_1 \cdot f(x,y) & \Rightarrow 0 \leq f(x,y) < f_1(x,y) \\ k_2 \cdot f(x,y) & \Rightarrow f_1(x,y) \leq f(x,y) \leq f_2(x,y) \\ k_3 \cdot f(x,y) & \Rightarrow f_2(x,y) < f(x,y) \leq W \end{cases}$$

4) Binarização (“Thresholding”)

“Thresholding” ==> Limiarização (Transforma a Imagem em uma Imagem Binária (2 níveis de cinza)



Fazendo:

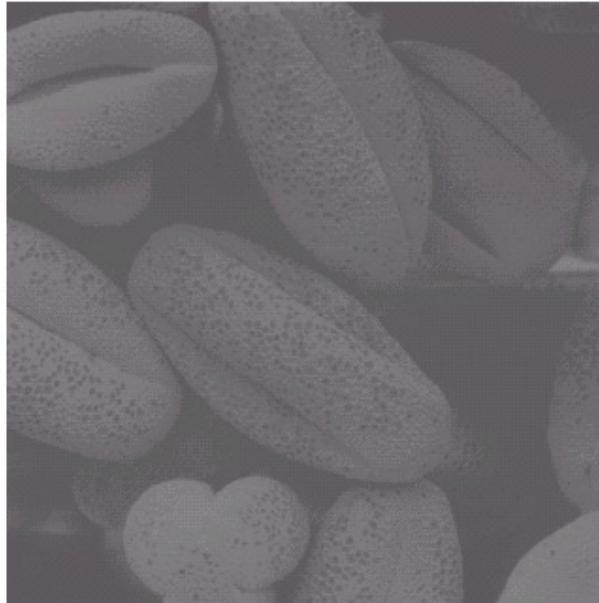
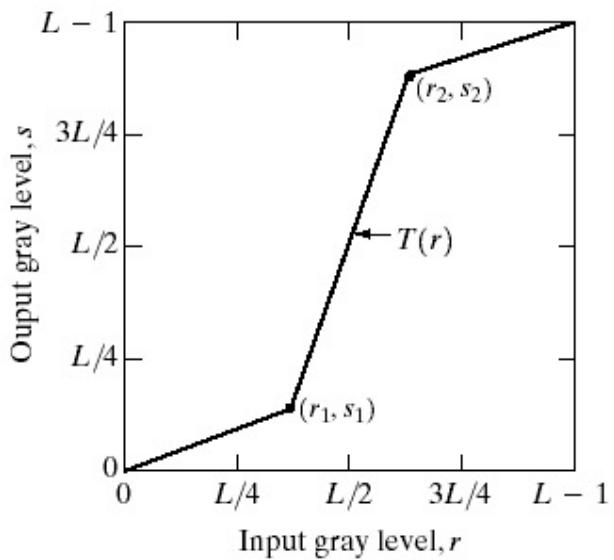
$$k_1 = 0$$

$$f_1(x,y) = f_2(x,y)$$

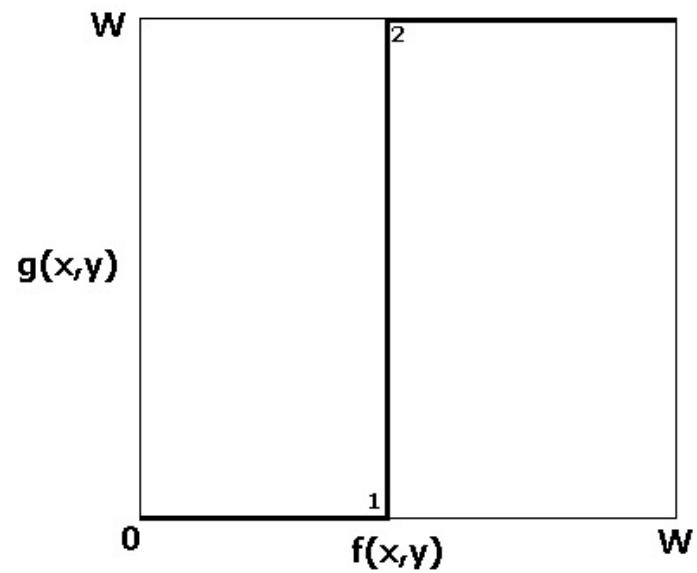
$$k_3 \cdot f(x,y) = W$$

$$g(x,y) = \begin{cases} 0 & \Rightarrow 0 < f_1(x,y) \\ W & \Rightarrow f_1(x,y) \leq f(x,y) \leq W \end{cases}$$

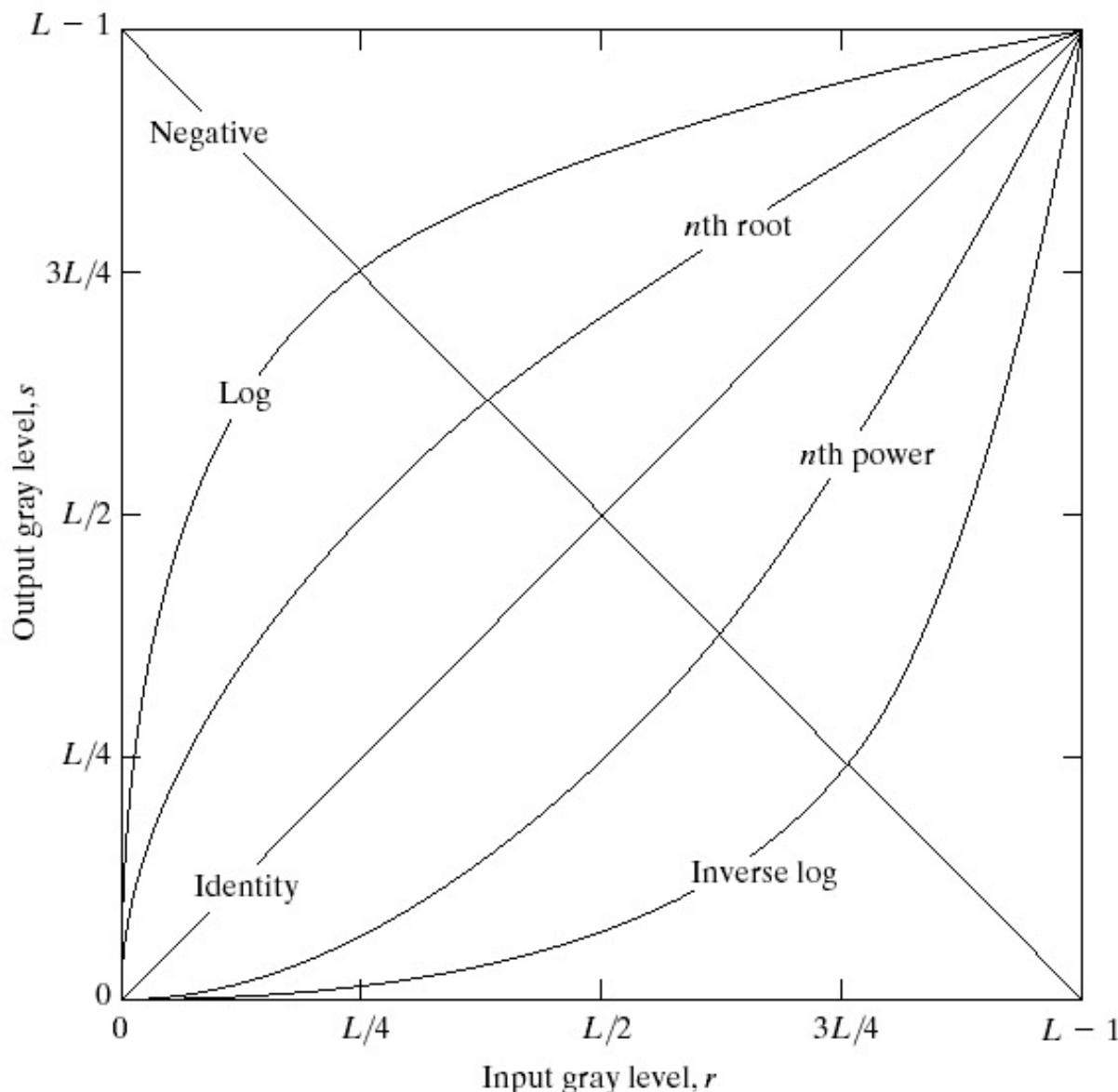
Contraste Seletivo e (“Thresholding”)

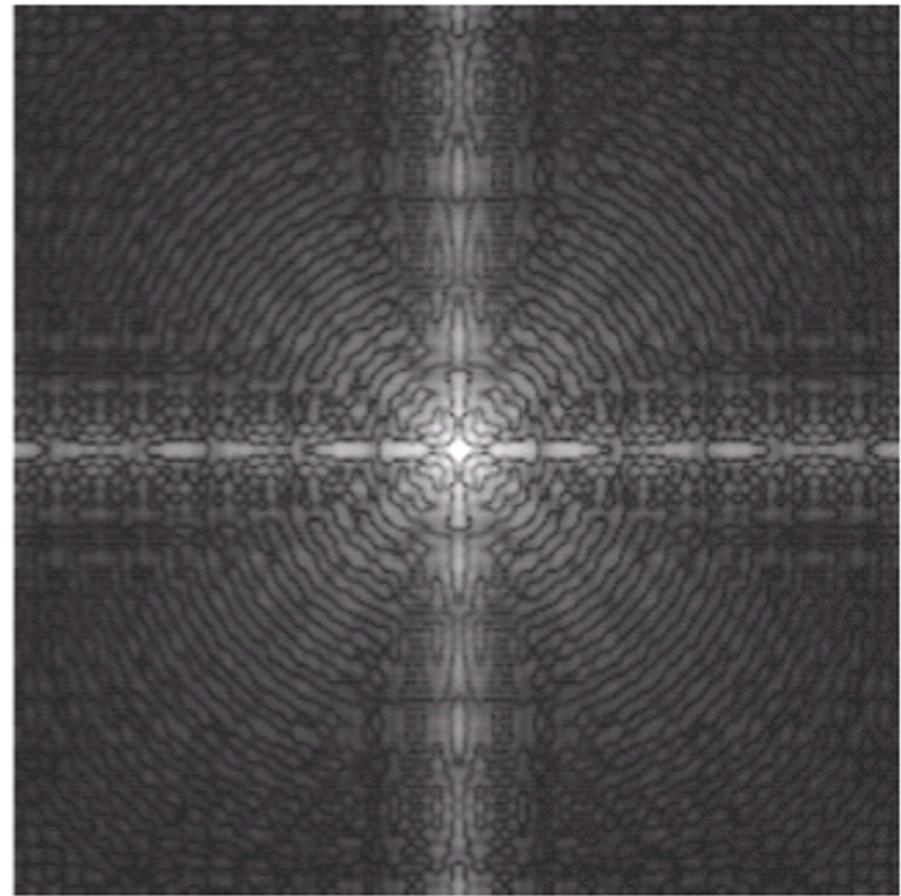
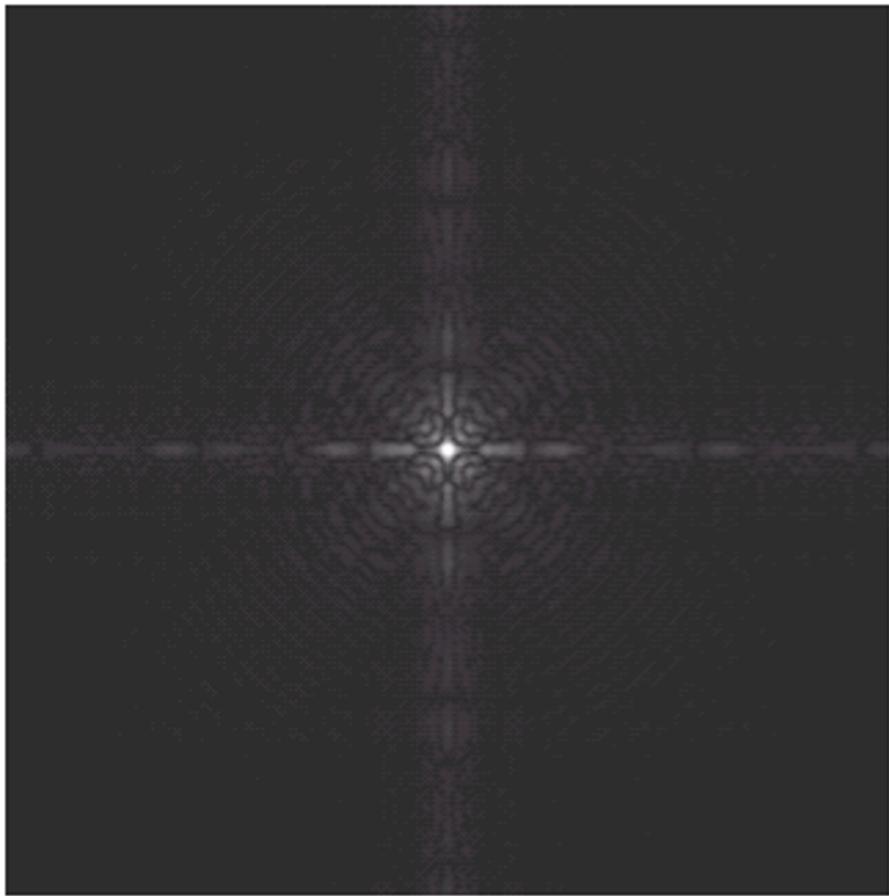


5) Binarização (“Thresholding”)

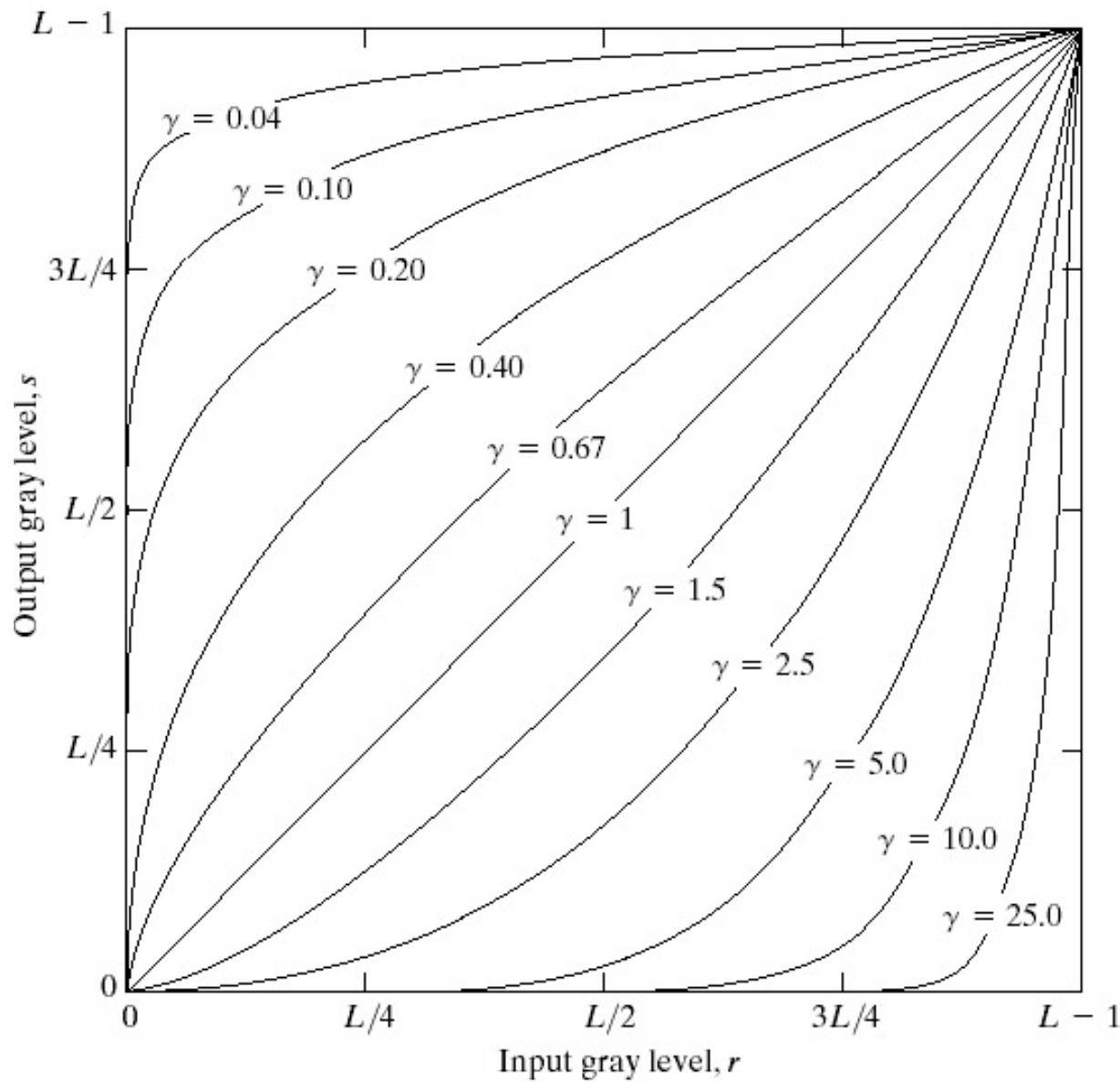


Transformações Não-Lineares

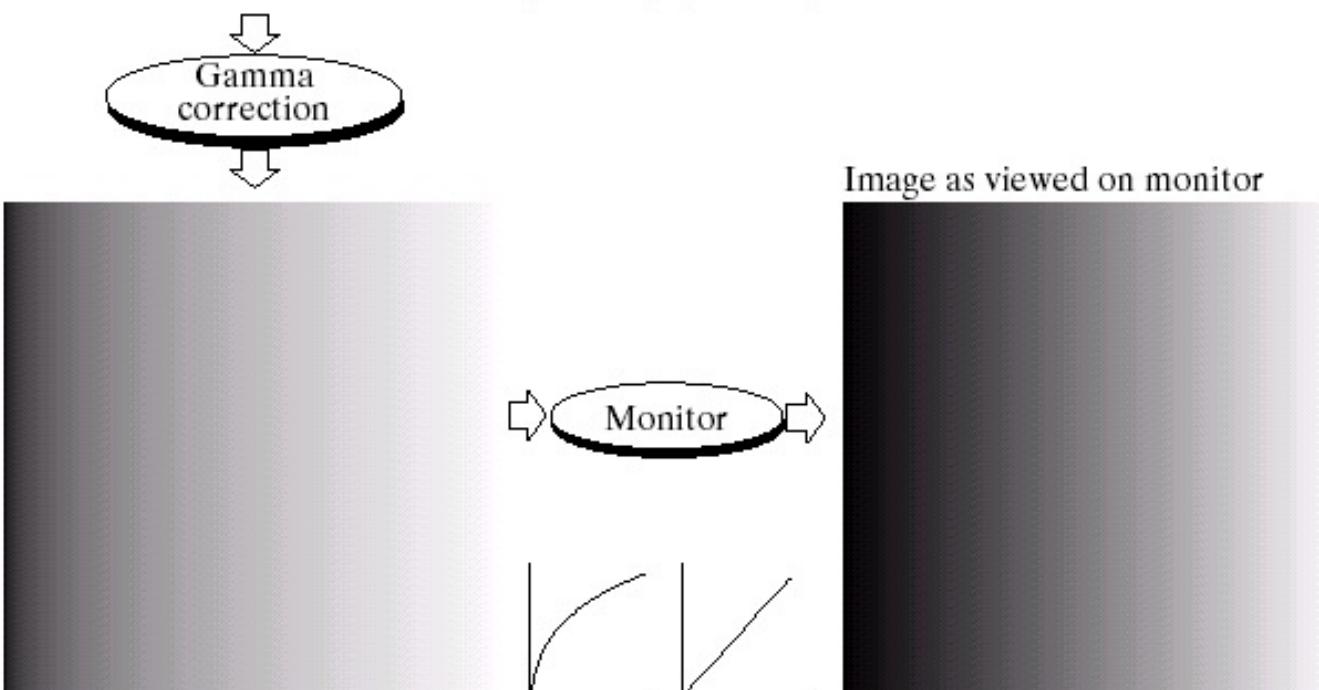
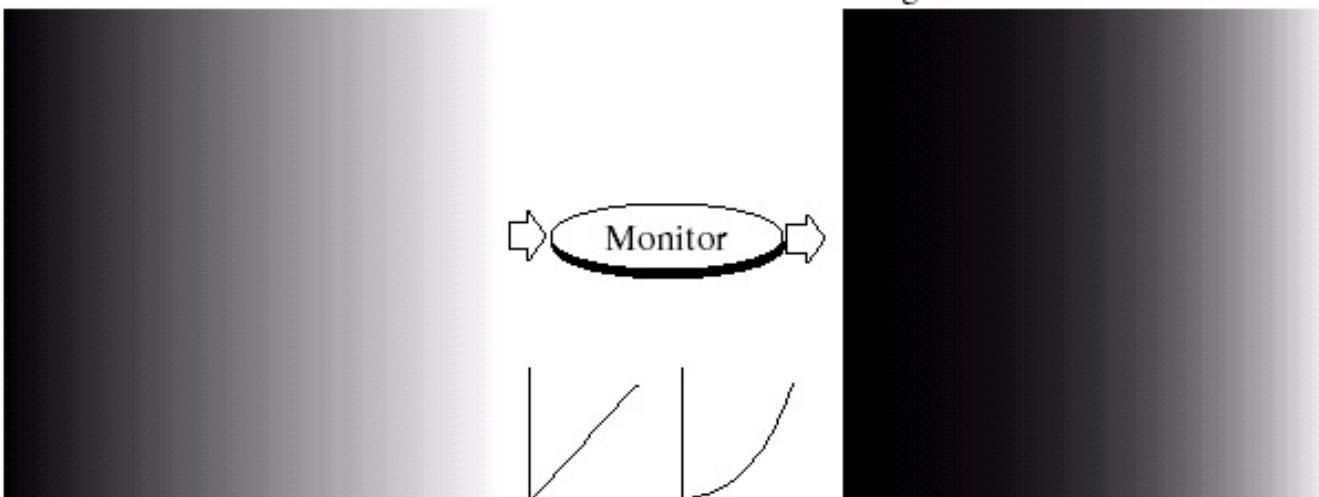




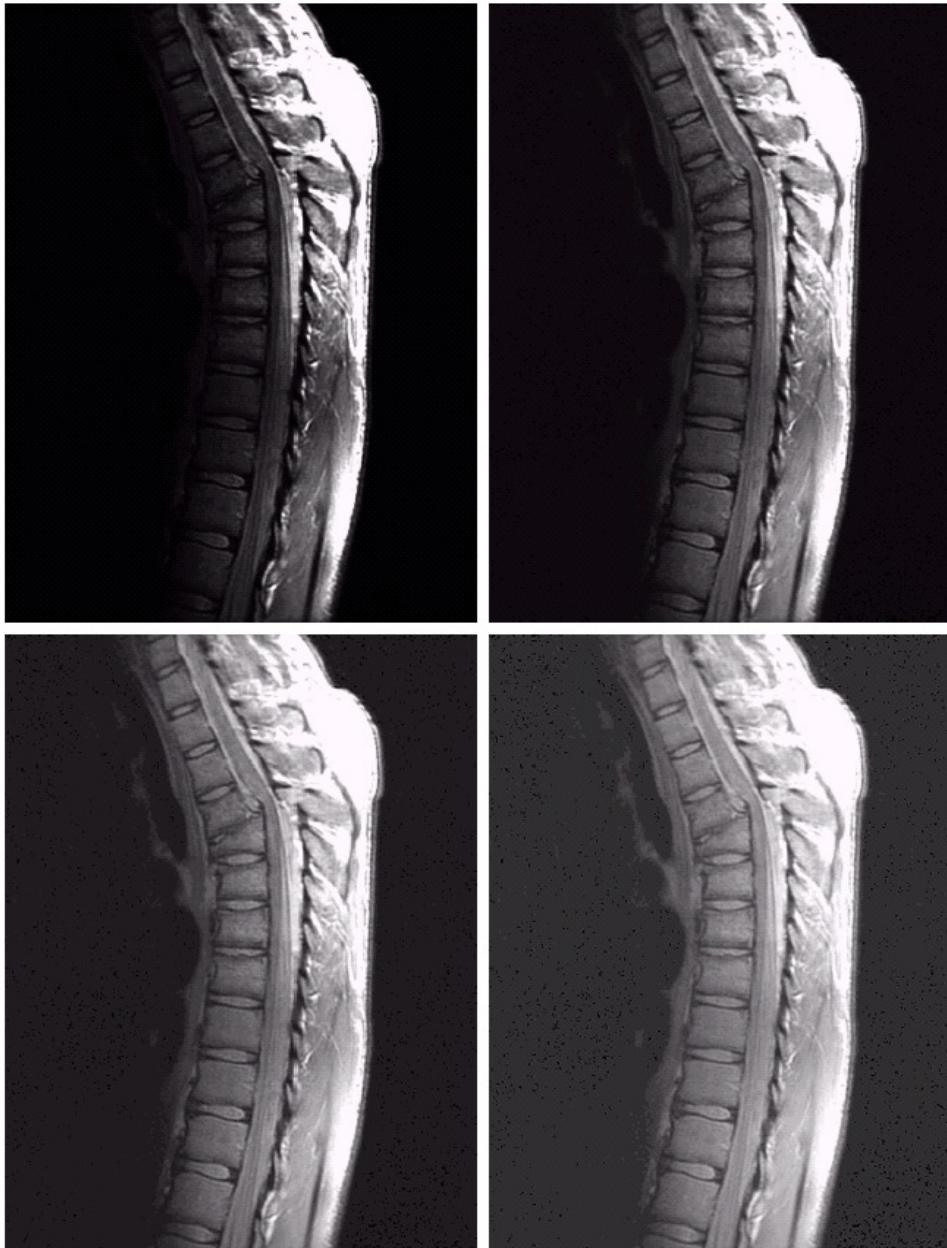
Correção Gamma



Correção Gamma



Correção Gamma



a b
c d

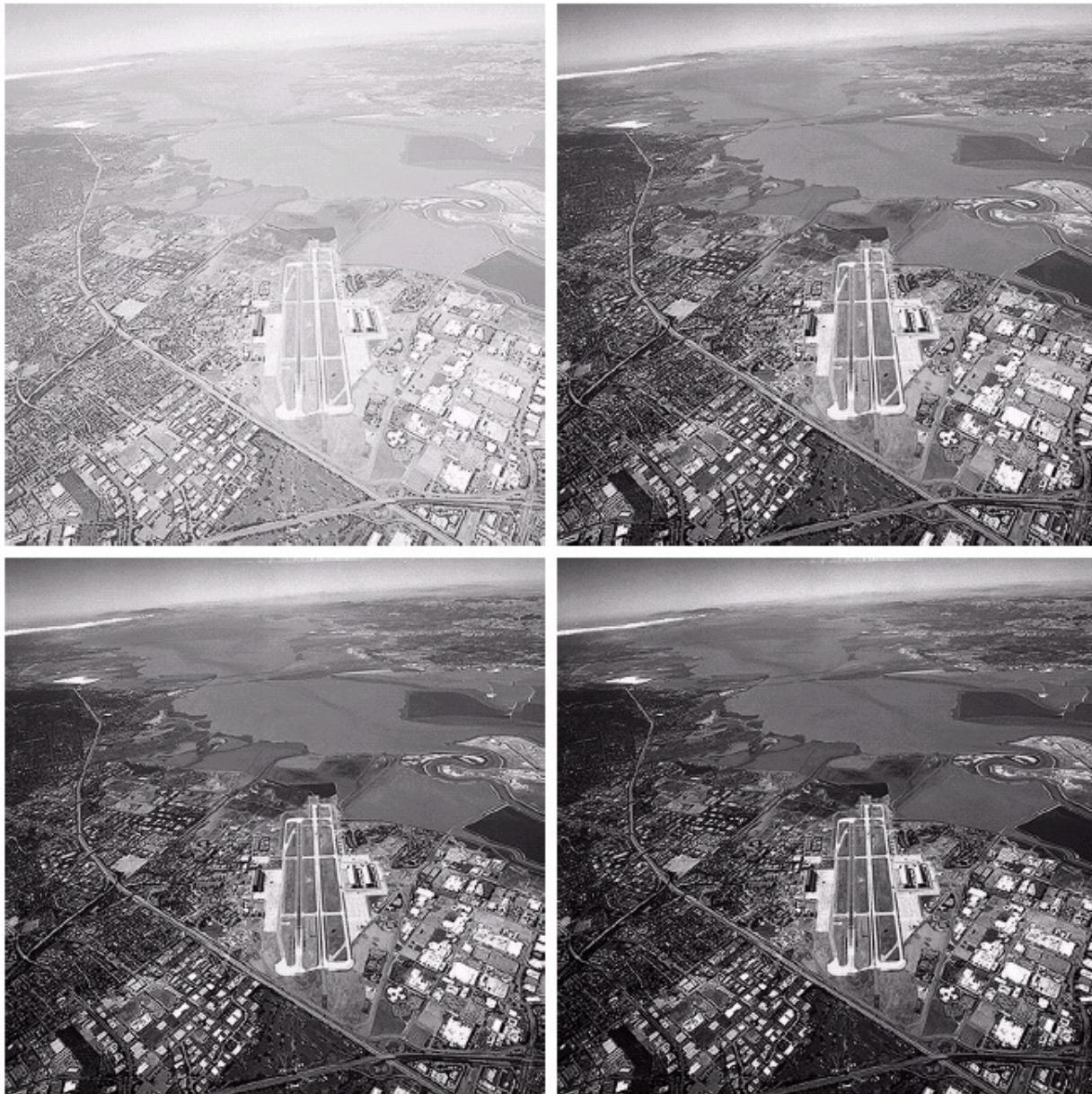
FIGURE 3.8
(a) Magnetic resonance (MR) image of a fractured human spine.
(b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 0.6, 0.4$, and 0.3 , respectively.
(Original image for this example courtesy of Dr. David R. Pickens, Department of Radiology and Radiological Sciences, Vanderbilt University Medical Center.)

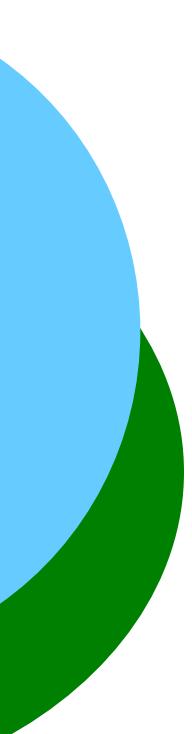
Correção Gamma

a b
c d

FIGURE 3.9

(a) Aerial image.
(b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 3.0, 4.0$, and 5.0 , respectively. (Original image for this example courtesy of NASA.)





FIM