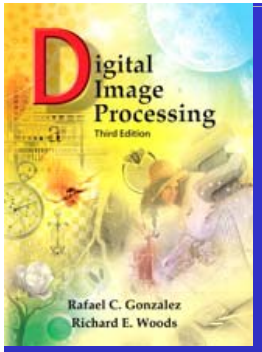
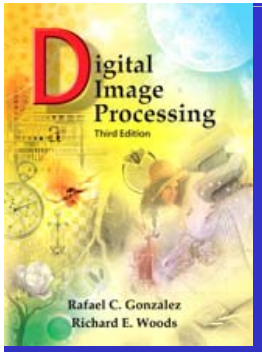


Chapter 3

強度轉換與空間濾波

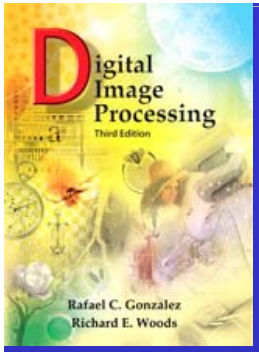
基本觀念
與
基本強度轉換函數



Chapter 3

強度轉換與空間濾波

- 影像強化(Image enhancement)
  - 處理一幅影像,使其結果對 “特定的應用” 比原始影像更合用
  - 依方法分爲兩大類
    - 空間域 (Spatial domain)
      - 直接處理影像中的像素
    - 頻率域 (Frequency domain)
      - 修改影像的傅立葉轉換爲基礎



Chapter 3

強度轉換與空間濾波

空間域的處理

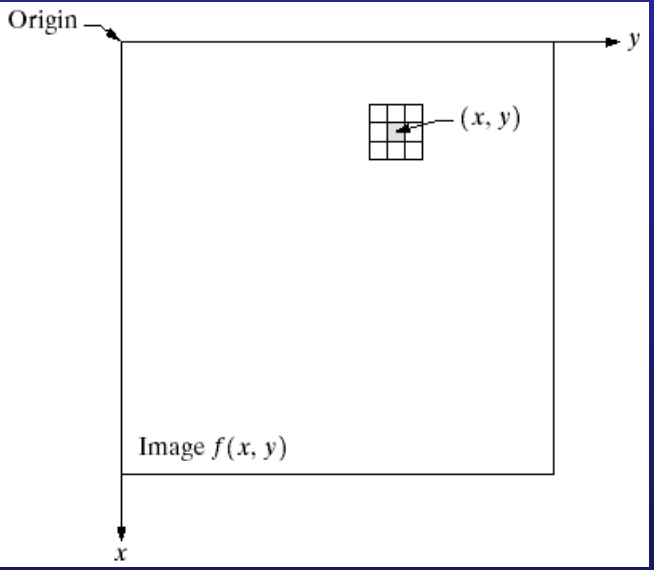
- 通常使用3*3 鄰域 (遮罩)
  - 遮罩處理(mask processing)或濾波(filtering)
- 定義一點(x,y)附近一個方形的子影像區域
- 運算子T在每個子影像區域作用而在(x,y)產生g(x,y)

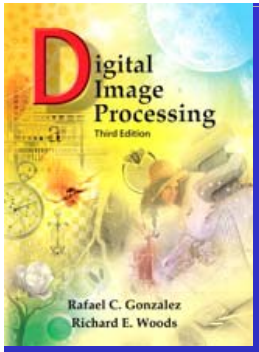
$$g(x,y) = T[f(x,y)]$$

$f(x,y)$: 輸入影像

$g(x,y)$: 處理後的影像

FIGURE 3.1 A 3×3 neighborhood about a point (x, y) in an image.





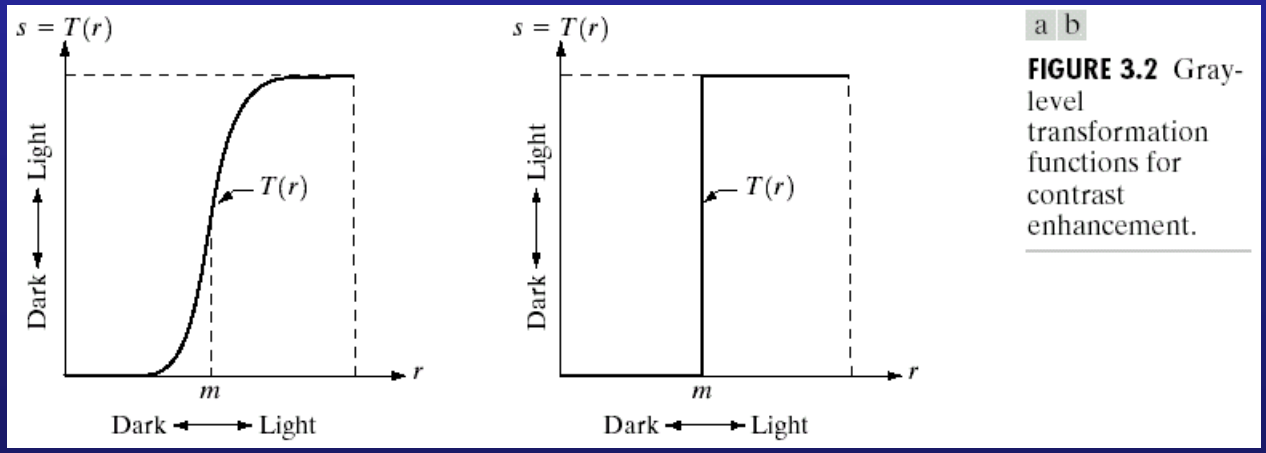
Chapter 3

強度轉換與空間濾波

灰階度轉移函數(Gray-level transformation function)

$$s = T(r)$$

r: the gray-level of $f(x,y)$
s: the gray-level of $g(x,y)$

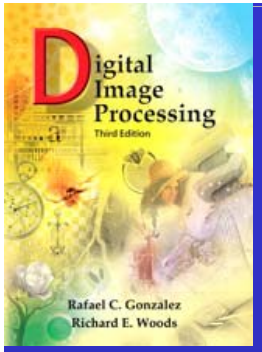


a b

FIGURE 3.2 Gray-level transformation functions for contrast enhancement.

對比度擴展
Contrast stretching

臨界函數
Thresholding



Chapter 3

強度轉換與空間濾波

影像增強常用的三種基本函數

1. 線性
   恆等Identity
   負片Image negatives

$$s = (L-1) - r$$

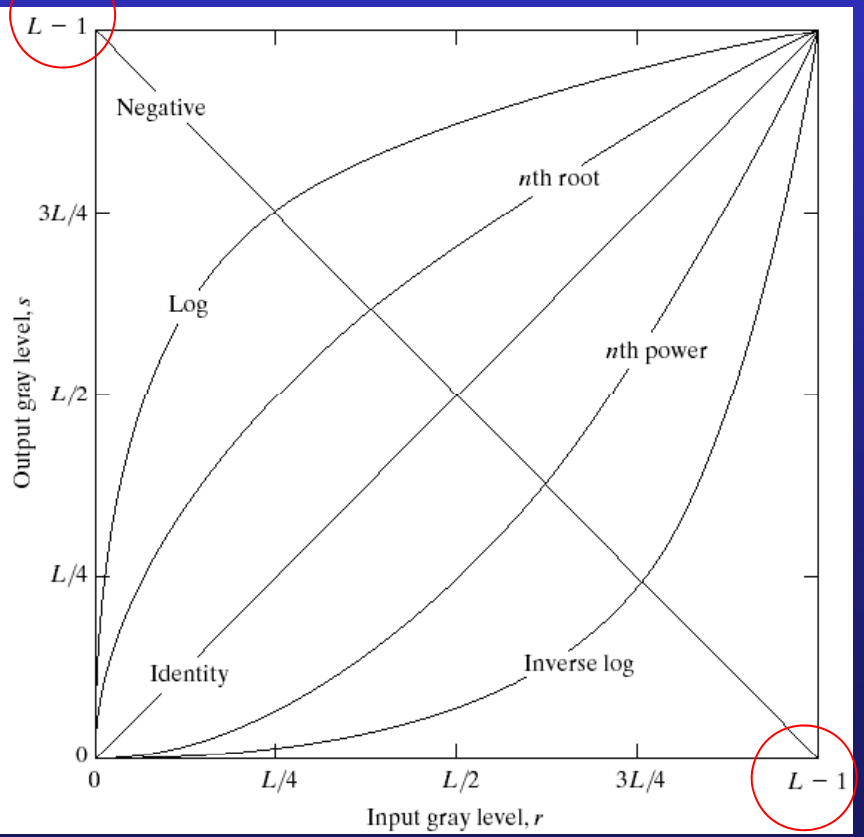
2. Log transformation
   Log and inverse log

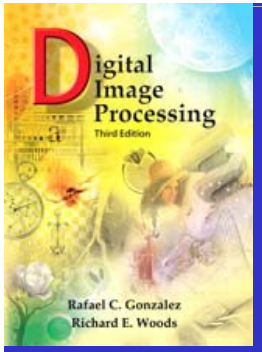
$$s = c\log(1+r)$$

3. Power-Law
   *r*次冪次及方根

$$s = cr^{\gamma}$$

FIGURE 3.3 Some basic gray-level transformation functions used for image enhancement.





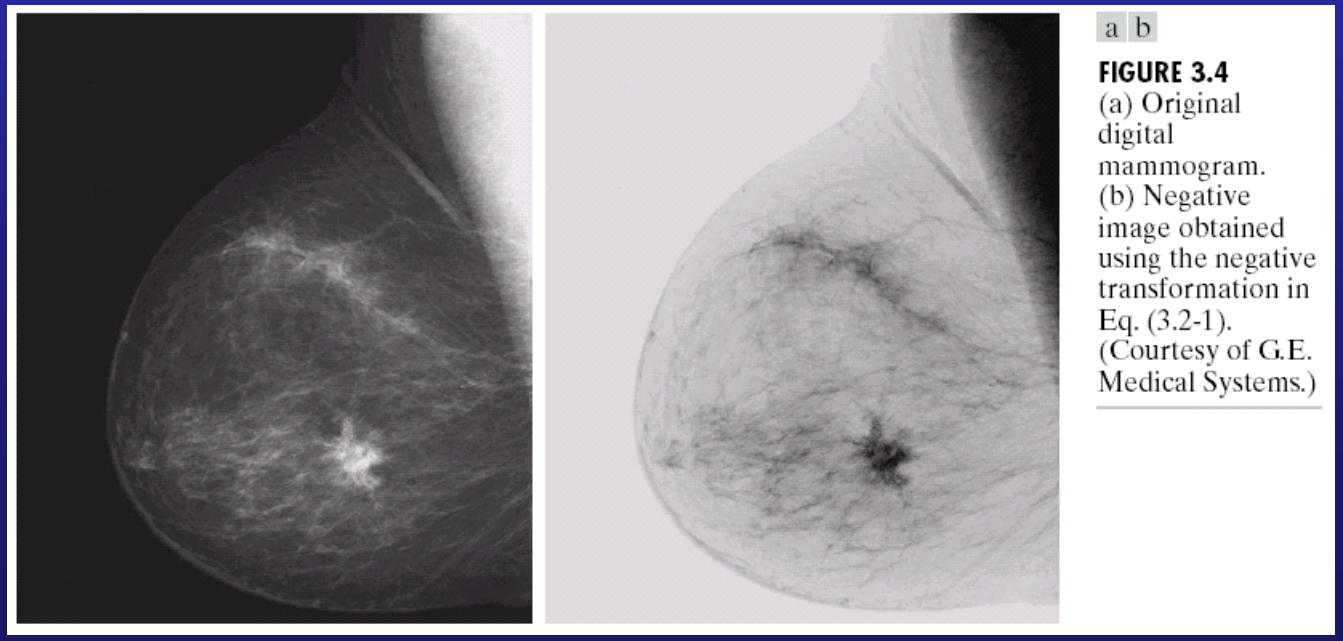
Chapter 3

強度轉換與空間濾波

Negative transformation

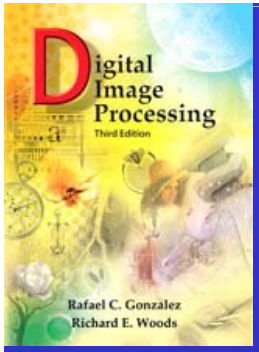
將影像強度反轉產生等同照片負片的效果
適合增強埋藏在黑暗影像中的白色或灰色細節

$$s = (L-1) - r$$



a b

FIGURE 3.4 (a) Original digital mammogram. (b) Negative image obtained using the negative transformation in Eq. (3.2-1). (Courtesy of G.E. Medical Systems.)



Chapter 3

強度轉換與空間濾波

Log轉換(Log transformation)

- 將輸入影像的低灰階窄範圍映射至一輸出準位較寬的範圍較高灰階的輸入值則對應一輸出準位較窄的範圍
- 用於擴張影像中黑暗像素的值，同時壓縮比較高準位的值

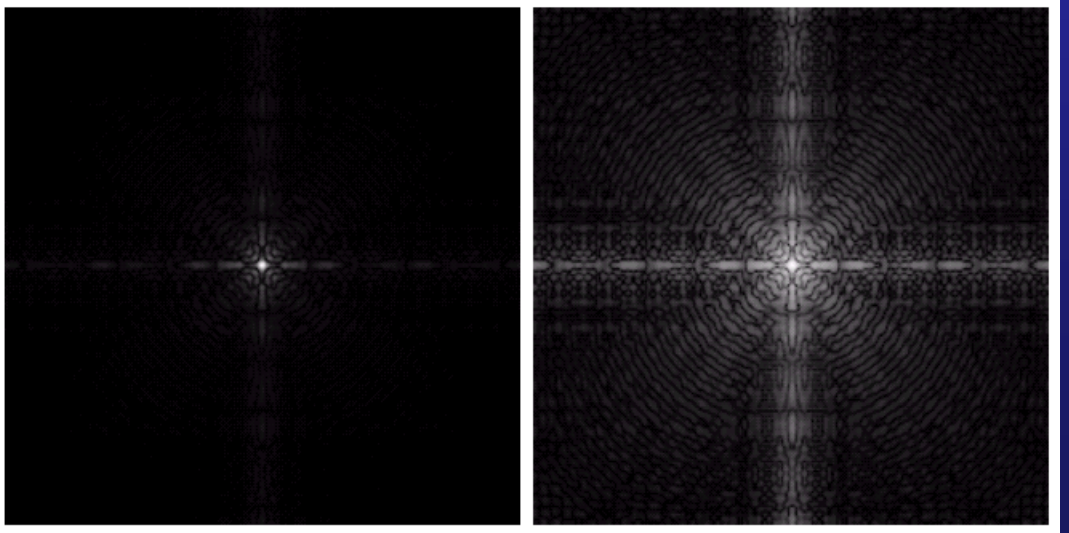
$$s = c\log(1+r)$$

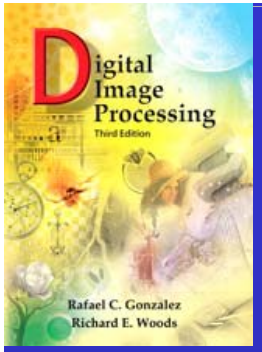
c : 常數

$r \geq 0$

a b

FIGURE 3.5 (a) Fourier spectrum. (b) Result of applying the log transformation given in Eq. (3.2-2) with $c = 1$.





Chapter 3

強度轉換與空間濾波

乘冪律轉換(Gamma, Power-Law transformation)

- 小γ值
  將黑暗輸入值對應至寬輸出範圍
- 大γ值
  將高亮度輸入值對應至寬輸出範圍
- γ >1與γ <1所產生的曲線恰有相反的效果
- c= γ =1 時簡化成恆等轉換

$$s = cr^{\gamma}$$

$$c > 0$$

$$\gamma > 0$$

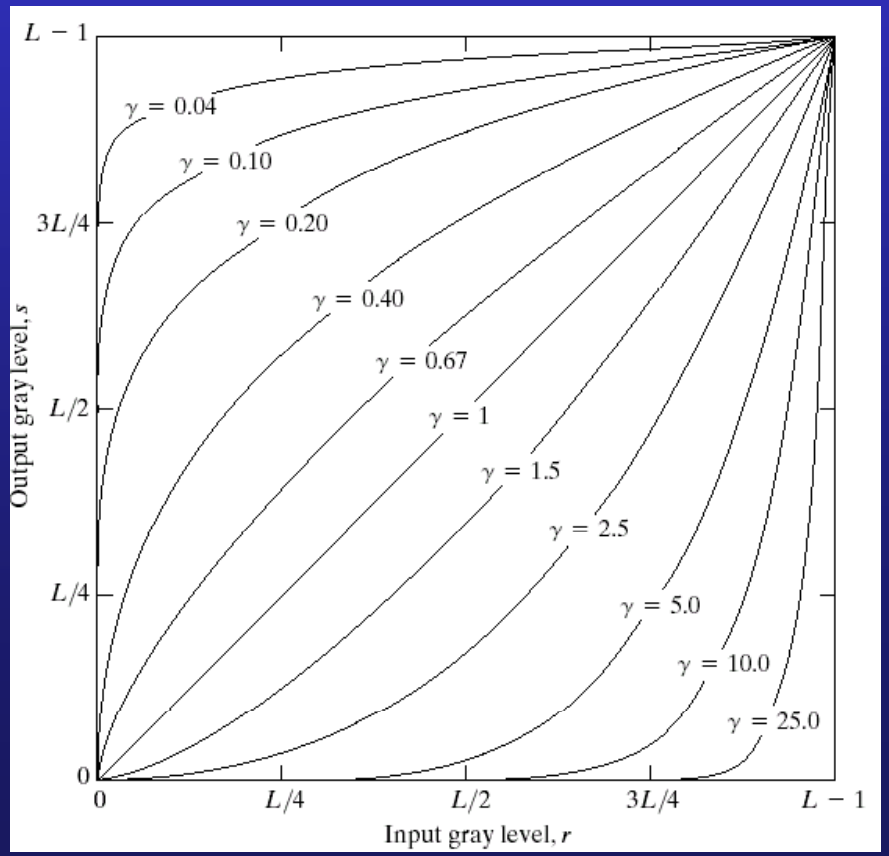
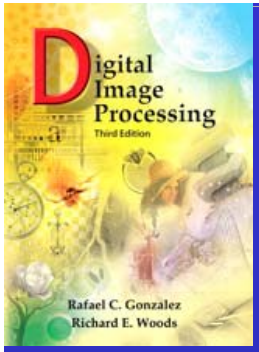


FIGURE 3.6 Plots of the equation $s = cr^{\gamma}$ for various values of γ ($c = 1$ in all cases).



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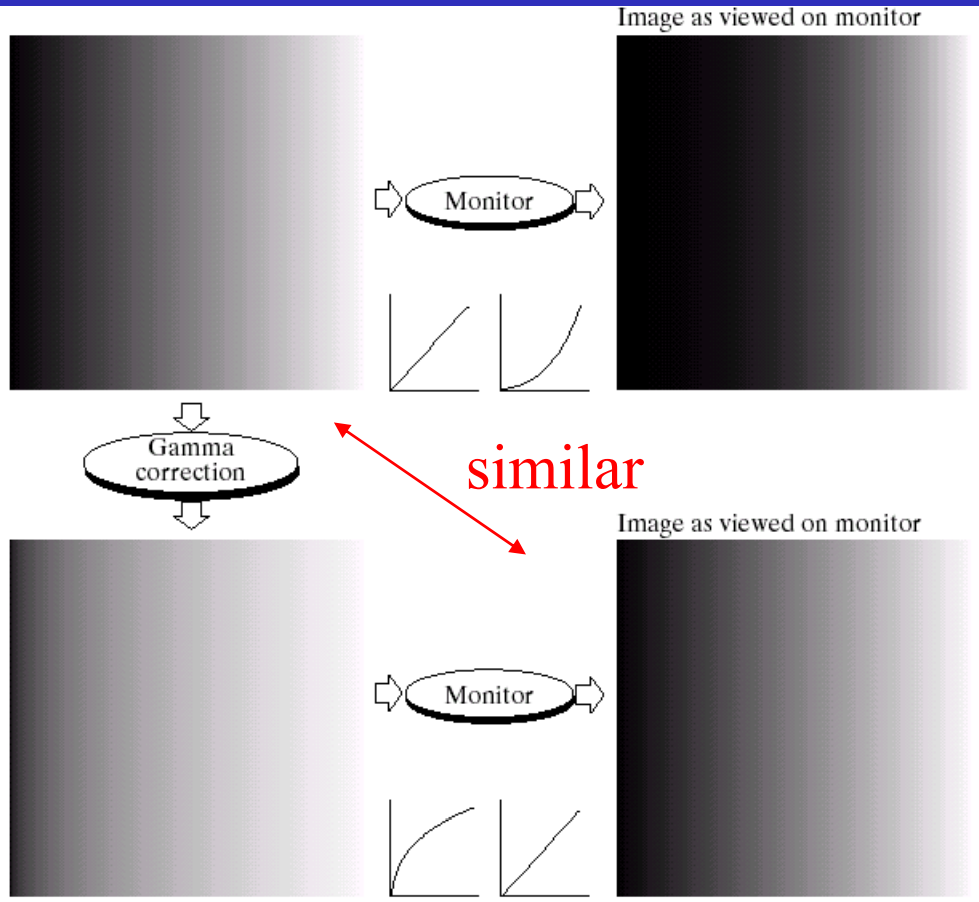
強度轉換與空間濾波

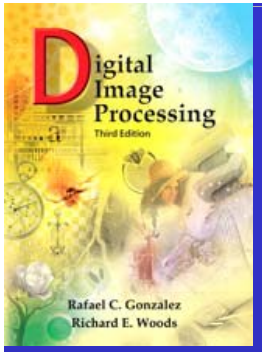
Gamma 校正

陰極射線管會呈現比設定來得暗的亮度
所以需將gamma調低

a b
c d

FIGURE 3.7
(a) Linear-wedge gray-scale image. (b) Response of monitor to linear wedge. (c) Gamma-corrected wedge. (d) Output of monitor.





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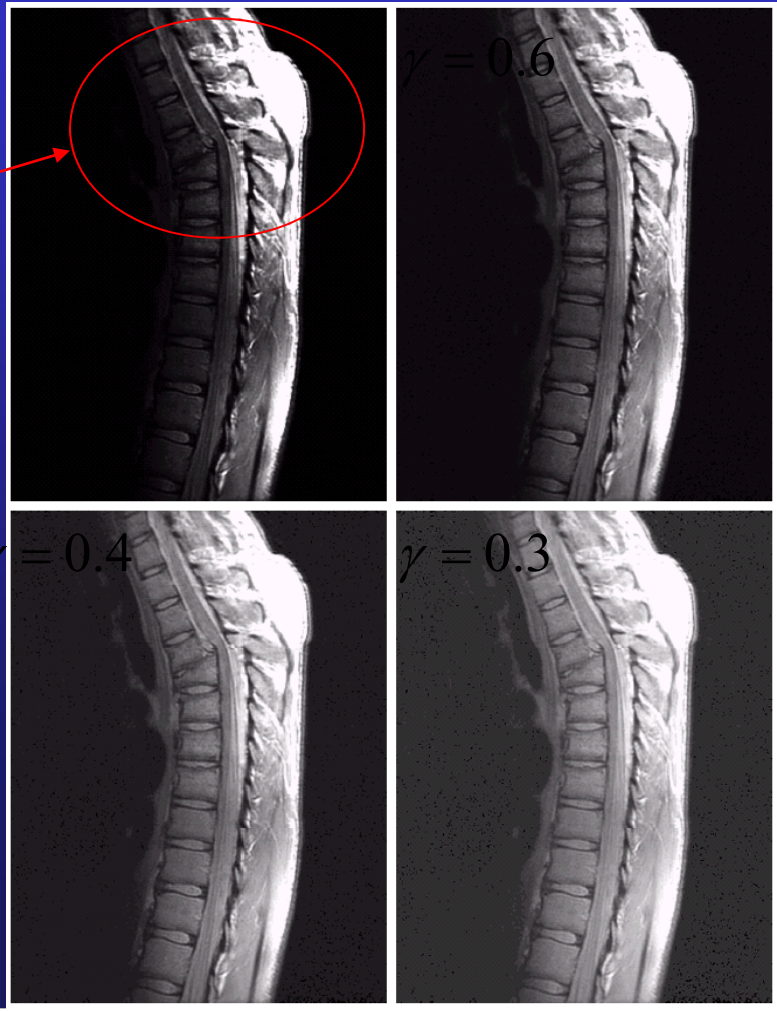
強度轉換與空間濾波

Application for Gamma correlation

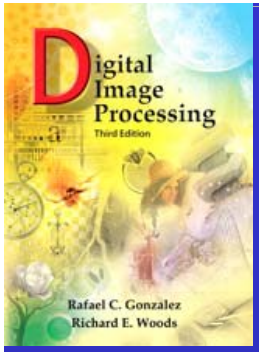
Fractured spine

從0.6~0.4時可以看到更多的細節, 然而降到0.3時對比度明顯降低



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.)



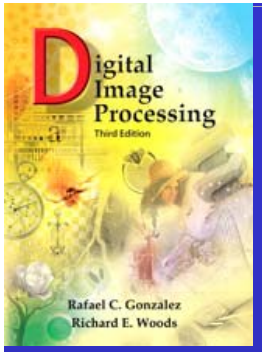
Chapter 3

強度轉換與空間濾波

從3~4時效果很好, 然而提升5時影像過暗

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.)



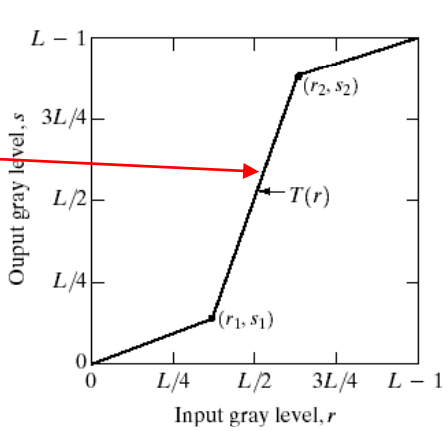
Chapter 3

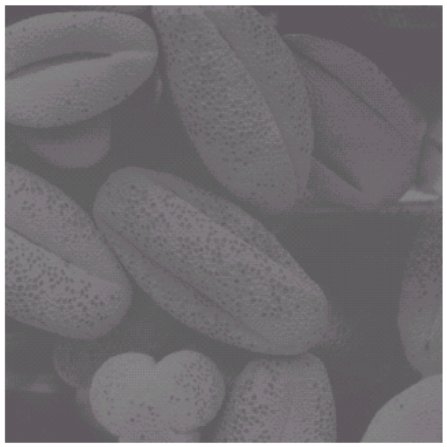
強度轉換與空間濾波

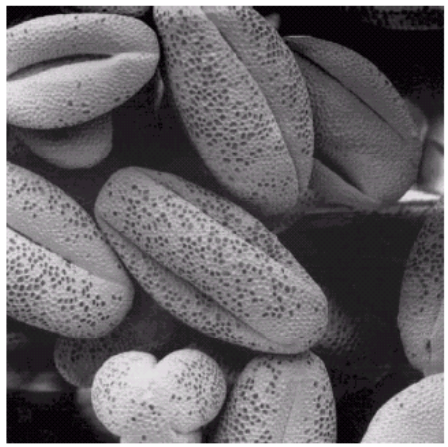
逐段性轉換函數(Piecewise-Linear Transformation)

對比度擴展
Contrast stretching

- 低對比度影像導源於低的照明、影像感測器的動態範圍不夠
- 對比度擴展增加影像中灰階的動態範圍

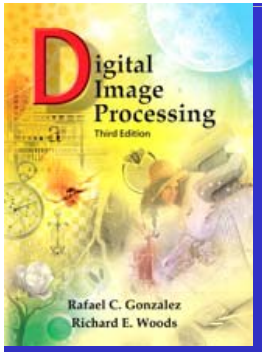






a b
c d

FIGURE 3.10 Contrast stretching. (a) Form of transformation function. (b) A low-contrast image. (c) Result of contrast stretching. (d) Result of thresholding. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)



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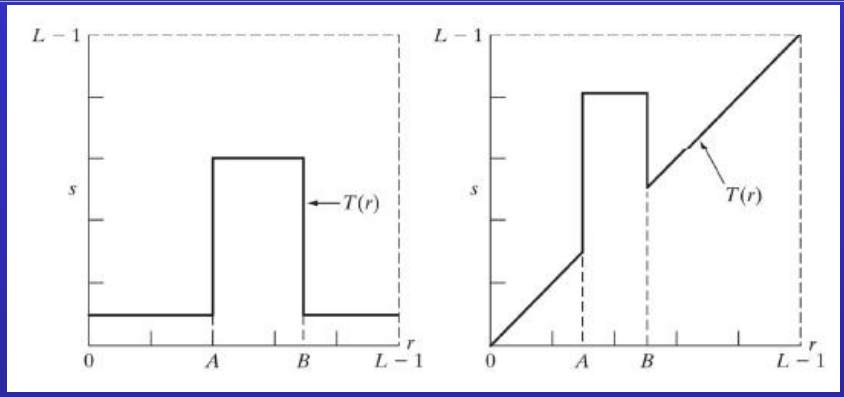
強度轉換與空間濾波



強度準位切片 (Intensity-level slicing)

用於突顯一幅影像的特定灰階範圍

1. 將感興趣範圍的所有灰階顯示爲高灰階，其他的爲另一個灰階值
2. 希望的灰階變亮，保持影像的背景灰階色調

血管與腎臟爲白色　血管與腎臟的灰階被保留

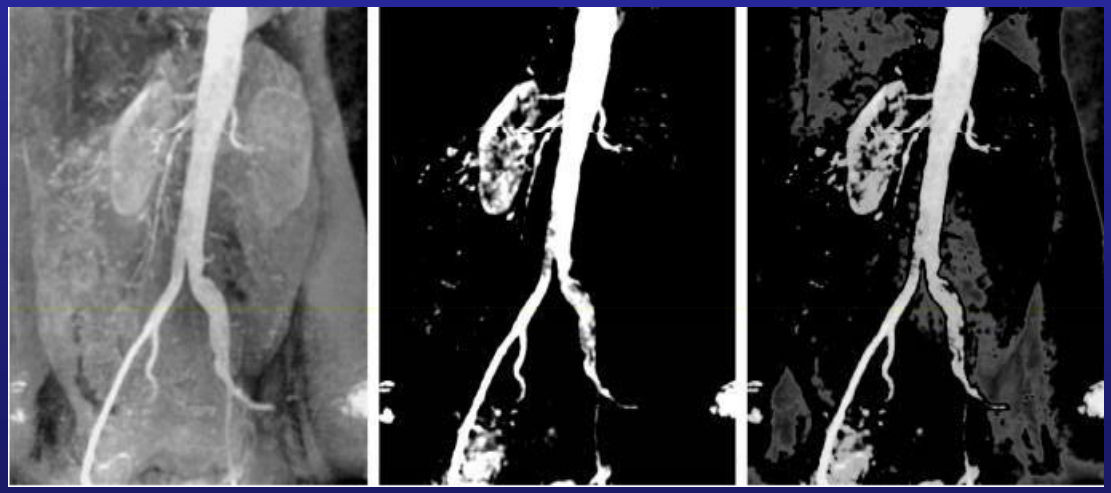
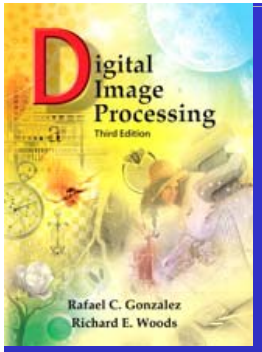


圖3.11 (a) 此轉換凸顯出強度範圍 [*A*, *B*]，並減少所有其它強度到一個較低的位準；(b) 此轉換凸顯 [*A*, *B*] 的範圍並保存所有其它強度準位。



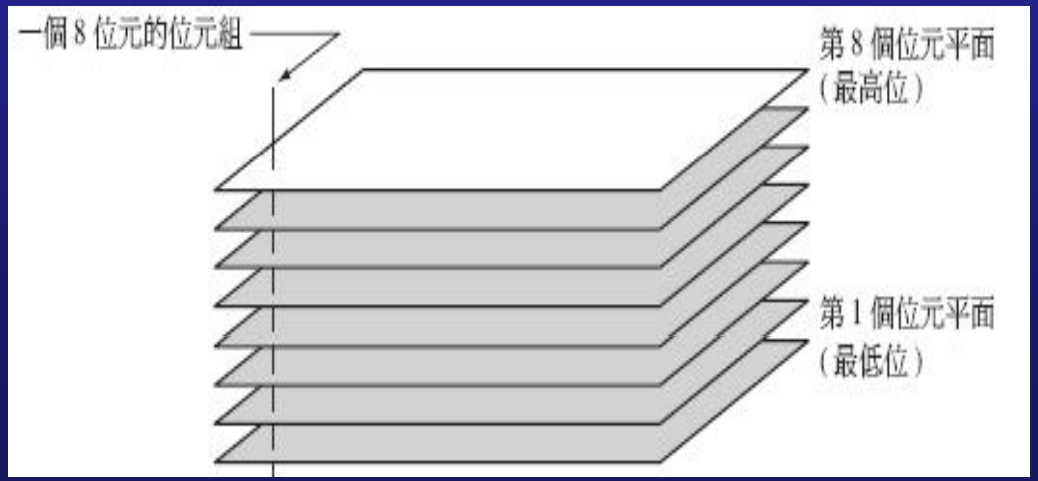
Chapter 3

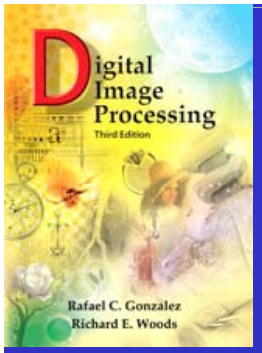
強度轉換與空間濾波

位元平面切片

Bit-plane slicing for a 8-bit image

- 不強調灰階範圍而強調特定位元對整體影像顯示的貢獻
- 高位元通常含有可見的有意義資料
- 平面1—包含組成所有像素位元組的最低位元(通常最不重要)
- 平面8—包含所有高位元
- 意義– 由每一位元的相對重要性可適當決定影像位元數，也對壓縮有幫助



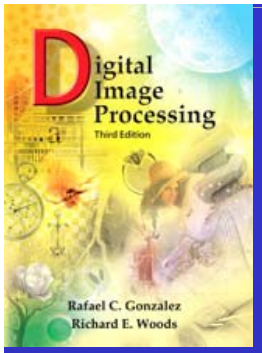


Chapter 3

強度轉換與空間濾波

a b c
d e f
g h i

FIGURE 3.14 (a) An 8-bit gray-scale image of size 500 × 1192 pixels. (b) through (i) Bit planes 1 through 8, with bit plane 1 corresponding to the least significant bit. Each bit plane is a binary image.



Chapter 3

強度轉換與空間濾波

a b c

FIGURE 3.15 Images reconstructed using (a) bit planes 8 and 7; (b) bit planes 8, 7, and 6; and (c) bit planes 8, 7, 6, and 5. Compare (c) with Fig. 3.14(a).