暑期課程
基本影像處理 day5-1

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Course Outline

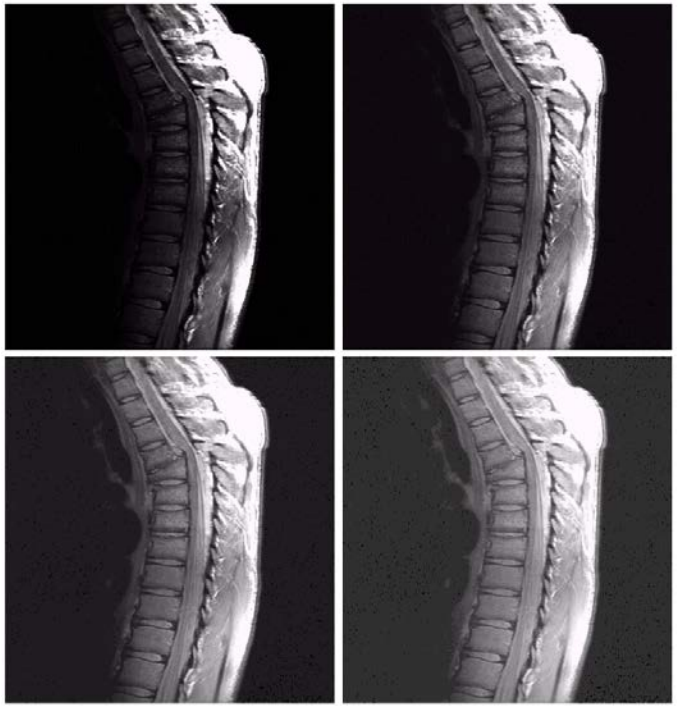
- Image Enhancement (影像強化)
  - Histogram (直方圖)
  - Contrast Enhancement (對比強化)
- A short introduction to Pattern Recognition
- Histogram of Oriented Gradients (方向梯度直方圖)

Image Enhancement

- 影像強化之目的
  - 處理影像使其處理後之結果，較原始影像更能適合該影像之特定用途

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.)



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.)

Image Enhancement (cont.)

- Image Histogram (影像直方圖)
  - probability density function (pdf)

Pixel Value	Number of Pixels
0	5
1	7
2	9
3	4

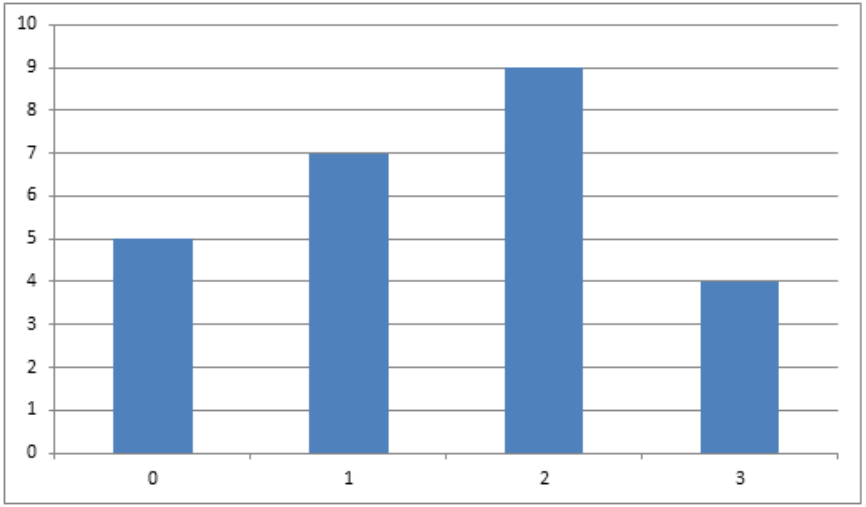
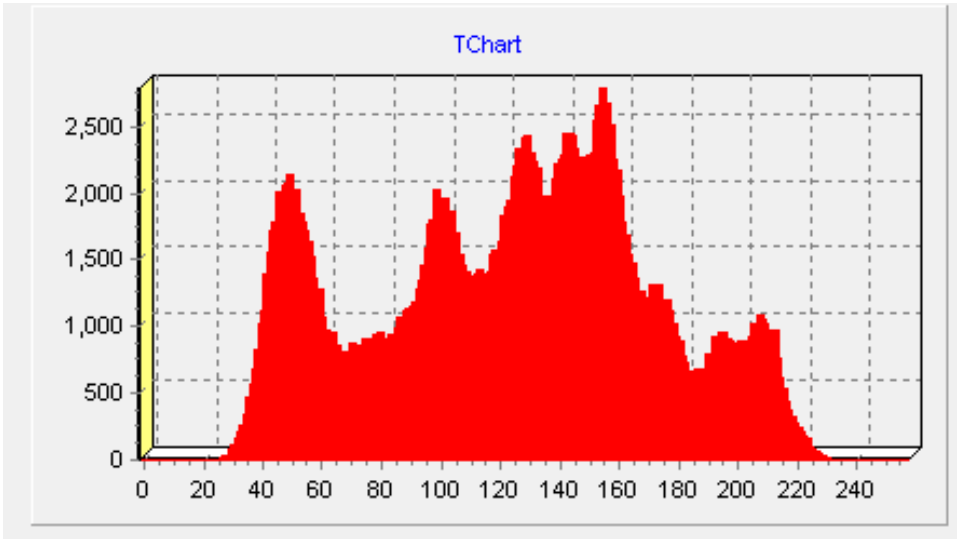


Image Enhancement (cont.)

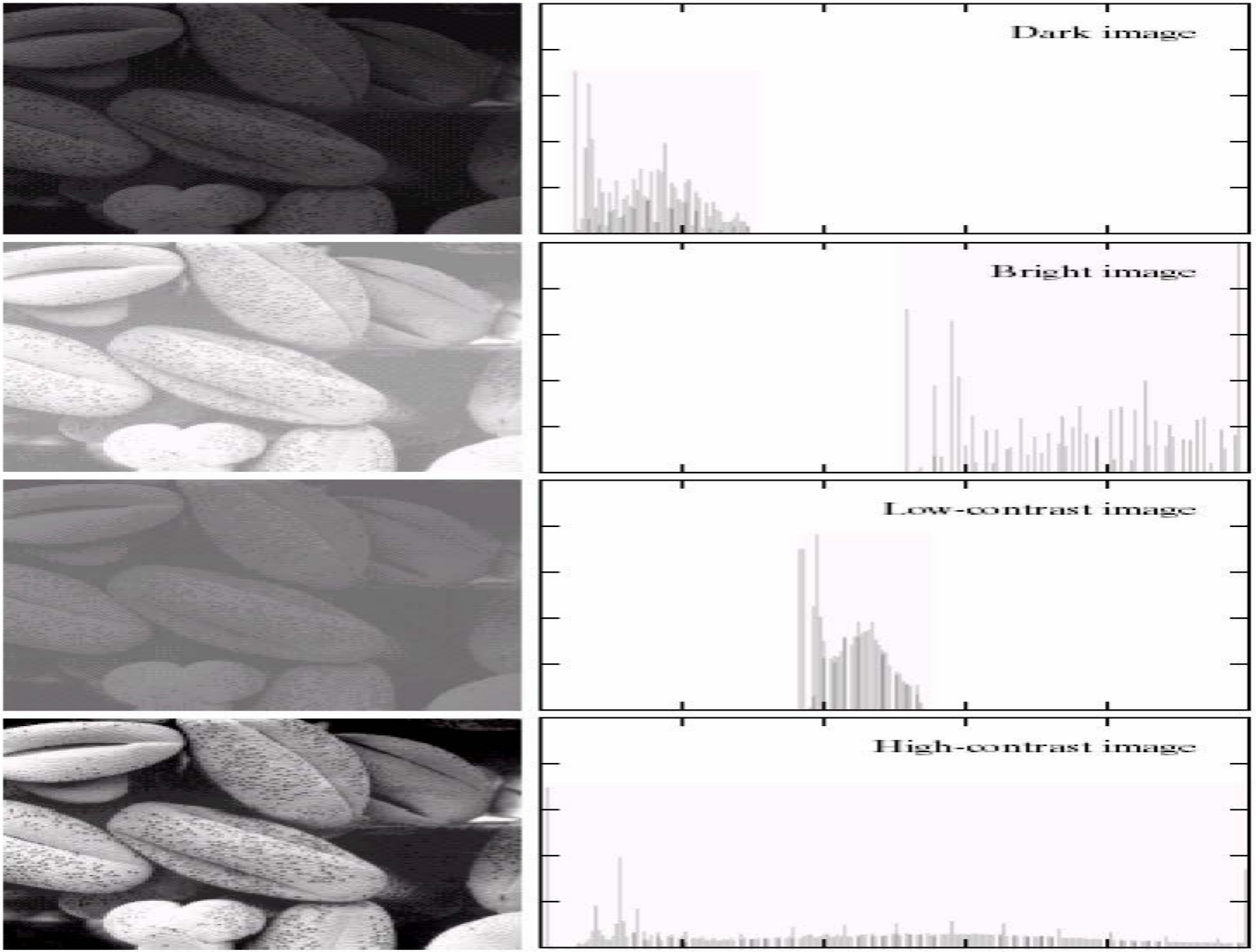
- grayscale histogram



  - 以gray value為x軸的Pixel數量統計圖
  - histogram[gray]++

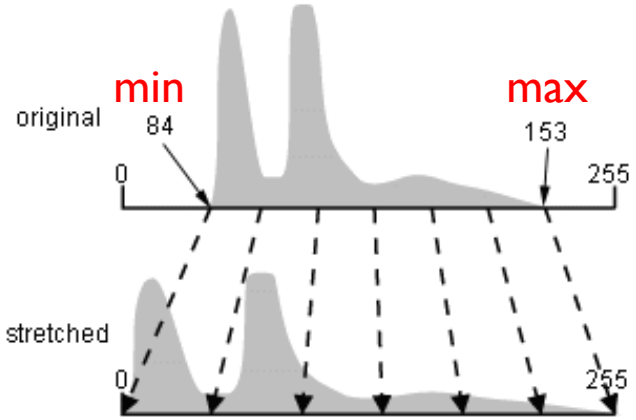
Image Enhancement (cont.)

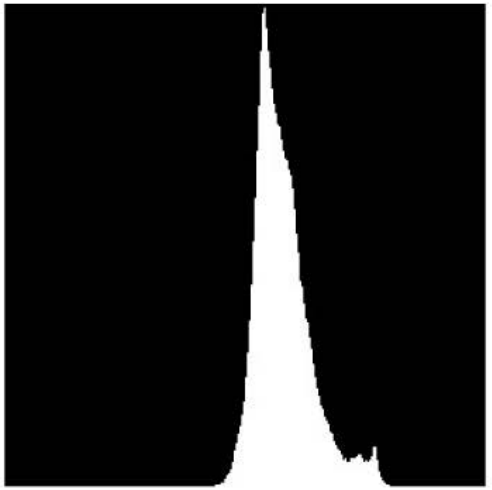
- Histogram Enhancement (直方圖強化)
  - Contrast Stretch (對比延展)
  - Histogram equalization (直方圖等化)

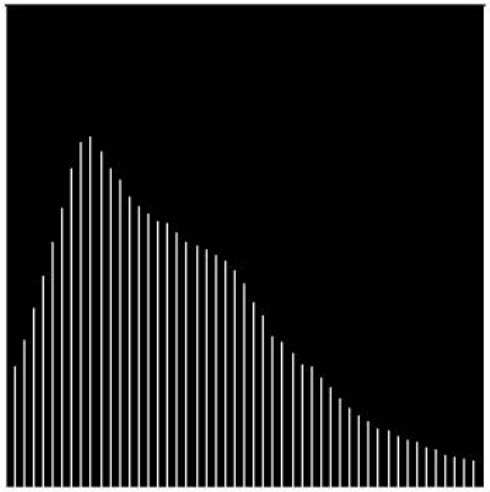

Dark image
Bright image
Low-contrast image
High-contrast image

Contrast Stretch (對比延展)

- F(x, y) 代表強化後的pixel
- f(x, y) 代表原始的pixel
- F(x, y)
- = 0 if f(x,y) < min
- = 255 if f(x,y) > max
- = ((f(x, y) - min) / (max - min)) * 255 else







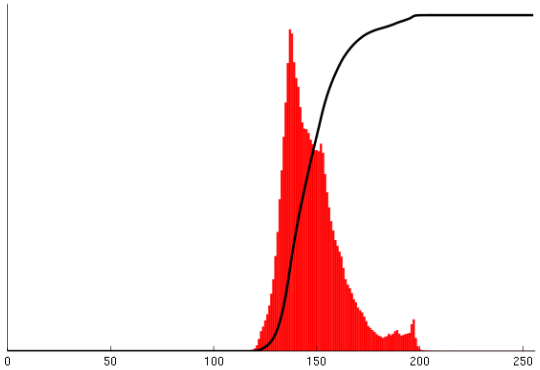
Histogram Equalization

- 直方圖均衡化(Histogram Equalization)是通過灰度機率分佈的變換，將一影像轉換為另一影像使其具有均衡直方圖，將原先的亮度分佈重新均勻的等化到新的亮度值。

- 把原本集中在某區塊的機率函數(PDF)平均分布在所有顏色上面

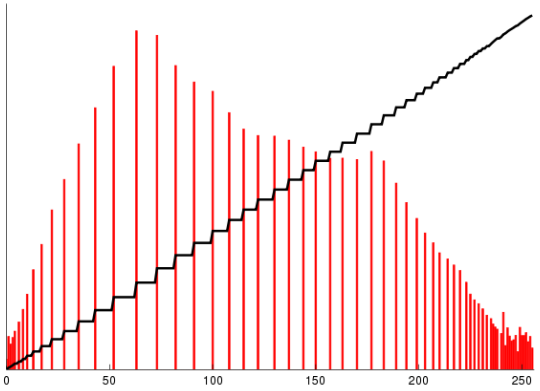
Histogram Equalization (cont.)

An unequalized image



Corresponding histogram (red) and cumulative histogram (black)

The same image after histogram equalization



Corresponding histogram (red) and cumulative histogram (black)

Histogram Equalization (cont.)

- 步驟如下：

  1. 建立影像的 histogram (PDF).
  2. 計算影像的 cumulative distribution function (CDF).
  3. 根據 CDF 以及 cumulative equalization 公式計算灰階亮度的對應關係.

$$c(i) = \sum_{j=0}^{i} p_x(j)$$

  4. 根據對應關係計算出新的灰階亮度.

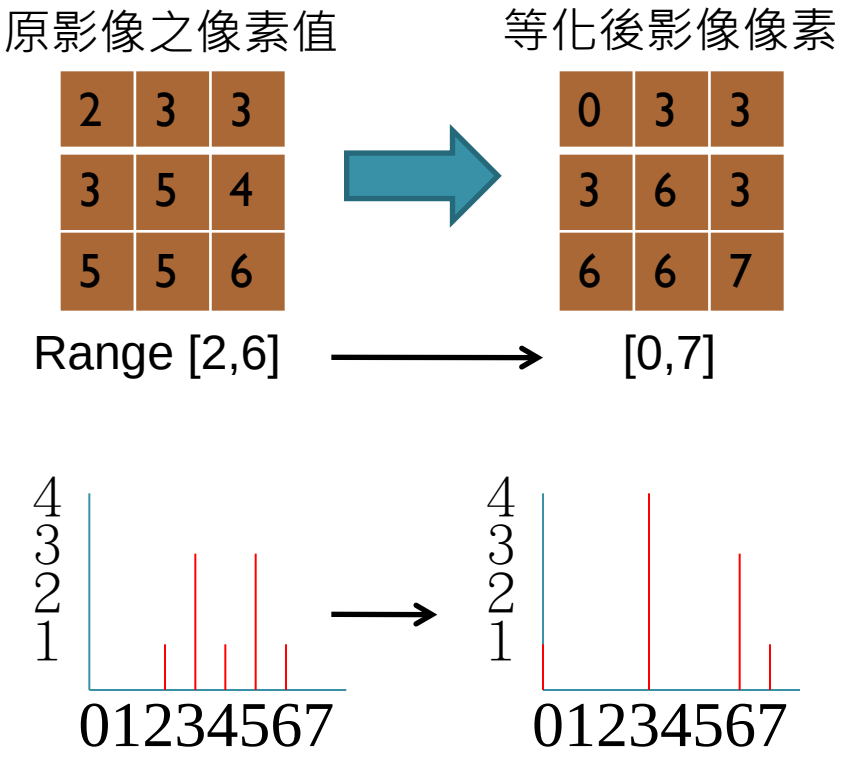
example

假設pixe value之範圍為0~7

k = 0 to n-1; n = 8

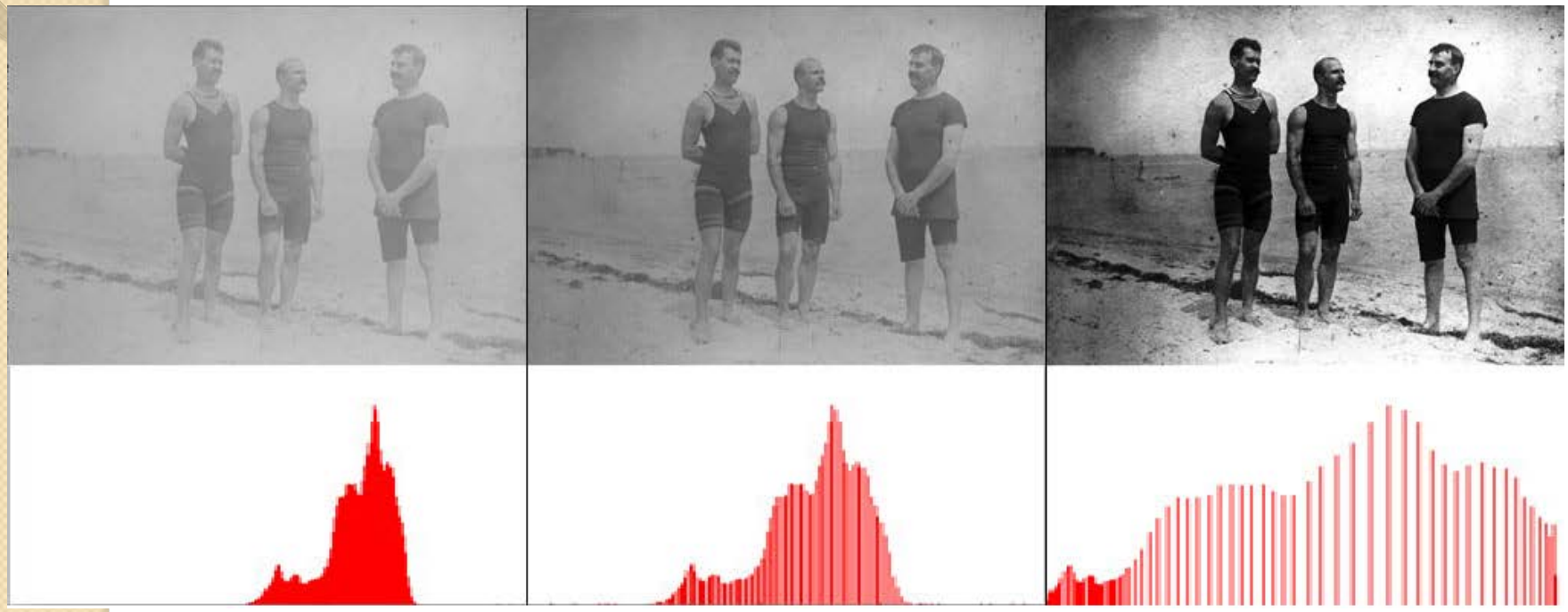
$$c(i) = \sum_{j=0}^{i} p_x(j)$$

r_k	n_k	$P(r_k)$	$C(r_k)$	新的pixel value (S_k)
0	0	0	0	$[C(r_k)\times(n-1)] = 0$
1	0	0	0	$[0\times(7)] = 0$
2	1	1/9	1/9	$[(1/9)\times(7)] = 0$
3	3	3/9	4/9	$[(4/9)\times(7)] = 3$
4	1	1/9	5/9	$[(5/9)\times(7)] = 3$
5	3	3/9	8/9	$[(8/9)\times(7)] = 6$
6	1	1/9	1	$[1\times(7)] = 7$
7	0	0	1	$[1\times(7)] = 7$



r_k = 原始 gray value
n_k = gray value對應的pixel數
$P(r_k)$ = pdf = n_k/(width*height)
$C(r_k)$ = cdf
S_k = 轉換後的新 gray value

Contrast Stretch vs. Histogram Equalization



Original

Contrast stretch

Histogram equalization

Homework #5.1

- 實做Contrast Stretch
  - show出結果影像
  - show出gray historgram及histogram內容值

Homework #5.plus1

- 自由練習：
  - 實作Histogram Equalization