Image Histogram

Image Histogram

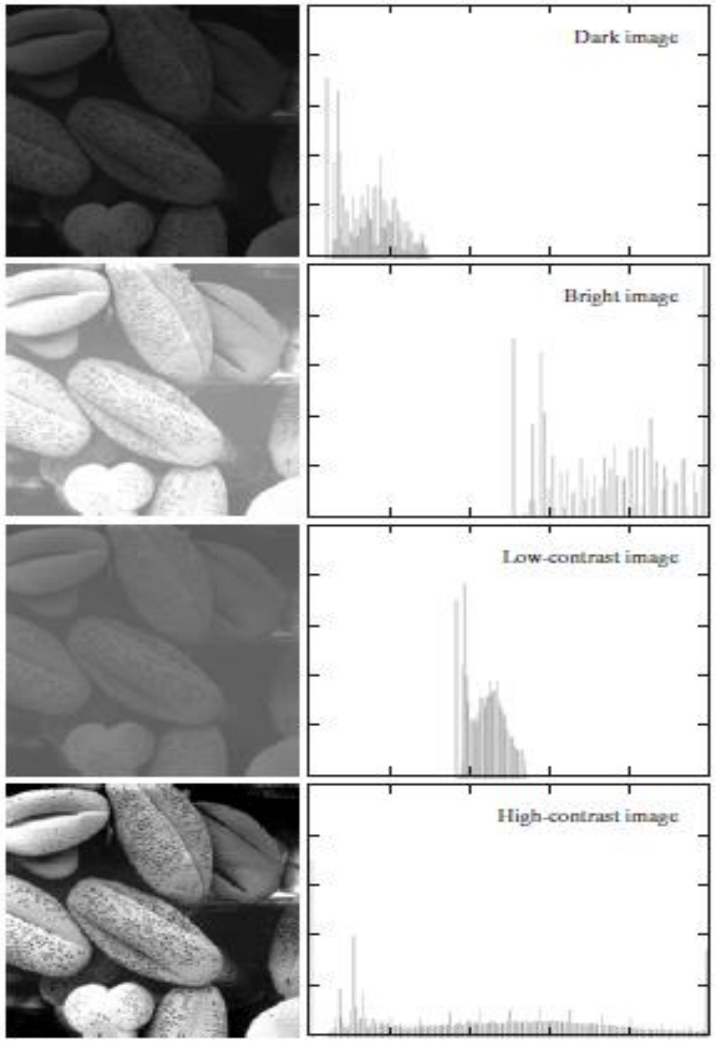
- Histogram

$$h(r_k) = n_k$$

Where r_k is the kth gray level and n_k is the number of pixels in the image having gray level r_k

- Normalized histogram

$$p(r_k) = n_k / n$$



a b

FIGURE 3.15 Four basic image types: dark, light, low contrast, high contrast, and their corresponding histograms. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)

Image Histogram Algo

```
// Initialize the histogram
for (g = 0; g<= 255; g++)
h(g) = 0

// Compute the histogram
for (i = 0; i < MAX_column; i++)
 for (j = 0; j < MAX_row; j++)
  h(f(i,j))++
```

Calculating Histogram in OpenCV

- cv2.calcHist(images, channels, mask, histSize, range)

- hist = cv2.calcHist([img],[0],None,[256],[0,255])

Histogram Equalization

- Histogram equalization can be used to improve the visual appearance of an image.

- Histogram equalization automatically determines a transformation function that produce and output image that has a near uniform histogram.

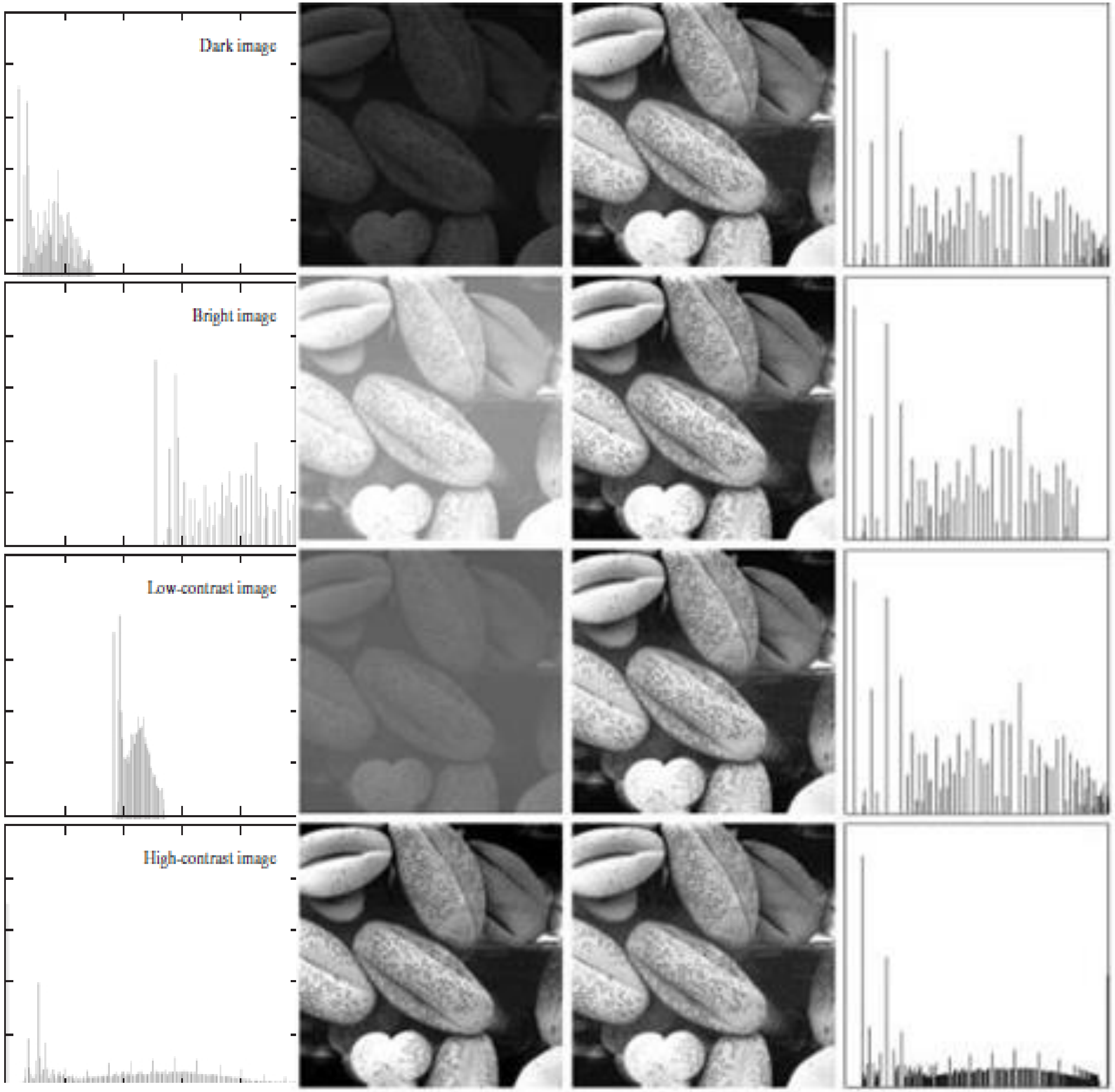


FIGURE 3.20 Left column: images from Fig. 3.16. Center column: corresponding histogram equalized images. Right column: histograms of the images in the center column.

Histogram Equalization

- Let r_k, $k \in [0..L-1]$ be intensity levels and let $p(r_k)$ be its normalized histogram function.
- The intensity transformation function for histogram equalization is

$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} p_r(r_j)$$

$$= \frac{L-1}{MN}\sum_{j=0}^{k} n_j, k = 0,1,2,\ldots,L-1$$

Histogram Equalization - Example

- Let f be an image with size 64x64 pixels and L=8 and let f has the intensity distribution as shown in the table

r_k	n_k	$p_r(r_k)=n_k/MN$
0	790	0.19
1	1023	0.25
2	850	0.21
3	656	0.16
4	329	0.08
5	245	0.06
6	122	0.03
7	81	0.02

$$s_0 = T(r_0) = 7\sum_{j=0}^{0} p_r(r_j) = 7p_r(r_0) = 1.33$$

$$s_1 = T(r_1) = 7\sum_{j=0}^{1} p_r(r_j) = 7(p_r(r_0) + p_r(r_1)) = 3.08$$

$$s_2 = 4.55, s_3 = 5.67, s_4 = 6.23, s_5 = 6.65, s_6 = 6.86, s_7 = 7.00.$$

$s_0 = 1.33 \to 1$	$s_4 = 6.23 \to 6$
$s_1 = 3.08 \to 3$	$s_5 = 6.65 \to 7$
$s_2 = 4.55 \to 5$	$s_6 = 6.86 \to 7$
$s_3 = 5.67 \to 6$	$s_7 = 7.00 \to 7$

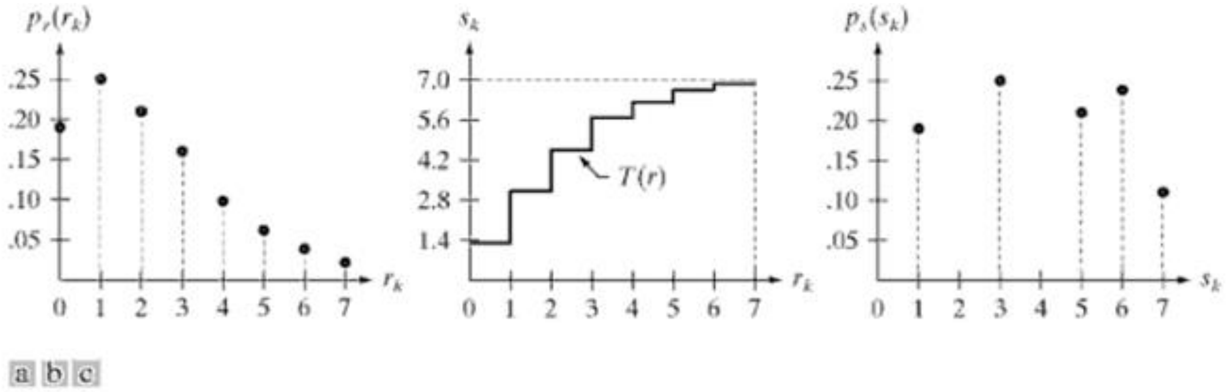


FIGURE 3.19 Illustration of histogram equalization of a 3-bit (8 intensity levels) image. (a) Original histogram. (b) Transformation function. (c) Equalized histogram.