University of Diyala
Computer Science Department
Image Processing
3rd Class
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Image Processing

معالجة صور

5th lecture

Introduction to Image Enhancement

What is the image enhancement?

Modify the intensities of pixels in an image so that it can be more suitable for a specific application. Different enhancement process suits different applications. An enhancement method is good for an application but maybe bad for another application.

Two categories of methods for enhancement process

One is based on the spatial domain of the image. Another is based on the frequency domain of the image.

- Spatial domain: process pixels in the image plane directly.
- Frequency domain: modify the Fourier transform of an image.

For the enhancement in the spatial domain, we use the transform function:

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

f(x,y) --- input image,

g(x,y) --- output image,

T --- a transform

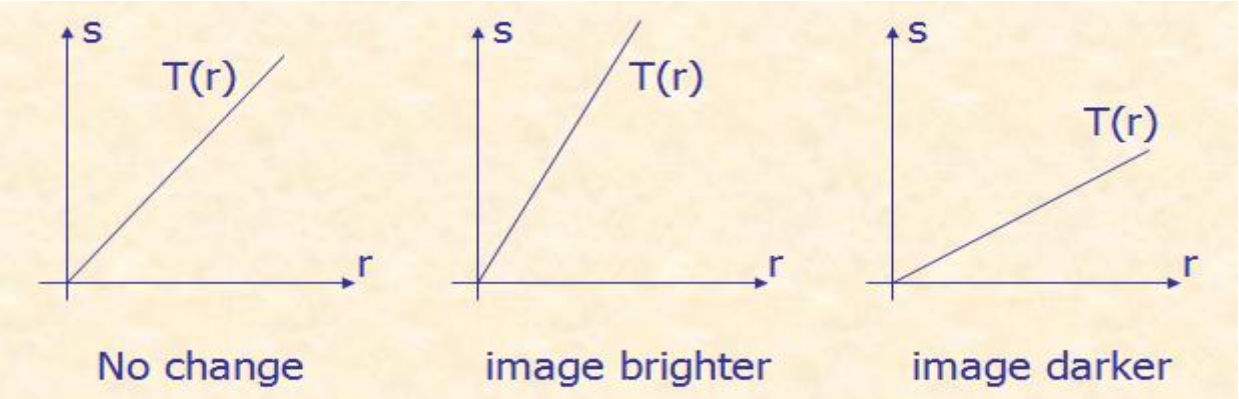
The object transformed may be a sub-image with 2x2, 3x3 or 1x1. For simplicity, 1x1, so we have s = T (r)

r --- gray-level value for an inputting pixel

s --- gray-level value for an outputting pixel

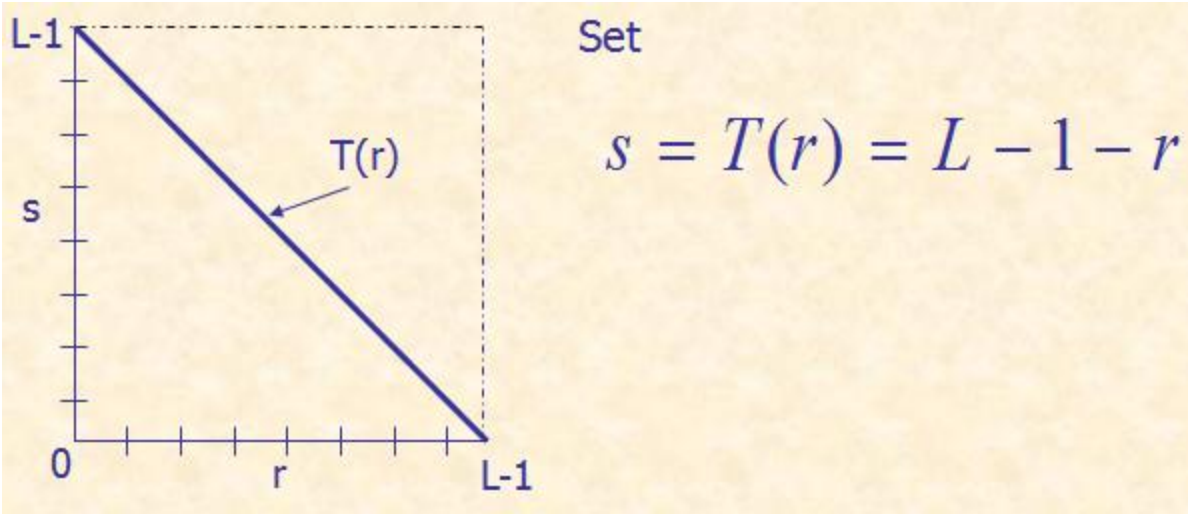
Grey-level value transform graph

We use a graph to denote the transform function s = T (r).



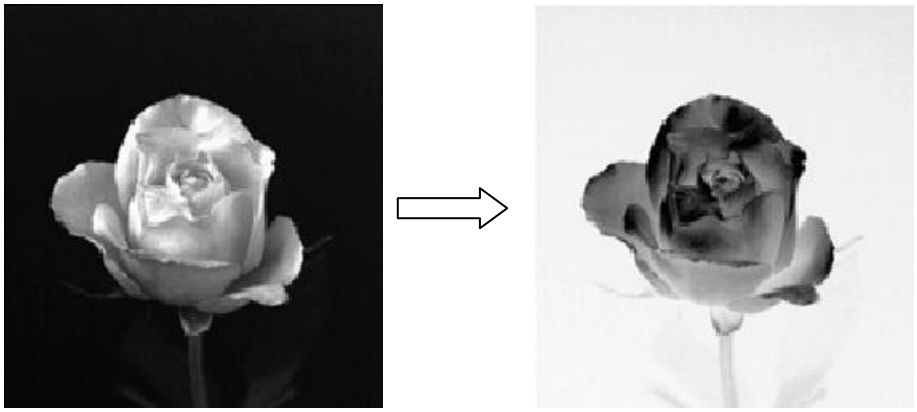
Some Simple Enhancement Methods

1- Image negatives



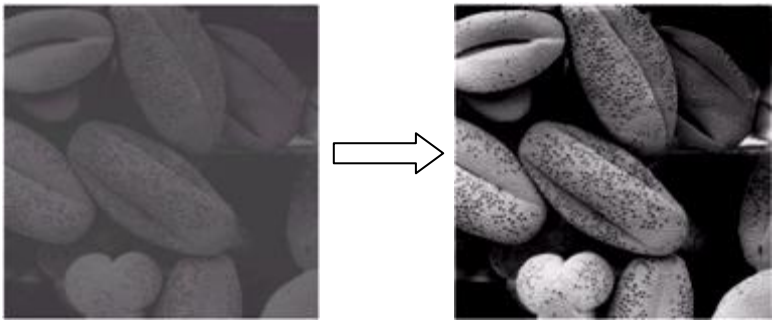
Example:

```
>> f=imread('E:\rose.jpg');
>> size (f)
ans =
  252   237
>> imshow(f);
>> c=imcomplement(f);
>> figure; imshow(c);
>> imwrite ( c, 'E:\rosecomplement.jpg');
```



2- Contrast stretching

For a low-contrast image, we feel it uncomfortable and sometimes cannot see any details clearly.



3- Compression of dynamic range

When the dynamic range of the gray-level in an image far exceeds the capability of the display device, it needs to be compressed to display it better. A good transform function is as follow;

$$s = c \cdot \log(1 + |r|)$$ c is a scaling constant

Histogram Processing

What is the histogram of an image?

The distribution of the pixel gray level is very important for an image display. For a limited gray-level domain [0, L-1] we hope there is a uniform distribution of the pixel gray level instead of non-uniform distribution. Based on the distribution of the pixel gray level we define the image histogram.

For a digital image with gray levels in the range [0, L-1], we define a discrete function:

$$p(r_k) = n_k / n \quad r_k \text{ is the } k\text{th gray level.}$$

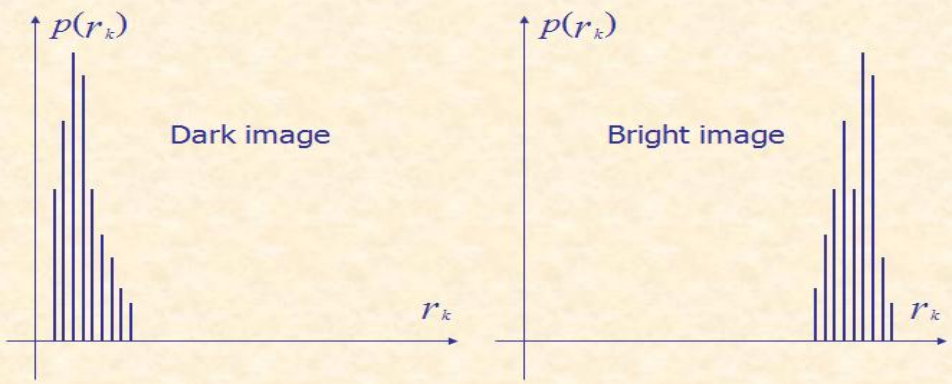
Where:

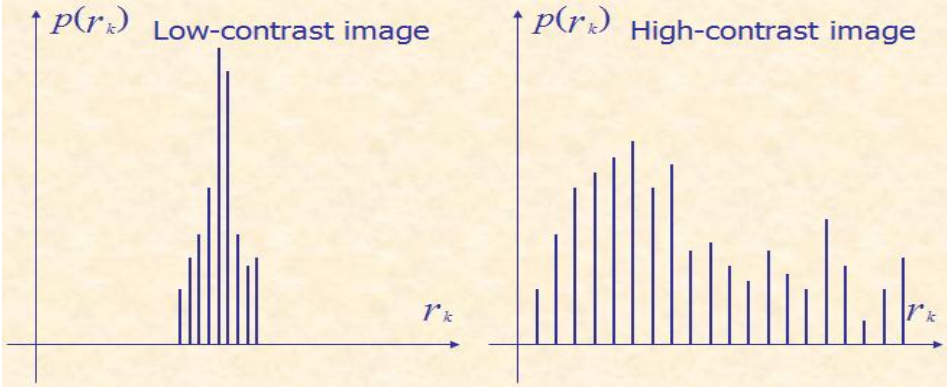
n_k is the number of the pixels with the gray level r_k

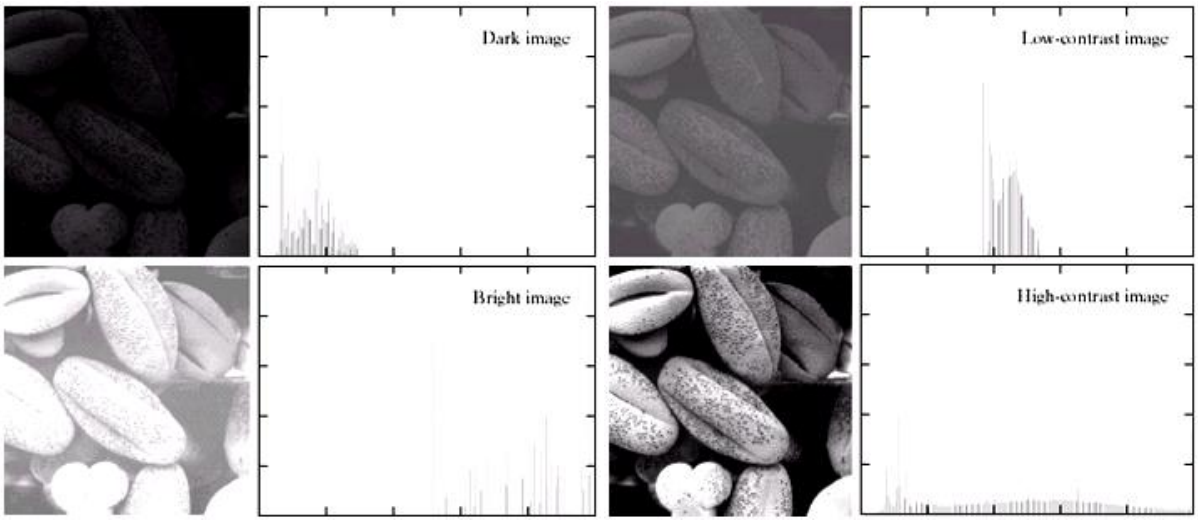
n is the total number of pixels in the image.

We call $p(r_k)$ the histogram of a digital image.

Four special histograms are as follows.







Histogram equalization

Sometimes we need to convert a low-contrast image into a high-contrast image for displaying it better. We can do it by extending its histogram.

Example:

>> f=imread('E:\rose.jpg');

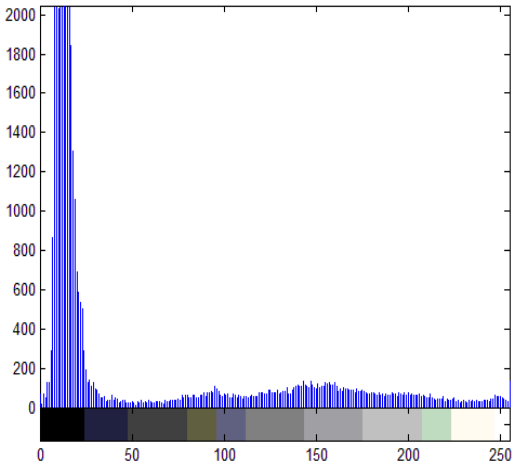
>> imshow(h);

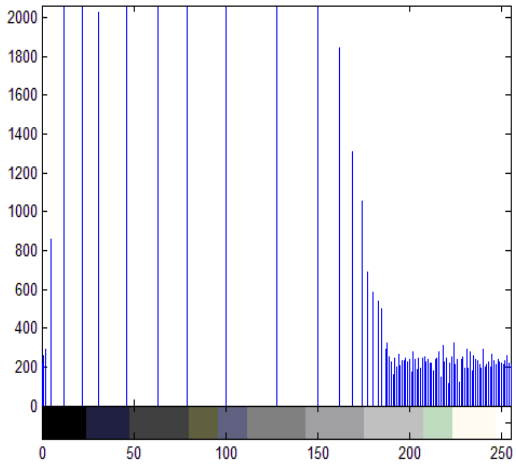
>> figure; imhist(f);

>> h=histeq(f, 256);

>> figure; imhist(h);

>> figure; imshow(h);





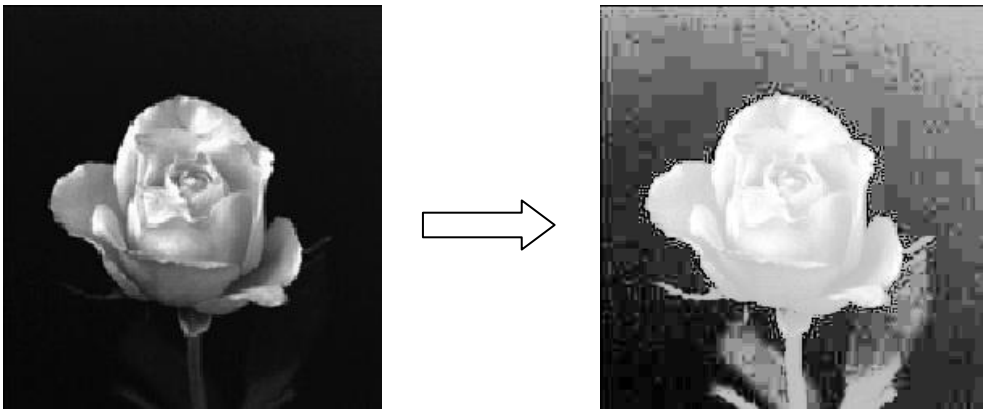


Image Subtraction

$$g(x, y) = f(x, y) - h(x, y)$$

The result is that the different parts between two images are kept but the same parts between them are removed (become dark). A typical application is the medical X-ray image test for a specific body area of the patient.

>> sub=f-g;

>> imshow(sub);