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FACULTY OF EGINEERING

Digital Image Processing
LECTURE-09

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OUTLINE

- ❖Smoothing Frequency Domain Filters
- ❖Gaussian Smoothing
- ❖2-D Gaussian Smoothing
- ❖MCQ
- ❖References

Gaussian Smoothing

The Gaussian smoothing operator is a 2-D convolution operator that is used to `blur' images and remove detail and noise. In this sense it is similar to the mean filter, but it uses a different kernel that represents the shape of a Gaussian (`bell-shaped') hump. This kernel has some special properties which are detailed below.

The Gaussian distribution in 1-D has the form:

$$G(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}}$$

where is the standard deviation of the distribution. We have also assumed that the distribution has a mean of zero (i.e. it is centered on the line x=0).

Gaussian Smoothing

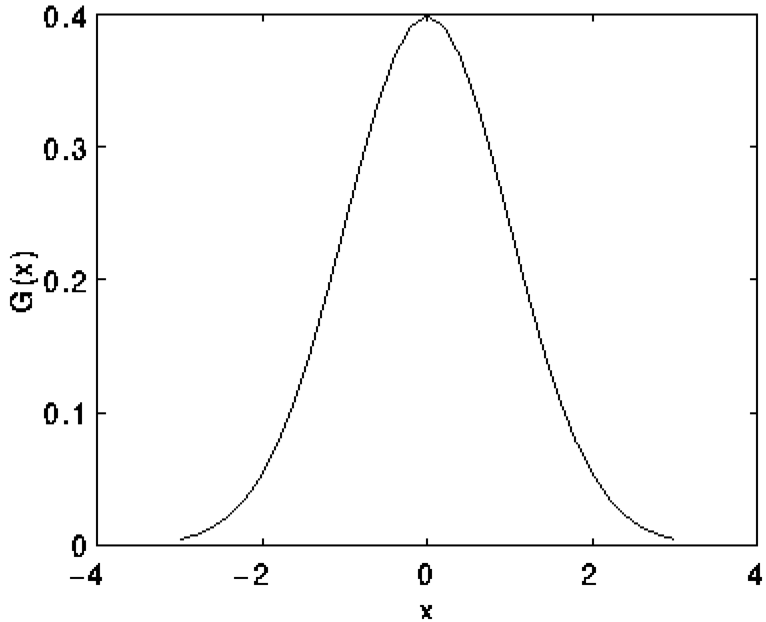


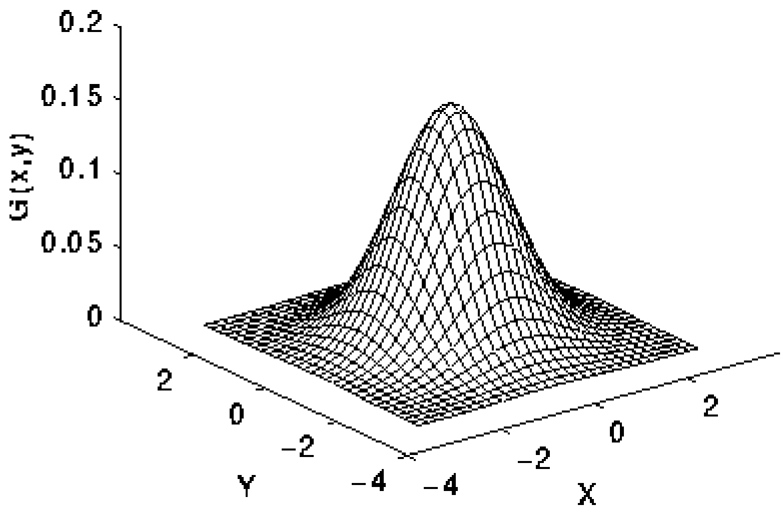
Figure 1 1-D Gaussian distribution with mean 0 and σ=1

Gaussian Smoothing

In 2-D, an isotropic (i.e. circularly symmetric) Gaussian has the form:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

This distribution is shown in Figure



Gaussian distribution with mean (0,0) and σ=1

Gaussian Smoothing

The idea of Gaussian smoothing is to use this 2-D distribution as a `point-spread' function, and this is achieved by convolution. Since the image is stored as a collection of discrete pixels we need to produce a discrete approximation to the Gaussian function before we can perform the convolution. In theory, the Gaussian distribution is non-zero everywhere, which would require an infinitely large convolution kernel, but in practice it is effectively zero more than about three standard deviations from the mean, and so we can truncate the kernel at this point. Figure 3 shows a suitable integer-valued convolution kernel that approximates a Gaussian with a of 1.0. It is not obvious how to pick the values of the mask to approximate a Gaussian. One could use the value of the Gaussian at the centre of a pixel in the mask, but this is not accurate because the value of the Gaussian varies non-linearly across the pixel. We integrated the value of the Gaussian over the whole pixel (by summing the Gaussian at 0.001 increments). The integrals are not integers: we rescaled the array so that the corners had the value 1. Finally, the 273 is the sum of all the values in the mask.

$\frac{1}{273}$

1	4	7	4	1
4	16	26	16	4
7	26	41	26	7
4	16	26	16	4
1	4	7	4	1

Discrete approximation to Gaussian function with σ=1.0

MCQ

1. Massless particle containing a certain amount of energy is called
   a) Photon
   b) Shell
   c) Electron
   d) None of the mentioned

2. What do you mean by achromatic light?
   a) Chromatic light
   b) Monochromatic light
   c) Infrared light
   d) Invisible light

3. Which of the following embodies the achromatic notion of intensity?
   a) Luminance
   b) Brightness
   c) Frequency
   d) Radiance

MCQ

1. A continuous image is digitized at _______ points.

   a) Random
   b) Vertex
   c) Contour
   d) Sampling

2.The transition between continuous values of the image function and its digital equivalent is called ___

a) Quantization

b) Sampling

c) Rasterisation

d) None of the Mentioned

3. Images quantised with insufficient brightness levels will lead to the occurrence of ____________

a) Pixilation

b) Blurring

c) False Contours

d) None of the Mentioned

MCQ

4. Of the following, _________ has the maximum frequency.

a) UV Rays

b) Gamma Rays

c) Microwaves

d) Radio Waves

5. In the Visible spectrum the ______ colour has the maximum wavelength.

a) Violet

b) Blue

c) Red

d) Yellow

References

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