Digital Image Processing Basics*

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Abstract

The module provides an introduction to the concepts of digital imaging processing through basic equations and examples.

1 Digital Image Processing

A sampled image gives us our usual 2D array of pixels $f[m,n]$ (Figure 1):

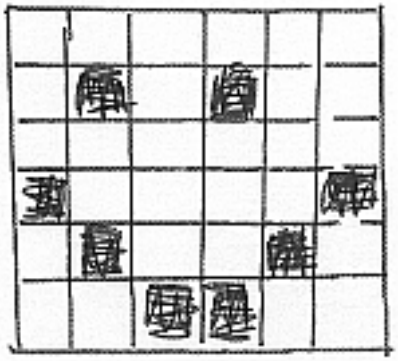

Figure 1: We illustrate a "pixelized" smiley face.

We can filter $f[m,n]$ by applying a 2D discrete-space convolution[1] as shown below (where $h[m,n]$ is our PSF):

$$\begin{aligned} g[m,n] &= h[m,n] * f[m,n] \\ &= \sum_{k=-\infty}^{\infty} \left(\sum_{l=-\infty}^{\infty} \left(h[m-k, n-l] f[k,l] \right) \right) \end{aligned} \tag{1}$$

Example 1: Sampled Image

*Version 2.2: Jul 22, 2005 2:42 pm GMT-5
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[1]"Discrete-Time Convolution" <http://cnx.org/content/m10087/latest/>

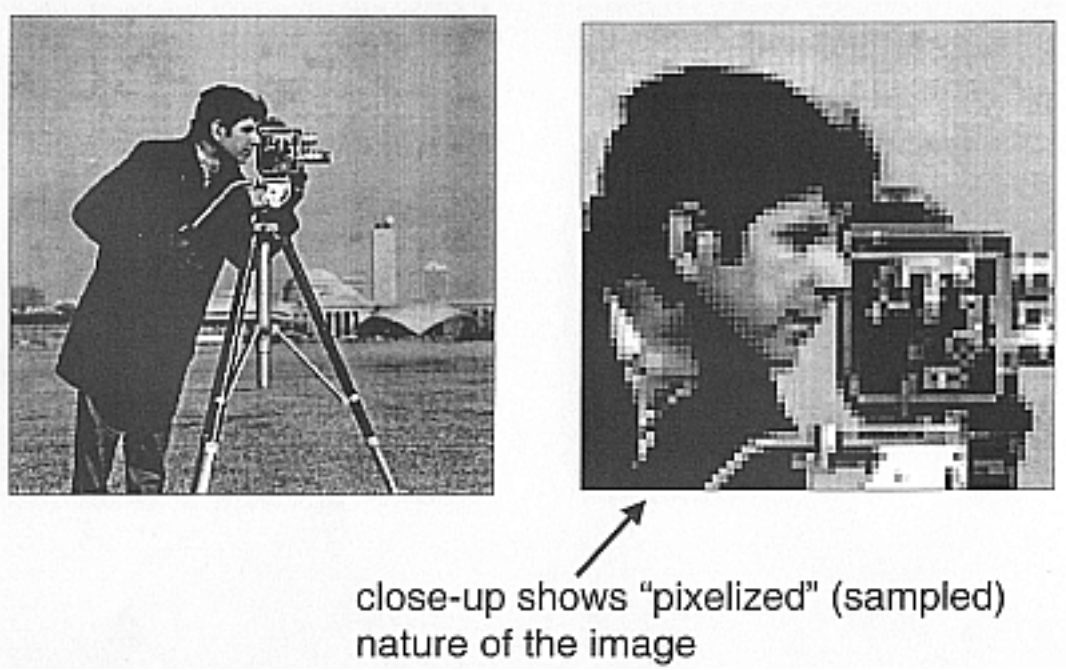

Figure 2: Illustrate the "pixelized" nature of all digital images.

We also have discrete-space FTS:

$$F[u,v] = \sum_{m=-\infty}^{\infty} \left(\sum_{n=-\infty}^{\infty} \left(f[m,n] e^{-(ium)} e^{-(ivm)} \right) \right) \tag{2}$$

where $F[u,v]$ is analogous to DTFT[2] in 1D.

NOTE: "Convolution in Time" is the **same** as "Multiplication in Frequency"

$$g[m,n] = h[m,n] * f[m,n] \tag{3}$$

which, as stated above, is the same as:

$$G[u,v] = H[u,v] F[u,v] \tag{4}$$

Example 2: Magnitude of FT of Cameraman Image

[2]"Discrete-Time Fourier Transform (DTFT)" <http://cnx.org/content/m10247/latest/>

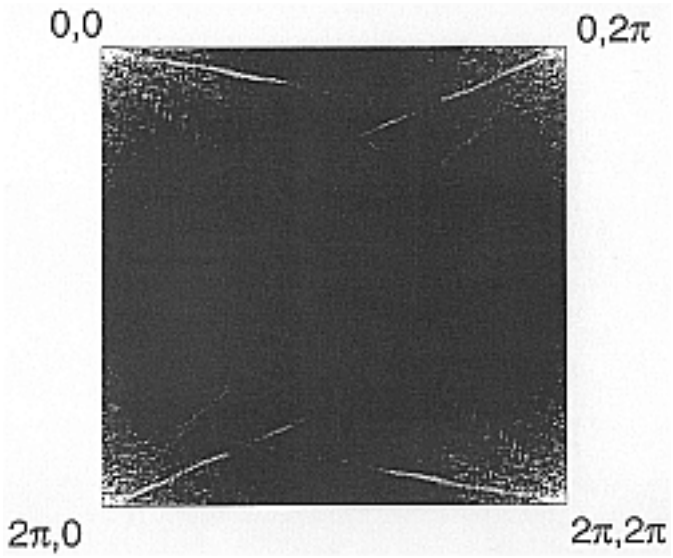

Figure 3

To get a better image, we can use the `fftshift` command in Matlab to center the Fourier Transform. The resulting image is shown in Figure 4:

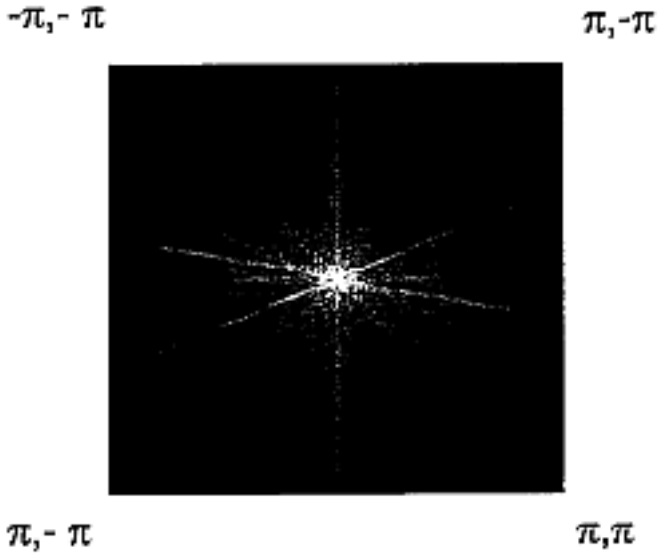

Figure 4