Govt Mahila Engineering College Ajmer

Department of Computer Engineering

Midterm I Exam Session 2017-18 Subject:Digital Image Processing

Sem VIII(IT) **MM.20**

Q1) Write a short note on color Image Representation 5

The appearance of an object is basically resulted from: the nature of the light reflected from the object, its optical characteristics, and the human perception. There are four main attributes that characterize the light: *intensity*, *radiance*,*luminance*, and *brightness*. In the case of achromatic light, the intensity is the only
attribute involved

This is the case where the called *gray-scale* is used: intensity varies from black to white (gray levels in between). On the other hand, in the case of chromatic light, the other three attributes are used to measure the quality of the light source. The radiance refers to the amount of emitted energy by the light source, and it is measured in watts (W). The luminance measures the amount of radiation perceived by an observer, and it is measured in lumens (lm). The brightness is associated to the light intensity.

The *color models* are used to specify colors as points in a coordinate system, creating a specific standard. In the following, the most common color spaces are briefly presented.

RGB Color Model

The RGB (Red, Green, and Blue) color space is one of the most used color spaces, specially for 8 bit digital images. This model is usually used for representing colors in electronic devices as TV and computer monitors, scanners, and digital cameras. The theory of the trichromatic color vision of Young–Helmholtz and the Maxwell's triangle is the basis of the RGB model.

The RGB is an additive model where the red, green, and blue colors are combined on different quantities or portions to reproduce other colors. The pixels of an image represented in the RGB model have usually 8 bits depth, resulting in 256 possible intensities, i.e., the range of [0, 255] for each color.

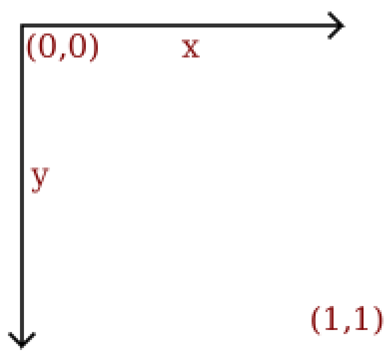
Vector images

One way to describe an image using numbers is to declare its contents using position and size of geometric forms and shapes like lines, curves, rectangles and circles; such images are called vector images.

Coordinate system

We need a coordinate system to describe an image, the coordinate system used to place elements in relation to each other is called *user space*, since this is the coordinates the user uses to define elements and position them in relation to each other.

Figure 1.1. Coordinate system.



Q2) Explain Sampling and quantization. 5

In order to become suitable for digital processing, an image function f(x,y) must be digitized both spatially and in amplitude. Typically, a frame grabber or digitizer is used to sample and quantize the analogue video signal. Hence in order to create an image which is digital, we need to covert continuous data into digital form. There are two steps in which it is done:

- Sampling
- Quantization

The sampling rate determines the spatial resolution of the digitized image, while the quantization level determines the number of grey levels in the digitized image. A magnitude of the sampled image is expressed as a digital value in image processing. The transition between continuous values of the image function and its digital equivalent is called quantization.

The number of quantization levels should be high enough for human perception of fine shading details in the image. The occurrence of false contours is the main problem in image which has been quantized with insufficient brightness levels

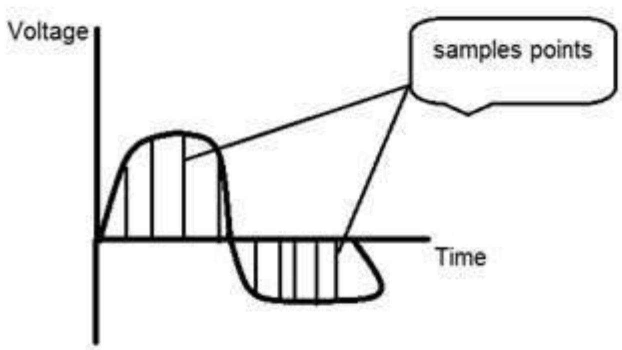


Fig:Sampling

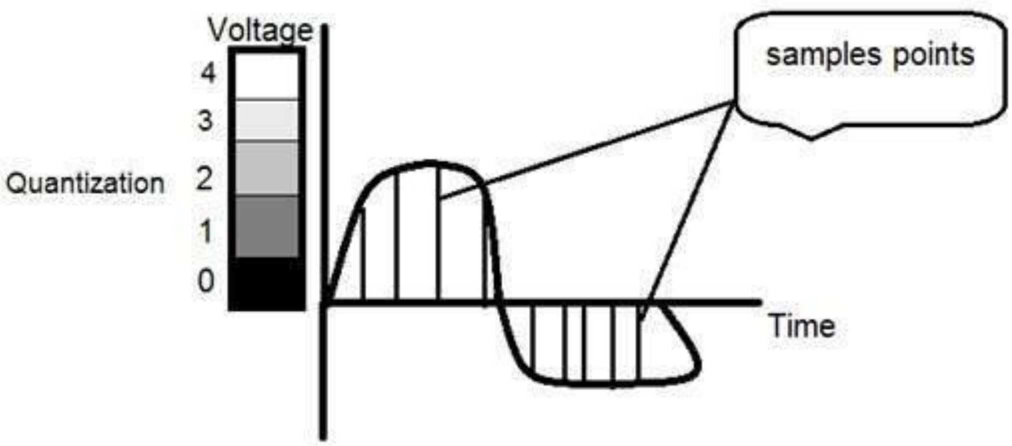


Fig:Quantization

Q3) Describe fourier transform and its properties. 5

The **Fourier transform** (**FT**) decomposes a function of time (a *signal*) into the frequencies that make it up, in a way similar to how a musical chord can be expressed as the frequencies (or pitches) of its constituent notes. The Fourier transform of a function of time itself is a complex-valued function of frequency, whose absolute value represents the amount of that frequency present in the original function, and whose complex argument is the phase offset of the basic sinusoid in that frequency. The Fourier transform is called the *frequency domain representation* of the original signal.

Wavelet Transform

The wavelet transform is similar to the Fourier transform (or much more to the windowed Fourier transform) with a completely different merit function. The main difference is this: Fourier transform decomposes the signal into sines and cosines, i.e. the functions localized in Fourier space; in contrary the wavelet transform uses functions that are localized in both the real and Fourier space. Generally, the wavelet transform can be expressed by the following equation:

$$F(a,b) = \int_{-\infty}^{\infty} f(x)\, \psi^*_{(a,b)}(x)\, \mathrm{d}x$$

where the * is the complex conjugate symbol and function ψ is some function. This function can be chosen arbitrarily provided that it obeys certain rules.

Properties of Fourier Transform

The properties of the Fourier transform are summarized below. The properties of the Fourier expansion of periodic functions discussed above are special cases of those listed here. In the following, we assume $\mathcal{F}[x(t)] = X(j\omega)$ and $\mathcal{F}[y(t)] = Y(j\omega)$.

- **Linearity**

$$\mathcal{F}[ax(t) + by(t)] = a\mathcal{F}[x(t)] + b\mathcal{F}[y(t)]$$

- **Time shift**

$$\mathcal{F}[x(t \pm t_0)] = X(j\omega)e^{\pm j\omega t_0}$$

Proof: Let $t' = t \pm t_0$, i.e., $t = t' \mp t_0$, we have

$$\mathcal{F}[x(t \pm t_0)] \quad : \quad \int_{-\infty}^{\infty} x(t \pm t_0) e^{-j\omega t} dt = \int_{-\infty}^{\infty} x(t') e^{-j\omega(t' \mp t_0)} dt'$$

$$: \quad e^{\pm j\omega t_0} \int_{-\infty}^{\infty} x(t') e^{-j\omega t'} dt' = X(j\omega) e^{\pm j\omega t_0}$$

- **Frequency shift**

$$\mathcal{F}^{-1}[X(j\omega \pm \omega_0)] = x(t) e^{\mp j\omega_0 t}$$

Q4) Explain the basics of wavelet transformation. 5

Discrete wavelet transform

In numerical analysis and functional analysis, a **discrete wavelet transform** (**DWT**) is any wavelet transform for which the wavelets are discretely sampled. As with other wavelet transforms, a key advantage it has over Fourier transforms is temporal resolution: it captures both frequency *and* location information (location in time).

Continuous Wavelet Transform

Continuous wavelet transform (CWT) is an implementation of the wavelet transform using arbitrary scales and almost arbitrary wavelets. The wavelets used are not orthogonal and the data obtained by this transform are highly correlated. For the discrete time series we can use this transform as well, with the limitation that the smallest wavelet translations must be equal to the data sampling. This is sometimes called Discrete Time Continuous Wavelet Transform (DT-CWT) and it is the most used way of computing CWT in real applications.

In principle the continuous wavelet transform works by using directly the definition of the wavelet transform, i.e. we are computing a convolution of the signal with the scaled wavelet. For each scale we obtain by this way an array of the same length N as the signal has. By using M arbitrarily chosen scales we obtain a field N×M that represents the time-frequency plane directly. The algorithm used for this computation can be based on a direct convolution or on a convolution by means of multiplication in Fourier space (this is sometimes called Fast Wavelet Transform).