Lec1_ Introduction to digital image processing

1. Introduction

Image is a kind of language which expresses visual information to human being. Two types of images are- Analog & Digital. An analog image is continuous and indiscrete such as natural picture and a digital image is two-dimensional image having finite set of digital values, called picture elements or pixels. Digital image is composed of discrete pixels, or set of pixels each having associated integer brightness value which is called gray-level.

Modern digital technology has made it possible to manipulate multi-dimensional signals with systems that range from simple digital circuits to advanced parallel computers. The goal of this manipulation can be divided into three categories:

• Image Processing

• Image Analysis

• Image Understanding

image in → image out

image in → measurements out

image in → high-level description out

We will focus on the fundamental concepts of *image processing*. Space does not permit us to make more than a few introductory remarks about *image analysis*. *Image understanding* requires an approach that differs fundamentally from the theme of this book. Further, we will restrict

ourselves to two–dimensional (2D) image processing although most of the concepts and techniques that are to be described can be extended easily to three or more dimensions.

We begin with certain basic definitions. An image defined in the "real world" is considered to be a function of two real variables, for example, $a(x,y)$ with a as the amplitude (e.g. brightness) of the image at the *real* coordinate position (x,y). An image may be considered to contain sub-images sometimes referred to as *regions– of–interest*, *ROIs*, or simply *regions*. This concept reflects the fact that images frequently contain collections of objects each of which can be the basis for a region. In a sophisticated image processing system it should be possible to apply specific image processing operations to selected regions. Thus one part of an image (region) might be processed to suppress motion blur while another part might be processed to improve color rendition.

The amplitudes of a given image will almost always be either real numbers or integer numbers. The latter is usually a result of a quantization process that converts a continuous range (say, between 0 and 100%) to a discrete number of levels. In certain image-forming processes, however, the signal may involve photon counting which implies that the amplitude would be inherently quantized. In other image forming procedures, such as magnetic resonance imaging, the direct physical measurement yields a complex number in the form of a real magnitude and a real phase.

Digital Image Definitions

A digital image $a[m,n]$ described in a 2D discrete space is derived from an analog image $a(x,y)$ in a 2D continuous space through a *sampling* process that is frequently referred to as digitization. For now we will look at some basic definitions associated with the digital image. The effect of digitization is shown in Figure 1.

The 2D continuous image $a(x,y)$ is divided into *N rows* and *M columns*. The intersection of a row and a column is termed a *pixel*. The value assigned to the integer coordinates $[m,n]$ with $\{m=0,1,2,...,M-1\}$ and $\{n=0,1,2,...,N-1\}$ is $a[m,n]$. In fact, in most cases $a(x,y)$ – which we might consider to be the physical signal that impinges on the face of a 2D sensor – is actually a function of many variables including depth (z), color (λ), and time (t).

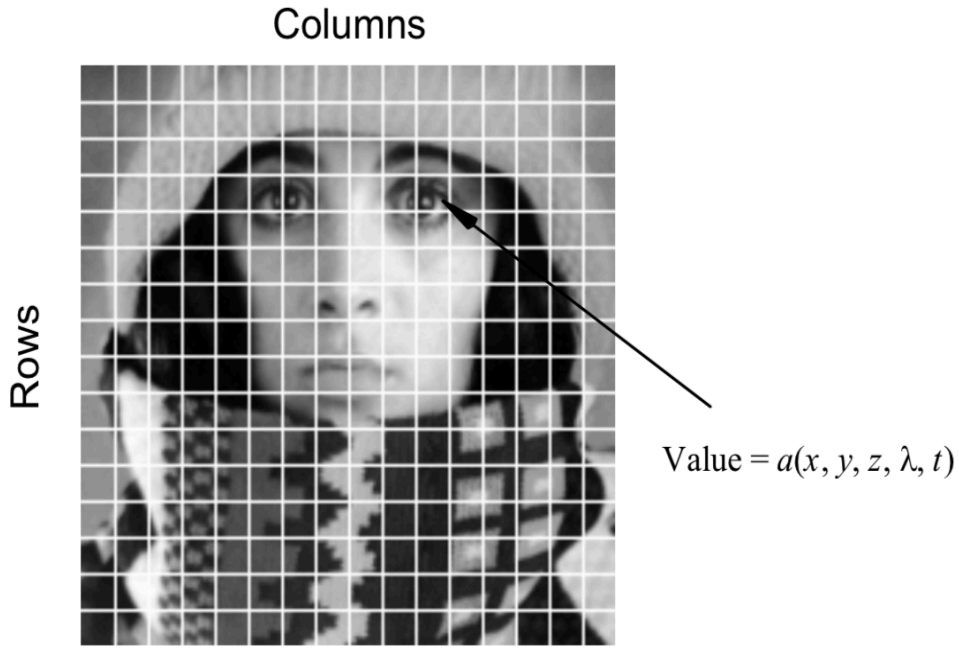

Figure (1)

Digitization of a continuous image. The pixel at coordinates [m=10, n=3] has the integer brightness value 110.

The image shown in Figure 1 has been divided into N = 16 rows and M = 16 columns. The value assigned to every pixel is the average brightness in the pixel rounded to the nearest integer value. The process of representing the amplitude of the 2D signal at a given coordinate as an integer value with L different grey levels is usually referred to as amplitude quantization or simply *quantization*.