Image processing

Introduction

Ch1-Part 1

INTRODUCTION

The visual experience is the principal way that humans sense and communicate with their world. A visual beings and images are being made increasing available in electronic digital format via digital cameras, the internet, and hand-held devices with large-format screens. With much of the technology being introduced to the consumer marketplace being rather new, digital image processing remains a “hot” topic and promises to be one for a very long time. Of course, digital image processing has been around for quite awhile, and indeed, methods pervade nearly every branch of science and engineering. One only has to view the latest space telescope images or read about the newest medical image modality to be aware of this.

Computer Vision

Computer vision emulate human vision, that's mean: understanding the scene based on image data. One of the major topics within this field of computer vision is image analysis.

1. **Image Analysis:** involves the examination of the image data to facilitate solving vision problem.

The image analysis process involves two other topics:

Feature Extraction: is the process of acquiring higher level image information, such as shape or color information.

Pattern Classification: is the act of taking this higher –level information and identifying objects within the image.

Computer Vision cont.

Computer vision systems are used in many and various types of environments, such as:

1. **Manufacturing Systems:** computer vision is often used for quality control, where the computer vision system will scan manufactured items for defects, and provide control signals to a robotics manipulator to remove detective part automatically.
2. **Medical Community:** current example of medical systems to aid neurosurgeons during brain surgery, systems to diagnose skin tumors automatically.
3. **The field of Law Enforcement and security** in an active area for computer vision system development, with application ranging from automatic identification of fingerprints to DNA analysis.
4. Infrared Imaging.
5. Satellites Orbiting.

Digital Image Processing

Digital image processing is a high growth sector fed by the rapidly falling costs of the hardware (computers, scanners, digital cameras, etc.) and the availability of quality image processing software. Extracting information about the content of the image is part from the aim of image processing. For example examining a blood sample under a microscope to automatically count the number of white blood cells or examining an image of a road scene to pick out the number and type of road signs present. These applications generally require more advanced techniques such as image segmentation followed by pattern recognition.

Image Processing Application

The digital image processing is a general term for a wide range of techniques that exists for manipulating and modifying images in various ways. Figure (1.1) represent some Applications of digital image processing.

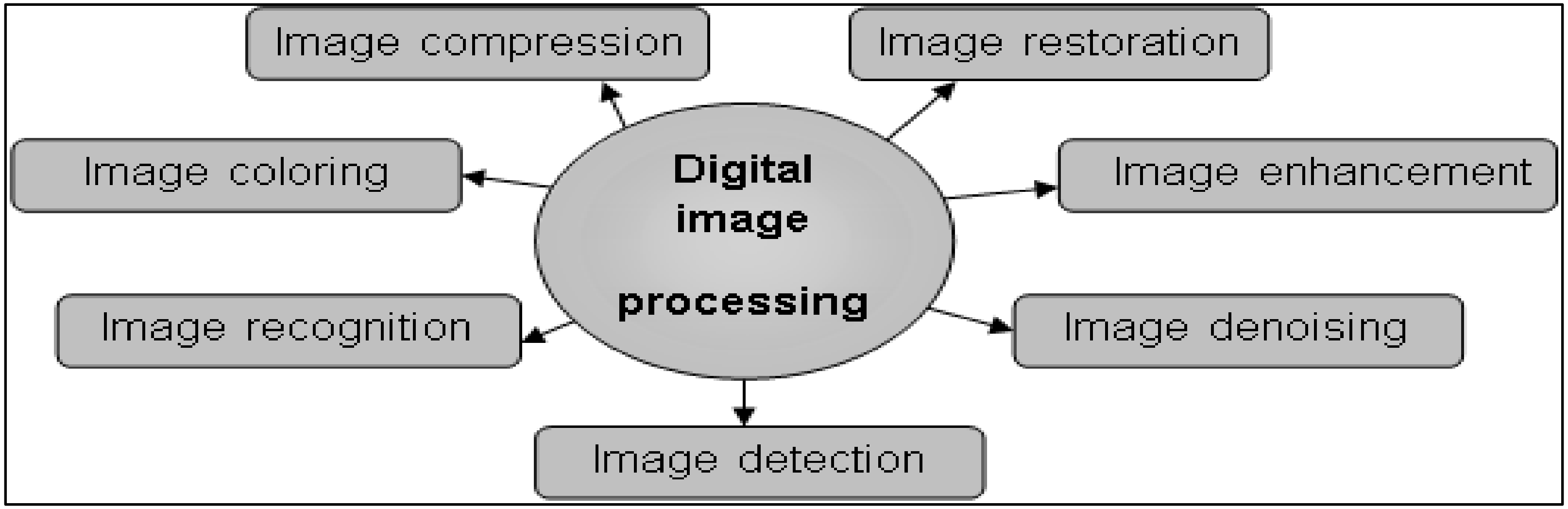


Figure (1-1) : Application of digital image processing

Image Restoration

Is the process of taking an image with some known, or estimated degradation, and restoring it to its original appearance. Image restoration is often used in the field of photography or publishing where an image was somehow degraded but needs to be improved before it can be printed (Figure 1.2).

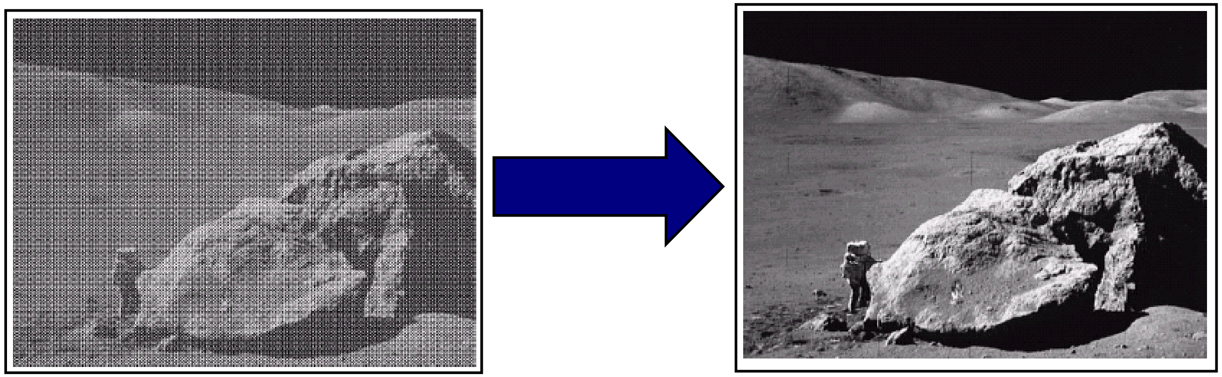


Figure (1.2) Image Restoration

Image Enhancement

Involves taking an image and improving it visually. One of the simplest enhancement techniques is to simply stretch the contrast of an image.

Enhancement methods tend to be problem specific. For example, a method that is used to enhance satellite images may not suitable for enhancing medical images.

Although enhancement and restoration are similar in aim, to make an image look better. Restoration method attempt to model the distortion to the image and reverse the degradation, where enhancement methods use knowledge of the human visual systems responses to improve an image visually.(Figure 1.3)

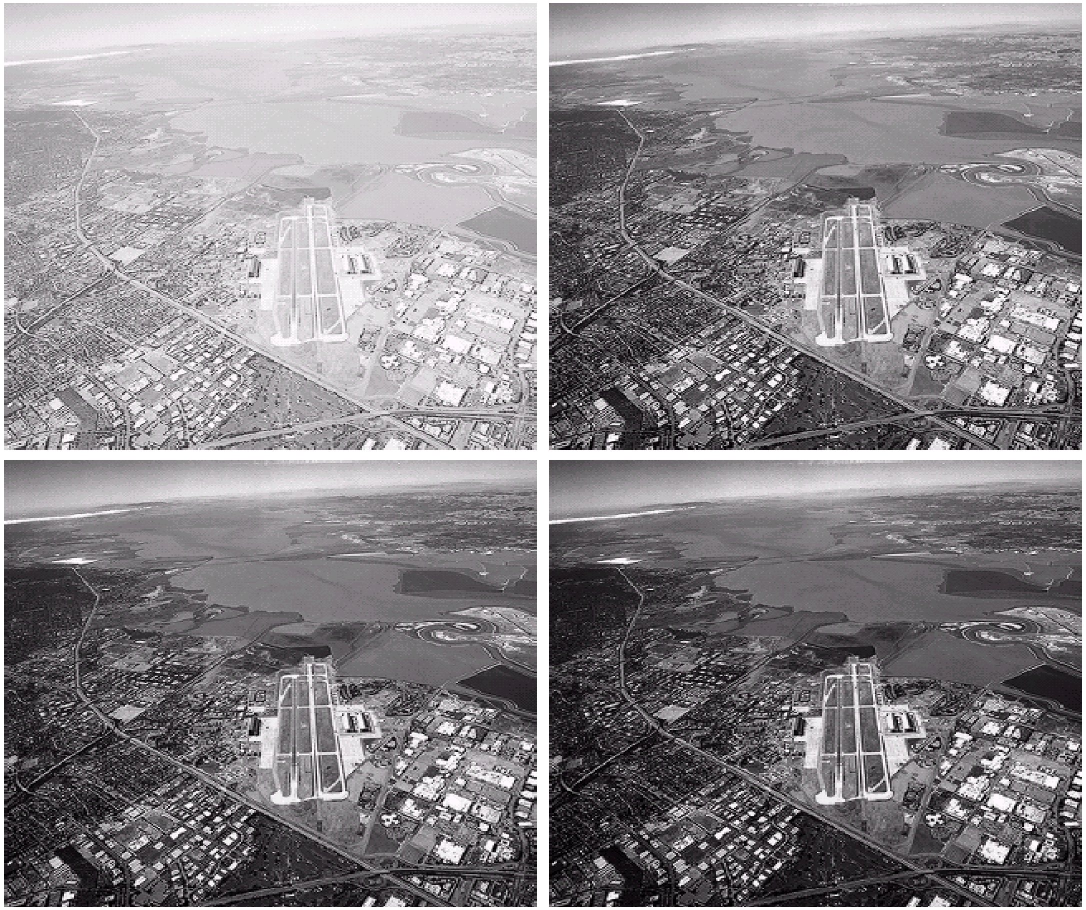


FIGURE (1.3) : IMAGE ENHANCEMENT WITH DIFFERENT LEVEL OF CONTRAST

IMAGE DENOISING

Images are often corrupted by additive noise. Thus, it is an important problem to recover the signal by removing the noise with minimum signal distortion. Since edges are among the most important features of image, the aim of denoising techniques tailored towards preserving the sharpness of these features.(Figure 1.4)

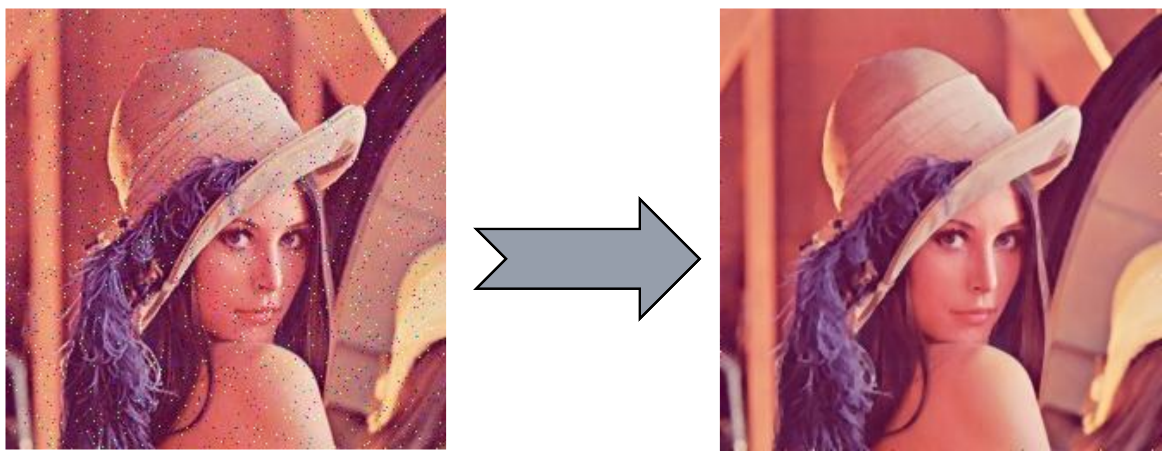
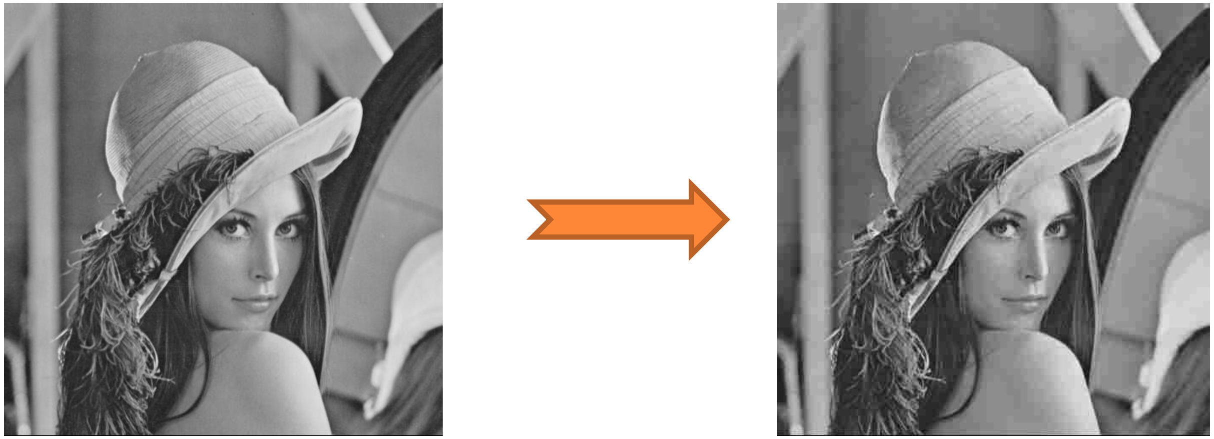


Figure (1.4):Represent Lena.jpg with noisy image and Denoising Image.

IMAGE COMPRESSION

Involves reducing the typically massive amount of data needed to represent an image. This done by eliminating data that are visually unnecessary and by taking advantage of the redundancy that is inherent in most images. Image data can be reduced 10 to 50 times, and motion image data (video) can be reduced by factors of 100 or even 200.



Original Compression 27:1

Figure (1.4):Represent Image with Compression ratio equal 27 to1.

Computer Imaging Systems

Computer imaging systems are comprised of two primary components types, hardware and software. The hardware components can be divided into image acquiring sub system (computer, scanner, and camera) and display devices (monitor, printer).The software allows us to manipulate the image and perform any desired processing on the image data.

DIMENSION OF IMAGES

An important feature of digital images and video is that they are multidimensional signals, meaning that they are functions of more than a single variable. The signals are usually 1D functions of time. Images, however, are functions of two and perhaps three space dimensions, whereas digital video as a function includes a third (or fourth) time dimension as well. The dimension of a signal is the number of coordinates that are required to index a given point in the image. A consequence of this is that digital image processing, and especially digital video processing, is quite data-intensive, meaning that significant computational and storage resources are often required.(Fig. 1.5)

DIMENSION OF IMAGES CONT.

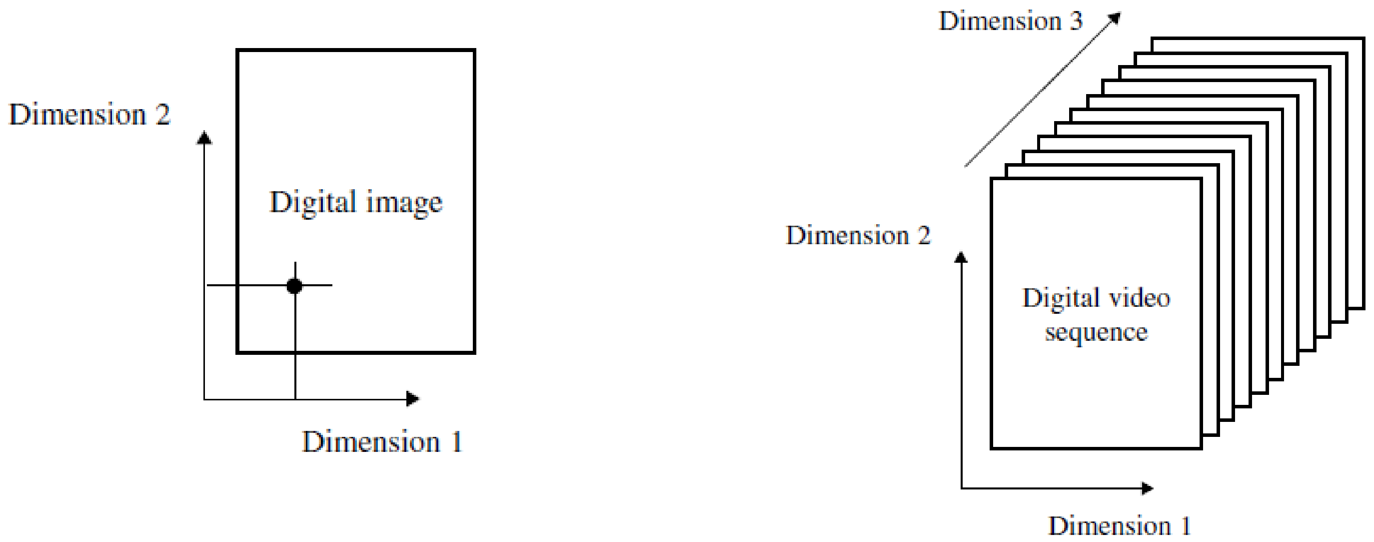


Figure 1.5 : The dimensionality of images and video.

SAMPLED IMAGES

Sampling is the process of converting a continuous-space (or continuous-space/time) signal into a discrete-space (or discrete-space/time) signal. The sampling of continuous signals is a rich topic that is effectively approached using the tools of linear systems theory. The mathematics of sampling. it is sample a signal sufficiently densely.

For a continuous signal of given space/time dimensions, there are mathematical reasons why there is a lower bound on the space/time sampling frequency (which determines the minimum possible number of samples) required to retain the information in the signal. However, image processing is a visual discipline, and it is more fundamental to realize that what is usually important is that the process of sampling does not lose visual information. Simply stated, the sampled image/video signal must “look good,” meaning that it does not suffer too much from a loss of visual resolution or from artifacts that can arise from the process of sampling.(Figure 1.6)

SAMPLED IMAGES
CONT.

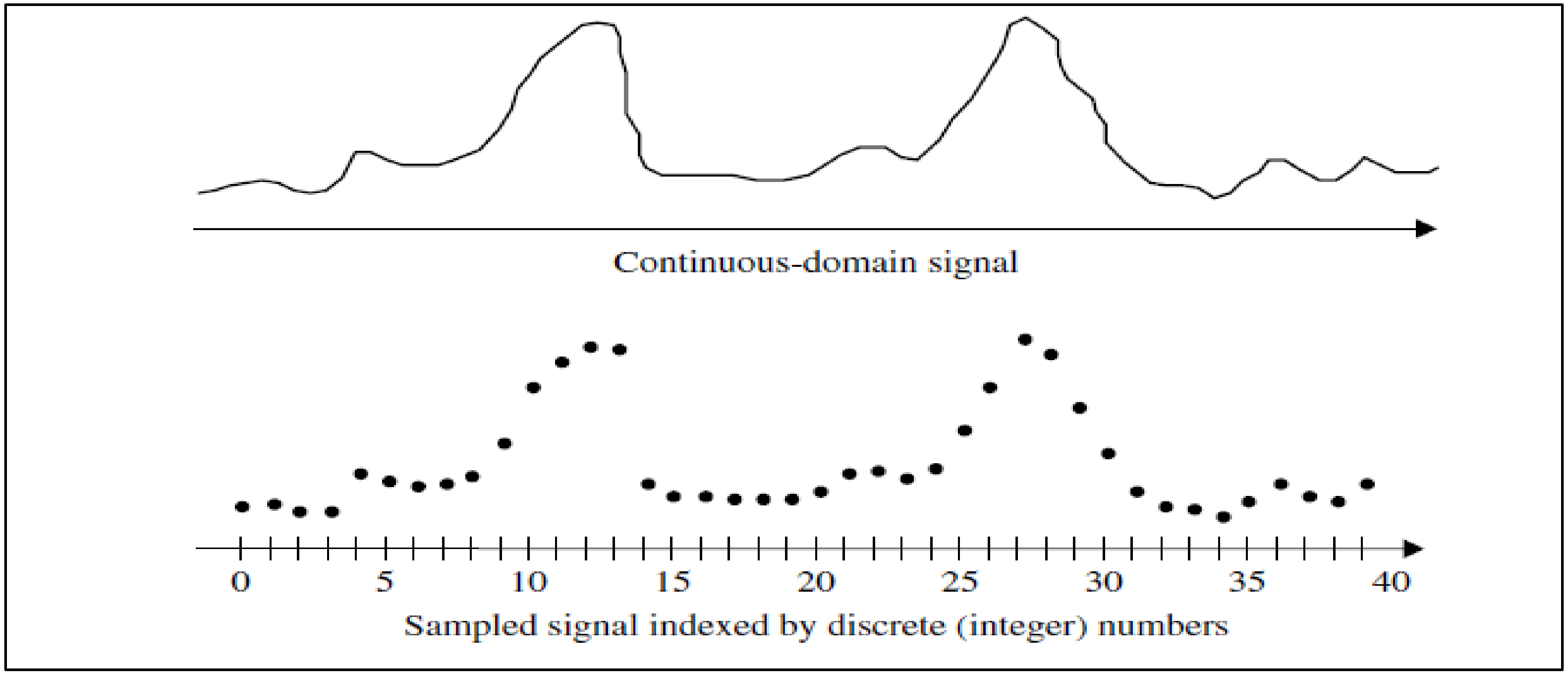


Figure 1.6: Sampling a continuous-domain one-dimensional signal.

SAMPLED IMAGES CONT.

The samples collectively describe the gross shape of the original signal very nicely, but that smaller variations and structures are harder to discern or may be lost. Mathematically, information may have been lost, meaning that it might not be possible to reconstruct the original continuous signal from the samples.

The samples are indexed by integer numbers. In fact, the sampled signal can be viewed as a vector of numbers. If the signal is finite in extent, then the signal vector can be stored and digitally processed as an array, hence the integer indexing becomes quite natural and useful. Likewise, image signals that are space/time sampled are generally indexed by integers along each sampled dimension, allowing them to be easily processed as multidimensional arrays of numbers. (Figure 1.7)

SAMPLED IMAGES CONT.

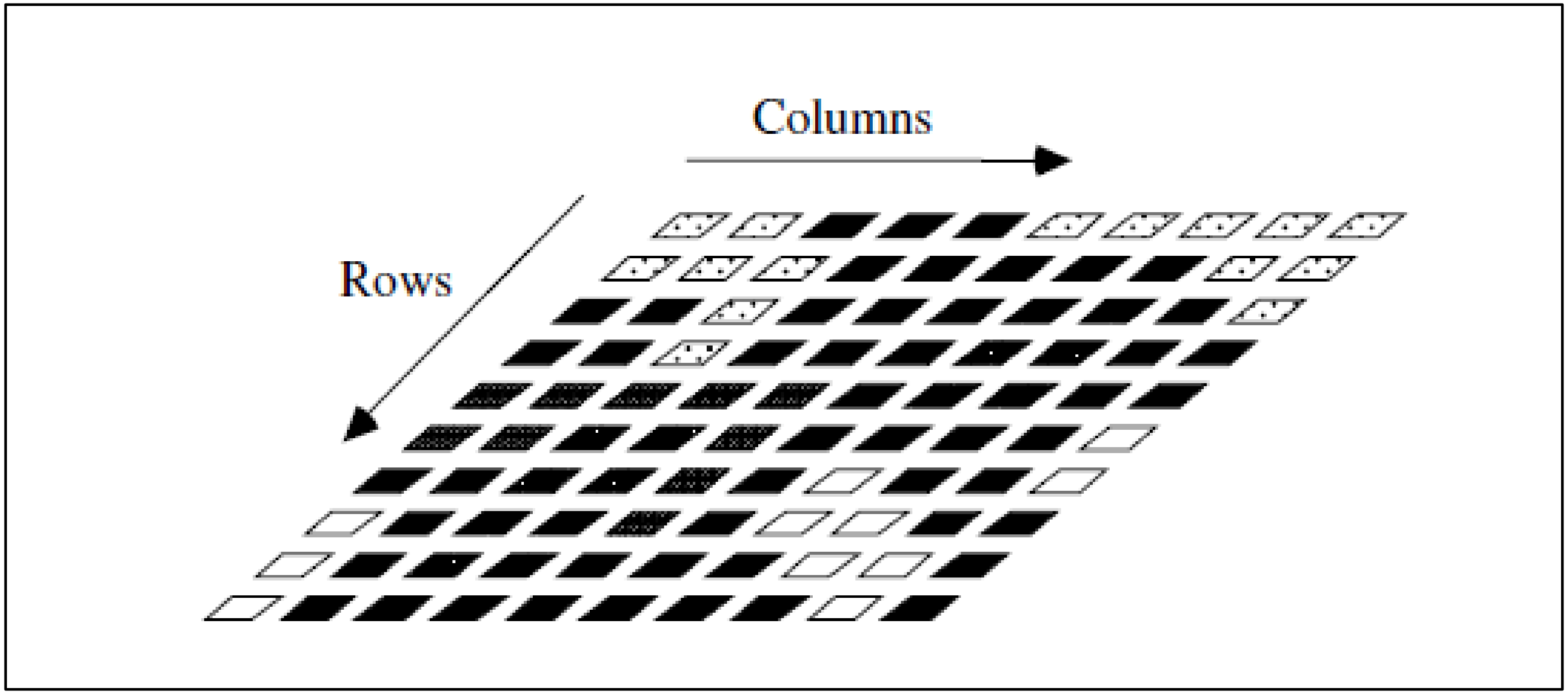


Figure 1.7: Depiction of a very small (10*10) piece of an image array.

SAMPLED IMAGES
CONT.

A sampled image is an array of sampled image values that are usually arranged in a row-column format. Each of the indexed array elements is often called a picture element, or pixel for short. The number of rows and columns in a sampled image is also often selected to be a power of 2, since it simplifies computer addressing of the samples.

The effects of insufficient sampling ("undersampling") can be visually obvious. Figure 1.8 shows two very illustrative examples of image sampling. The two images, which we will call "mandrill" and "fingerprint," both contain a significant amount of interesting visual detail that substantially defines the content of the images, all three scales of images are digital, and so there is potential loss of information relative to the original analog image. However, the perceptual quality of the images can easily be seen to degrade rather rapidly.

SAMPLED IMAGES
CONT.

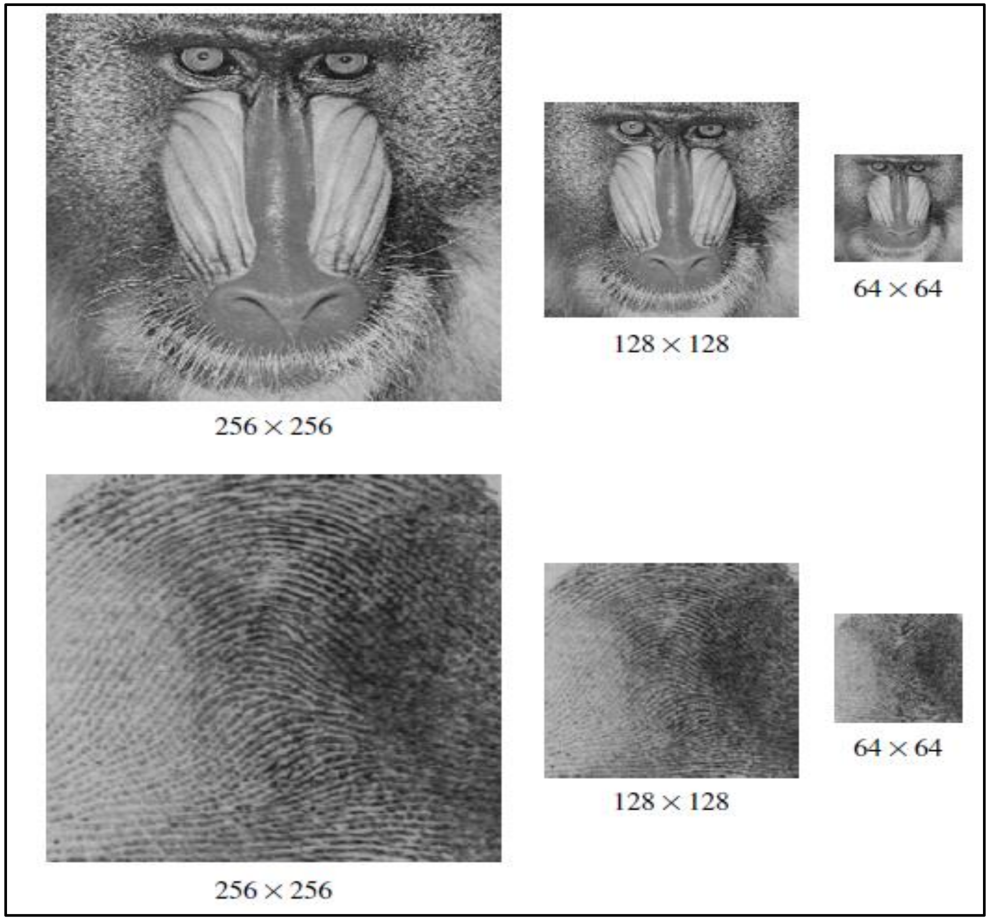


Figure 1.8: Examples of the visual effect of different image sampling densities.

SAMPLED IMAGES
CONT.

The image can now be accessed as a two-dimension array of data , where each data point is referred to a pixel (picture element).for digital images we will use the following notation :

I(r,c) = The brightness of image at the point (r,c) Where r= row and c= column.

"When we have the data in digital form, we can use the software to process the data".

The digital image is 2D- array as:

$$\begin{bmatrix} I(0,0) & I(0,1) & \ldots\ldots\ldots\ldots & I(0,N-1) \\ I(1,0) & I(1,1) & \ldots\ldots\ldots\ldots & I(1,N-1) \\ \ldots\ldots & & & \\ \ldots\ldots & & & \\ I(N-1,0) & I(N-1,1) & \ldots\ldots\ldots\ldots & I(N-1,N-1) \end{bmatrix}$$

SAMPLED IMAGES
CONT.

In above image matrix, the image size is (N×N) [matrix dimension] then:

Ng= 2 m ………..(1)

Where Ng denotes the number of gray levels m, where m is the no. of bits contains in digital image matrix.

Example : If we have (6 bit) in 128 X 128 image .Find the no. of gray levels to represent it ,then find the no. of bit in this image?

Solution:

Ng= 2^6=64 Gray Level

Nb= 128 * 128* 6= 9.8304 * 104 bit