

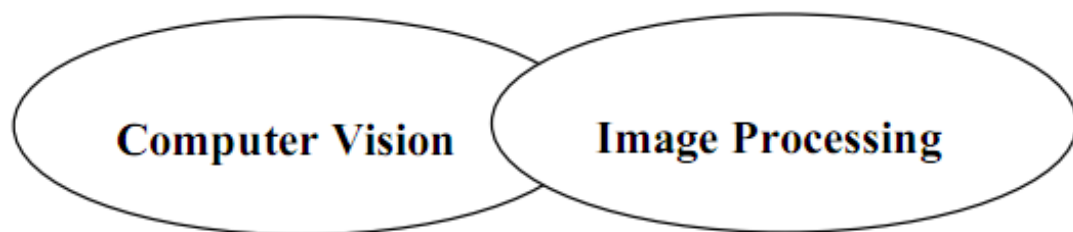
## 1.1 Computer Imaging

Can be defined a acquisition and processing of visual information by computer. Computer representation of an image requires the equivalent of many thousands of words of data, so the massive amount of data required for image is a primary reason for the development of many sub areas with field of computer imaging, such as image compression and segmentation. Another important aspect of computer imaging involves the ultimate “receiver” of visual information in some case the human visual system and in some cases the human visual system and in others the computer itself. Computer imaging can be separate into two primary categories :

1. Computer Vision.
2. Image Processing.

(In computer vision application the processed images output for use by a computer, whereas in image processing applications the output images are for human consumption).

These two categories are not totally separate and distinct. The boundaries that separate the two are fuzzy, but this definition allows us to explore the differences between the two and to explore the difference between the two and to understand how they fit together (Figure 1.1).



Computer imaging can be separated into two different but overlapping areas.

Figure (1.1) Computer Imaging [1].

Historically, the field of image processing grew from electrical engineering as an extension of the signal processing branch, whereas are the computer science discipline was largely responsible for developments in computer vision.



## 1.2 Computer Vision

Computer vision computer imaging where the application does not involve a human being in visual loop. 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 systems are used in many and various types of environments, such as:

1. Manufacturing Systems
2. Medical Community
3. Law Enforcement
4. Infrared Imaging
5. Satellites Orbiting.

## 1.3 Image Processing

Image processing is computer imaging where application involves a human being in the visual loop. In other words the image are to be examined and acted upon by people.

The major topics within the field of image processing include:

1. Image restoration.
2. Image enhancement.
3. Image compression.

### 1.3.1 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).



a. Image with distortion



b. Restored image

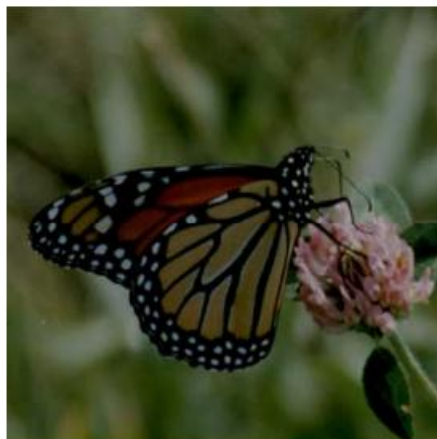
Figure (1.2) Image Restoration

### 1.3.2 Image Enhancement

Involves taking an image and improving it visually, typically by taking advantages of human Visual Systems responses. 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. They differ in how they approach the problem. 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.



a. image with poor contrast



b. Image enhancement by contrast stretching

Figure (1.3) Image Enhancement

### 1.3.1 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 processing systems are used in many and various types of environments, such as:

1. Medical community
2. Computer – Aided Design
3. Virtual Reality
4. Image Processing.



a. Image before compression  
(92) KB



b. Image after compression  
(6.59) KB

Figure (1.4) Image Compression.

### 1.4 Computer Imaging Systems

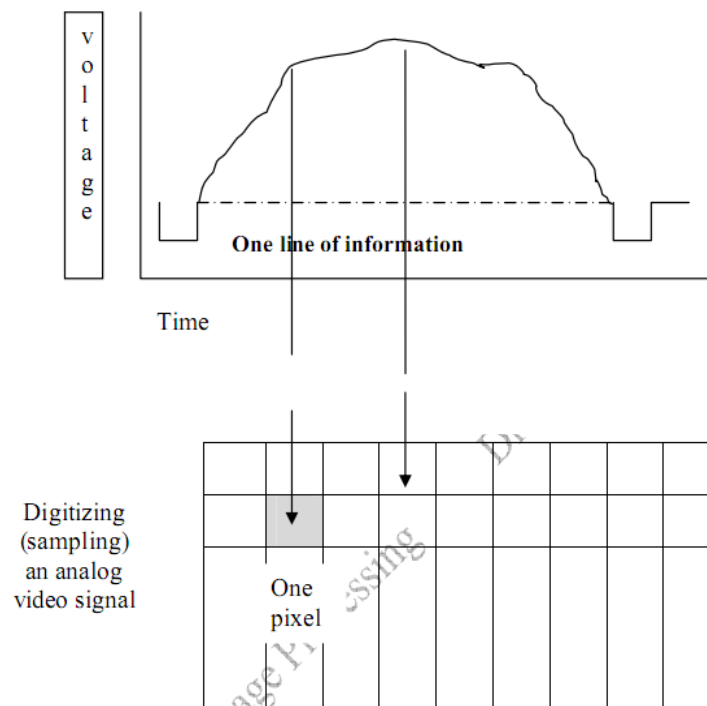
Computer imaging systems are comprised of two primary components types, hardware and software. The hard ware components can be divided into image acquiring sub system (computer, scanner, and camera) and display devices (monitor, printer).The software allows us to manipulate the image and perform any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

## 1.5 Digitization

The process of transforming a standard video signal into digital image. This transformation is necessary because the standard video signal in analog (continuous) form and the computer requires a digitized or sampled version of that continuous signal. The analog video signal is turned into a digital image by sampling the continuous signal at affixed rate. In the figure below we see one line of a video signal being sampled (digitized) by instantaneously measuring the voltage of the signal at fixed intervals in time.

The value of the voltage at each instant is converted into a number that is stored, corresponding to the brightness of the image at that point.

Note that the image brightness of the image at that point depends on both the intrinsic properties of the object and the lighting conditions in the scene.



**Figure (1.5) Digitizing (Sampling ) an Analog Video Signal[1].**

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:

$$\begin{pmatrix} I(0,0) & I(0,1) & \dots & I(0,N-1) \\ I(1,0) & I(1,1) & \dots & I(1,N-1) \\ \dots & \dots & \dots & \dots \\ I(N-1,0) & I(N-1,1) & \dots & I(N-1,N-1) \end{pmatrix}$$

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

$$N_g = 2^m \dots \dots \dots (1)$$

Where  $N_g$  denotes the number of gray levels  $m$  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 t he no. of bit in this image?

Solution:

$$N_g = 2^6 = 64 \quad \text{Gray Level}$$

$$N_b = 128 * 128 * 6 = 9.8304 * 10^4 \quad \text{bit}$$

## 1.6 The Human Visual System

The Human Visual System (HVS) has two primary components:

- Eye.
- Brian.

\* The structure that we know the most about is the image receiving sensors (the human eye).

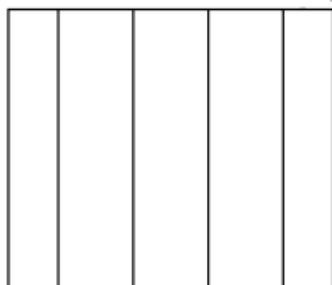
\* The brain can be thought as being an information processing unit analogous to the computer in our computer imaging system.

These two are connected by the optic nerve, which is really a bundle of nerves that contains the pathways for visual information to travel from the receiving sensor (the eye) to the processor (the brain).

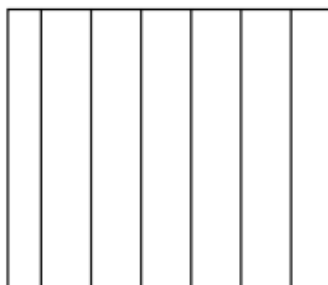
## 1.7 Image Resolution

The resolution has to do with ability to separate two adjacent pixels as being separate, and then we can say that we can resolve the two. The concept of resolution is closely tied to the concepts of spatial frequency.

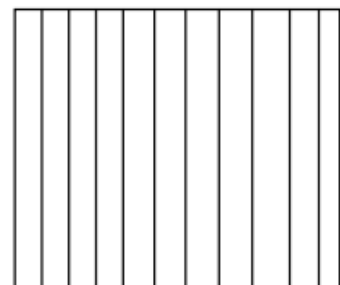
Spatial frequency concept, frequency refers to how rapidly the signal is changing in space, and the signal has two values for brightness-0 and maximum. If we use this signal for one line (row) of an image and then repeat the line down the entire image, we get an image of vertical stripes. If we increase this frequency the stripes get closer and closer together, until they finally blend together.



a. Low Freq. =2



b. Low Freq. =3



c. Low Freq. =5

Figure (1.6) Resolution and Spatial Frequency [1].

## 1.8 Image brightness Adaption

In image we observe many brightness levels and the vision system can adapt to a wide range. If the mean value of the pixels inside the image is around Zero gray level then the brightness is low and the images dark but for mean value near the 255 then the image is light. If fewer gray levels are used, we observe false contours (منحني) bogus lines resulting from gradually changing light intensity not being accurately represented.

## 1.9 Image Representation

We have seen that the human visual system (HVS) receives an input image as a collection of spatially distributed light energy; this form is called an optical image. Optical images are the type we deal with every day –cameras captures them, monitors display them, and we see them [we know that these optical images are represented as video information in the form of analog electrical signals and have seen how these are sampled to generate the digital image  $I(r, c)$ ].

The digital image  $I(r, c)$  is represented as a two- dimensional array of data, where each pixel value corresponds to the brightness of the image at the point  $(r, c)$ . in linear algebra terms , a two-dimensional array like our image model  $I(r, c)$  is referred to as a matrix , and one row ( or column) is called a vector.

The image types we will consider are:

### 1. Binary Image

Binary images are the simplest type of images and can take on two values, typically black and white, or '0' and '1'. A binary image is referred to as a 1 bit/pixel image because it takes only 1 binary digit to represent each pixel.

These types of images are most frequently in computer vision application where the only information required for the task is general shapes, or outlines information. For example, to position a robotics gripper to grasp (يمسك) an object or in optical character recognition (OCR).

Binary images are often created from gray-scale images via a threshold value is turned white ('1'), and those below it are turned black ('0').



Figure (1.7) Binary Images.



## 2. Gray Scale Image

Gray scale images are referred to as monochrome, or one-color image. They contain brightness information only brightness information only, no color information. The number of different brightness level available. The typical image contains 8 bit/ pixel (data, which allows us to have (0-255) different brightness (gray) levels. The 8 bit representation is typically due to the fact that the byte, which corresponds to 8-bit of data, is the standard small unit in the world of digital computer.



Figure (1.8) Gray Scale Images.