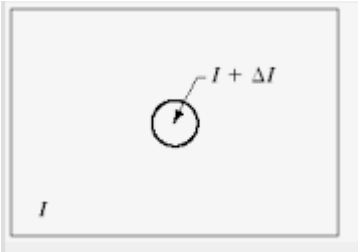
s=c log (1+r) where c is constant and it is assumed that r≥0 .

(f)The enhancement techniques that are using arithmetic operators are

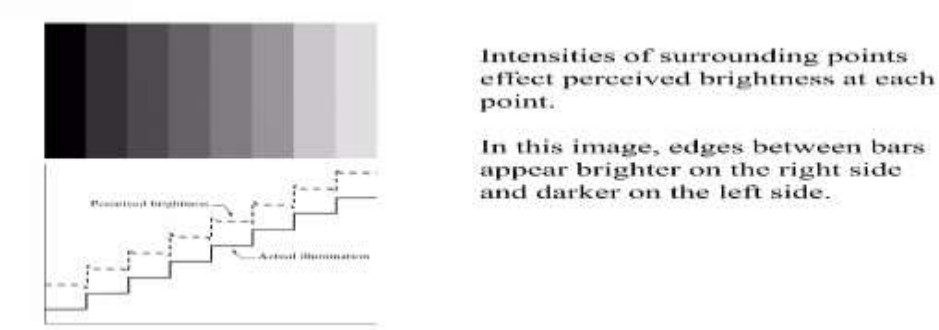
(i)Image subtraction

(ii)Image Averaging



Match band Effect

Mach bands or the Mach effect refers to an optical phenomenon from edge enhancement due to lateral inhibition of the retina 2. This is an inbuilt edge enhancement mechanism of the retina, where the edges of darker objects next to lighter objects will appear darker and vice versa, creating a false shadow



1.5 Fundamental Steps in Digital Image Processing:

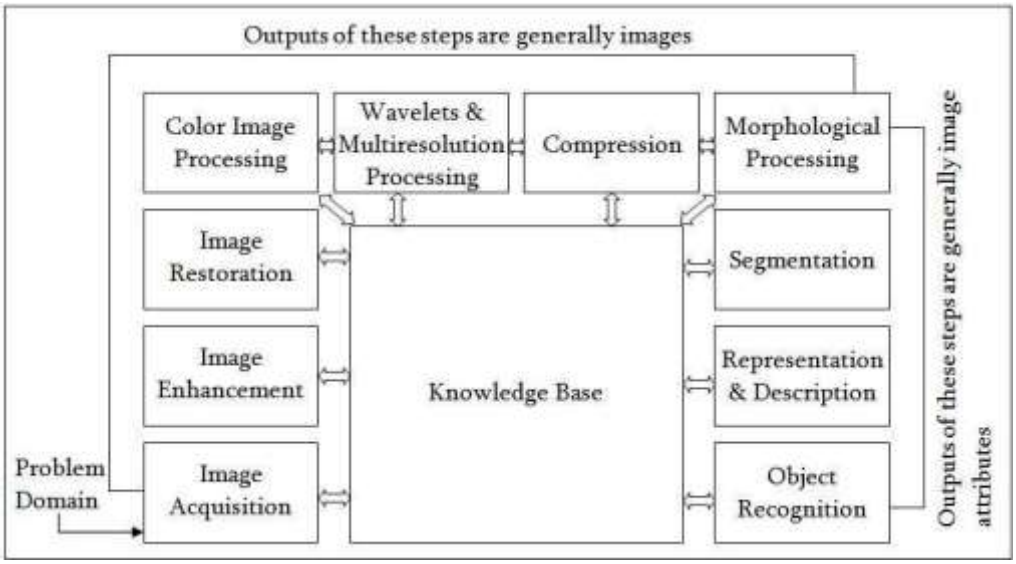


Fig 1.3 Fundamental Steps of Digital Image Processing

There are two categories of the steps involved in the image processing

(1) Methods whose outputs are input are images.

(2) Methods whose outputs are attributes extracted from those images.

There are some fundamental steps but as they are fundamental, all these steps may have sub- steps. The fundamental steps are described below with a neat diagram.

Image Acquisition: This is the first step or process of the fundamental steps of digital image processing. Image acquisition could be as simple as being given an image that is already in digital form. Generally, the image acquisition stage involves preprocessing, such as scaling etc.

Image Enhancement: Image enhancement is among the simplest and most appealing areas of digital image processing. Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image. Such as, changing brightness & contrast etc.

Image Restoration: Image restoration is an area that also deals with improving the appearance of an image. However, unlike enhancement, which is subjective, image restoration is objective, in the sense that restoration techniques tend to be based on mathematical or probabilistic models of image degradation.

Color Image Processing: Color image processing is an area that has been gaining its importance because of the significant increase in the use of digital images over the Internet. This may include color modeling and processing in a digital domain etc.

Wavelets and Multiresolution Processing: Wavelets are the foundation for representing images in various degrees of resolution. Images subdivision successively into smaller regions for data compression and for pyramidal representation.

Compression: Compression deals with techniques for reducing the storage required to save an image or the bandwidth to transmit it. Particularly in the uses of internet it is very much necessary to compress data. It has to major approaches a) Lossless Compression b) Lossy Compression.

Morphological Processing: Morphological processing deals with tools for extracting image components that are useful in the representation and description of shape.

Segmentation: Segmentation procedures partition an image into its constituent parts or objects.In general, autonomous segmentation is one of the most difficult tasks in digital image processing. A rugged segmentation procedure brings the process a long way toward successful solution of imaging problems that require objects to be identified individually.

Representation and Description: Representation and description almost always follow the output of a segmentation stage, which usually is raw pixel data, constituting either the boundaryof a region or all the points in the region itself. Choosing a representation is only part of the solution for transforming raw data into a form suitable for subsequent computer processing. Description deals with extracting attributes that result in some quantitative information of interest or are basic for differentiating one class of objects from another.

Object recognition: Recognition is the process that assigns a label, such as, “vehicle” to an object based on its descriptors.

Knowledge Base: Knowledge may be as simple as detailing regions of an image where the information of interest is known to be located, thus limiting the search that has to be conducted in seeking that information. The knowledge base also can be quite complex, such as an interrelated list of all major possible defects in a materials inspection problem or an image database containing high-resolution satellite images of a region in connection with change-detection applications.

1.6 Components of Image processing system:

Image Sensors: With reference to sensing, two elements are required to acquire digital image. The first is a physical device that is sensitive to the energy radiated by the object we wish to image and second is specialized image processing hardware.

Specialize image processing hardware: It consists of the digitizer just mentioned, plus hardware that performs other primitive operations such as an arithmetic logic unit, which performs arithmetic such addition and subtraction and logical operations in parallel on images

Computer: It is a general purpose computer and can range from a PC to a supercomputer depending on the application. In dedicated applications, sometimes specially designed computer are used to achieve a required level of performance.

Software: It consists of specialized modules that perform specific tasks a well-designed package also includes capability for the user to write code, as a minimum, utilizes the specialized module. More sophisticated software packages allow the integration of these modules.

Mass storage: This capability is a must in image processing applications. An image of size 1024 x1024pixels ,in which the intensity of each pixel is an 8- bit quantity requires one megabytes of storage space if the image is not compressed .Image processing applications falls into three principal categories of storage

i) Short term storage for use during processing

ii) On line storage for relatively fast retrieval

iii) Archival storage such as magnetic tapes and disks

Image displays: Image displays in use today are mainly color TV monitors. These monitors are driven by the outputs of image and graphics displays cards that are an integral part of computer system

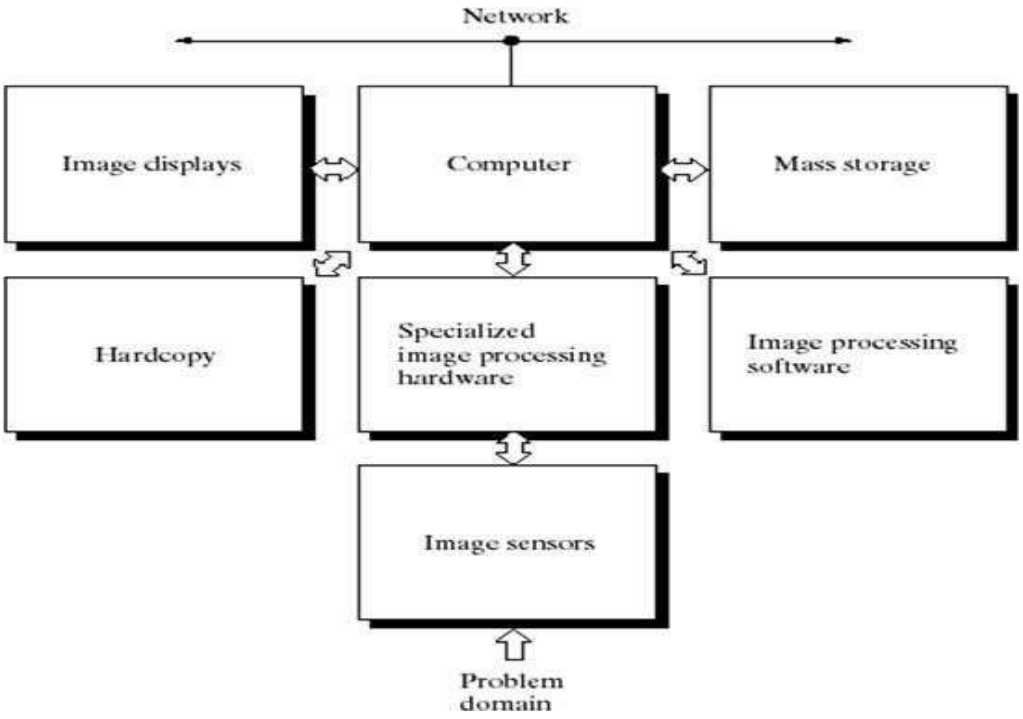


Fig1.4 Components of Image processing system

Hardcopy devices : The devices for recording image includes laser printers, film cameras, heat sensitive devices inkjet units and digital units such as optical and CD ROM disk. Films provide the highest possible resolution, but paper is the obvious medium of choice for written applications.

Networking: It is almost a default function in any computer system in use today because of the large amount of data inherent in image processing applications. The key consideration in image transmission bandwidth.

1.7 Image Formation Model:

An image is denoted by a two dimensional function of the form f{x, y}. The value or amplitude of f at spatial coordinates {x,y} is a positive scalar quantity whose physical meaning is determined by the source of the image.

When an image is generated by a physical process, its values are proportional to energy radiated by a physical source. As a consequence, f(x,y) must be nonzero and finite; that is o<f(x,y) <co.

The function f(x,y) may be characterized by two components-

The amount of the source illumination incident on the scene being viewed.

The amount of the source illumination reflected back by the objects in the scene These are called illumination and reflectance components and are denoted by i (x,y) and r (x,y) respectively. The functions combine as a product to form f(x,y).

We call the intensity of a monochrome image at any coordinates (x,y) the gray level (l) of the image at that point

l= f (x, y.)

L min ≤ l ≤ L max

L min is to be positive and L max must be finite L min = I min r min L max = I max r max

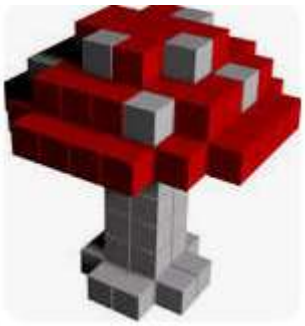
The interval [L min, L max] is called gray scale. Common practice is to shift this interval numerically to the interval [0, L-l] where l=0 is considered black and l= L-1 is considered white on the gray scale. All intermediate values are shades of gray of gray varying from black to white.

Definition for Pixels and Voxels

Pixel: The pixel -- a word invented from picture element -- is the basic unit of programmable color on a computer display or in a computer image. Pixels are the smallest unit in a digital display.

Voxel: In computer-based modelling or graphic simulation) each of an array of elements of volume that constitute a notional three-dimensional space, especially each of an array of discrete elements into which a representation of a three-dimensional object is divided.

The word voxel originated by analogy to "pixel", with vo representing "volume" (instead of pixel's "picture") and el representing "element"; a similar formation with el for "element" is the word "texel". The term hyper voxel is a generalization of voxel for higher-dimensional spaces.



1.8 Image Sampling and Quantization:

- To create a digital image, we need to convert the continuous sensed data into digital from. This involves two processes – sampling and quantization. An image may be continuous with respect to the x and y coordinates and also in amplitude. To convert it into digital form we have to sample the function in both coordinates and in amplitudes.

- **Digitalizing the coordinate values is called sampling**
- **Digitalizing the amplitude values is called quantization**

- There is a continuous the image along the line segment AB. To simple this function, we take equally spaced samples along line AB. The location of each samples is given by a vertical tick back (mark) in the bottom part. The samples are shown as block squares superimposed on function the set of these discrete locations gives the sampled function.