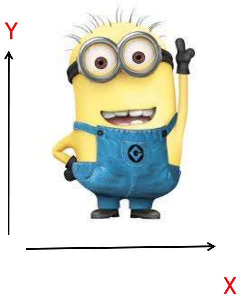
## FUNDAMENTAL OF DIP

IT4440
(MULTIMEDIA AND GAMES)


## WHAT IS AN IMAGE?

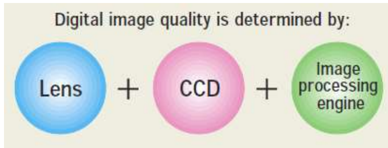
- An image is nothing more than a two dimensional signal.
- It is defined by the mathematical function f(x,y) where x and y are the two co-ordinates horizontally and vertically.
- The value of f(x,y) at any point is gives the pixel value at that point of an image.

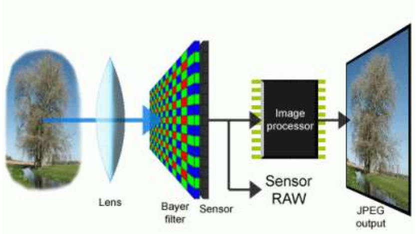



## TYPES OF IMAGES

1. Analog : An analog image can be represented as continuous range of value representing position and intensity.
2. Digital : It is composed of picture element called pixel.

A digital image is a representation of a two-dimensional image as a finite set of digital values, called picture elements or pixels



## CCD

- An **image** sensor or imaging sensor is a sensor that detects and conveys the information that constitutes an **image.**

▪the amount of light reflected by the object is sensed by the sensors, and a continuous voltage signal is generated by the amount of sensed data.


Electron-Bombarded Back-Thinned CCD

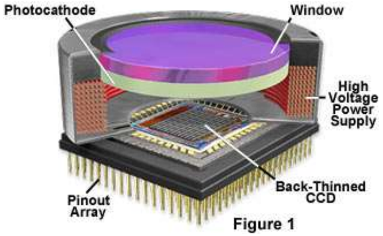
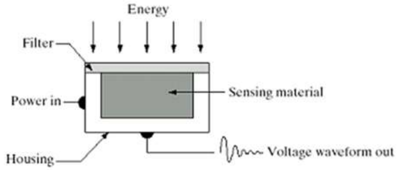
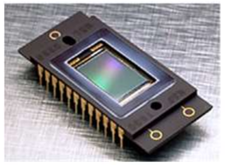



Figure 1

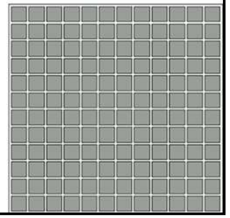
## CCD - CHARGED COUPLED DEVICE

- Since capturing an image from a camera is a physical procedure.
- The sunlight is used as a source of energy.
- A sensor array is used for the acquisition of the image.



*KAF-1600 - Kodak.*



## HOW A DIGITAL IMAGE IS GENERATED

- In order to create a digital image, we need to convert this data into a digital form.
- This involves sampling and quantization.
- The result of sampling and quantization results in an two dimensional array or matrix of numbers which are nothing but a digital image.

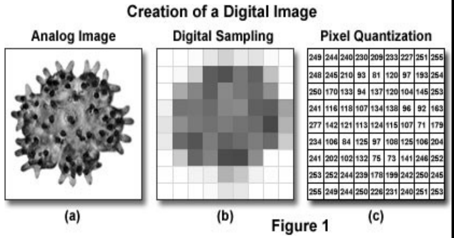



Figure 1

## IMAGES SAMPLING & QUANTIZING

Original

Cường độ sáng của đường quét ngang

sampling

quantizing

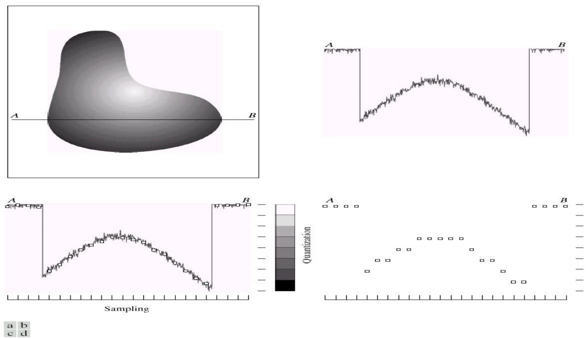


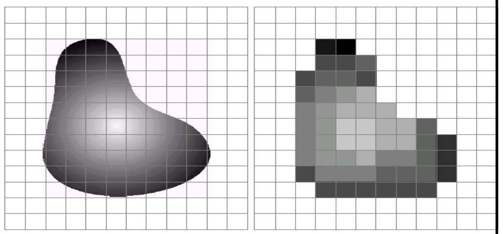

FIGURE 2.16 Generating a digital image. (a) Continuous image. (b) A scan line from A to B in the continuous image, used to illustrate the concepts of sampling and quantization. (c) Sampling and quantization. (d) Digital scan line.

*Source : Gonzalez and Woods. Digital Image Processing. Prentice-Hall, 2002.*

## SAMPLING & QUANTIZING

- an image is continuous not just in its co-ordinates (x axis), but also in its amplitude (y axis), so digitizing of co-ordinates is sampling
- Quantization is opposite to sampling. It is done on y axis, actually dividing a signal into quanta (partitions).
- On the x axis of the signal, are the co-ordinate values, and on the y axis, we have amplitudes. So digitizing the amplitudes is known as Quantization.

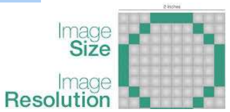
Continuos image | Image after sampling & quantization



a b
**FIGURE 2.17** (a) Continuos image projected onto a sensor array. (b) Result of image sampling and quantization.

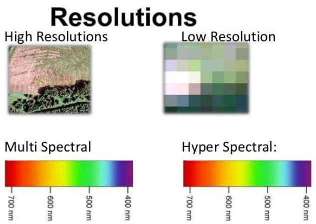
## IMAGE RESOLUTION

## TYPE OF RESOLUTION


The resolution can be defined in many ways.

- pixel resolution,
- spatial resolution,
- temporal resolution,
- spectral resolution.





## PIXEL RESOLUTION

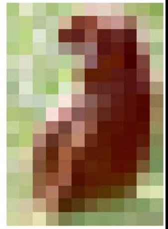
the term resolution refers to the total number of count of pixels in an digital image.

For example.

If an image has M rows and N columns, then its resolution can be defined as M X N.

200 X 278

50 X 70



12 X 18

## FOR EXAMPLE

If you are given an image with aspect ratio of 6:2 of an image

of pixel resolution of 480000 pixels

given the image is an gray scale image 8 bits

And you are asked to calculate two things.

Resolve pixel resolution to calculate the dimensions of image

*Calculate the size of the image*

Given:

Aspect ratio: c:r = 6:2

Pixel resolution: c * r = 480000

Bits per pixel: grayscale image = 8bpp

Find:

Number of rows = ?

Number of cols = ?

Equation 1. c:r = 6:2 → c = 6 r / 2

Equation 2. c = 480000/r

Comparing both equations → $\frac{6r}{2} = \frac{480000}{r}$

$r^2 = \sqrt{\frac{480000*2}{6}}$

That gives r = 400.

Put r in equation 1, we get → c = 1200.

So rows = 400 cols = 1200.

Solving 2nd part:

Size = rows * cols * bpp

Size of image in bits = 400 * 1200 * 8 = 3840000 bits

Size of image in bytes = 480000 bytes

Size of image in kilo bytes = 48 kb (approx).

## GRAY LEVEL RESOLUTION

Gray level resolution refers to the predictable or deterministic change in the shades or levels of gray in an image.

In short gray level resolution is equal to the number of bits per pixel

$L = 2^k$

Where k = 8

$L = 2^8$

L = 256.

8 bits 4 bits 2 bits

## MATHEMATICALLY

The mathematical relation that can be established between gray level resolution and bits per pixel can be given as.

$L = 2^k$

*In this equation L refers to number of gray levels.*

*k refers to bpp or bits per pixel.*

if we were to find the bits per pixel or in this case k, we will simply change it like this.

K = log base 2(L)

For example:

*If you are given an image of 256 levels. What is the bits per pixel required for it.*

*Putting 256 in the equation, we get.*

*K = log base 2 ( 256)*

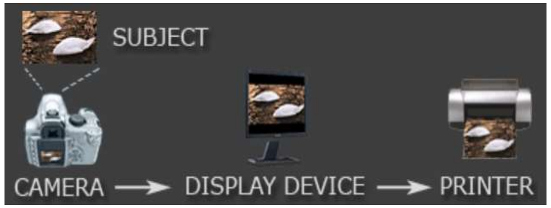
*K = 8.*

*So the answer is 8 bits per pixel.*

## SPATIAL RESOLUTION

A measure of the accuracy or detail of a graphic display, It is a measure of how fine an image is, usually expressed in dots per inch (dpi).

Spatial resolution can be defined as the smallest discernible detail in an image. *(Digital Image Processing - Gonzalez, Woods - 2nd Edition)*



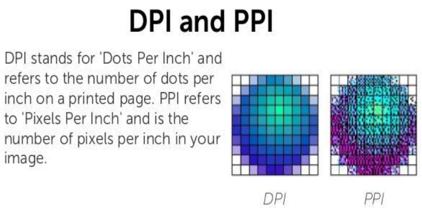


***Device resolution and image size***

Since the spatial resolution refers to clarity, so for different devices, different measure has been made to measure it.

For example: Dots per inch, Lines per inch, Pixels per inch

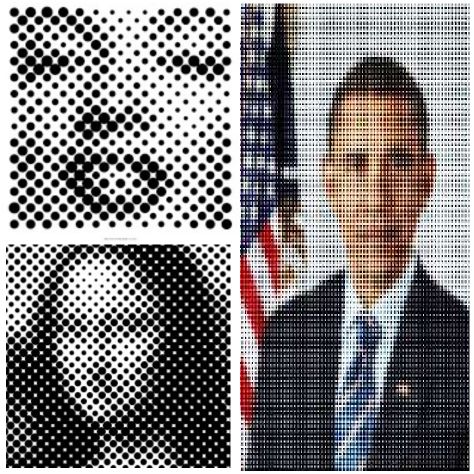
- Dots per inch or DPI is usually used in monitors.
- Pixel per inch or PPI is measure for different devices such as tablets , Mobile phones e.t.c.
- Lines per inch or LPI is usually used in la: printers using half tonning

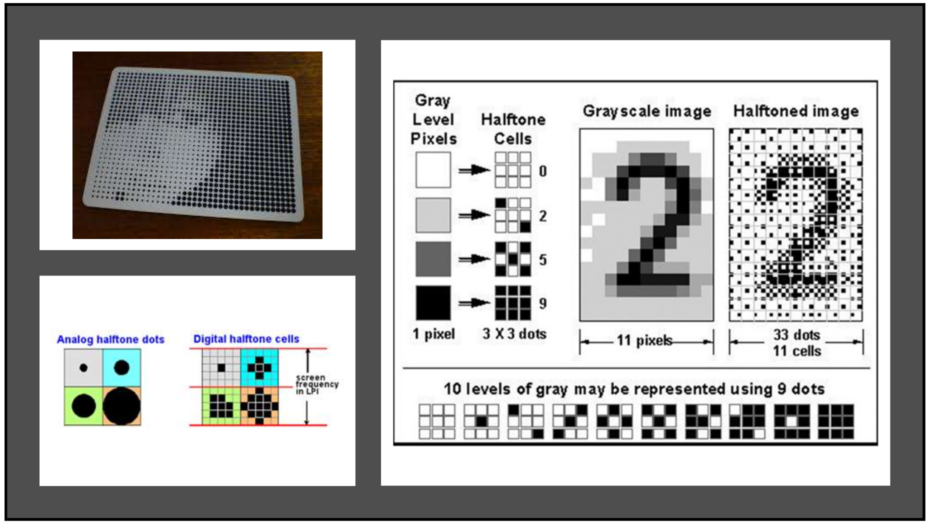



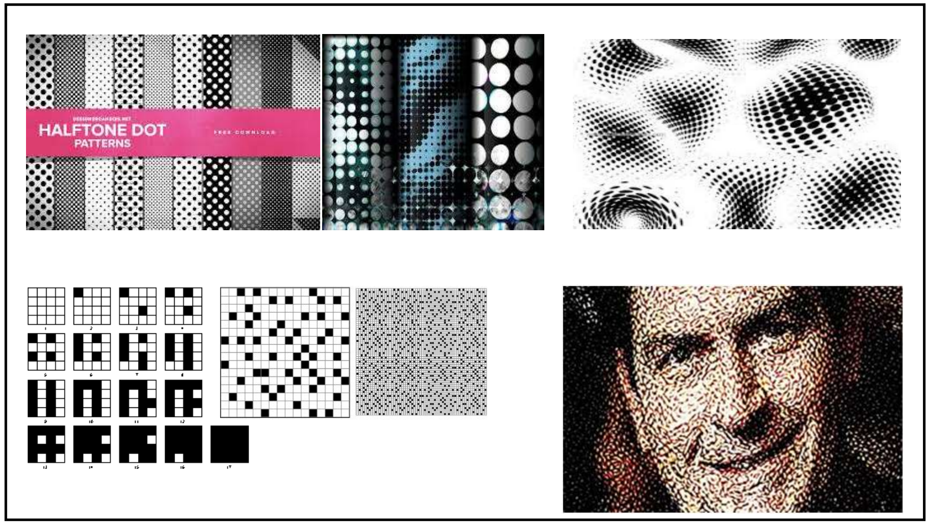

## HALF TONNING

**Halftone** is the reprographic technique that simulates continuous toneimagery through the use of dots thus generating a gradient-like effect

- A halftone, is an image comprised of discrete dots rather than continuous tones.
- Originally, halftoning was performed mechanically by printers that printed images. Now a day, goal of halftoning is typically to create a realistic image or artistic effect.



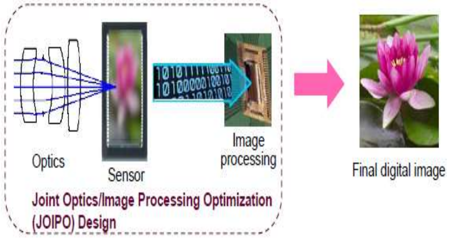



# DIP

## MEANING OF DIP

- **DIP**: The **Digital image processing** is the use of computer algorithms to perform image processing (or) manipulation on digital images.
- **Digital** :Information represented in discrete (digits) form.
- **Image** :A reproduction of the form of a person or object .
- **Processing** :Performing a series of actions or operations on data to convert into information

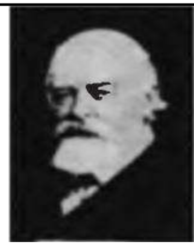


## HISTORY OF DIP

**Early 1920s**: One of the first applications of digital imaging was in the news paper industry.

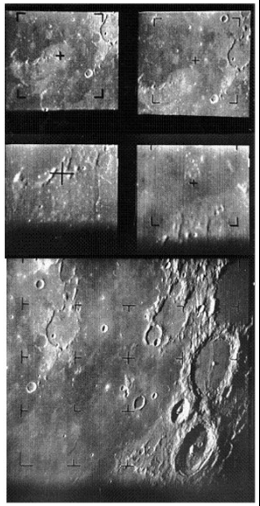
- The Bartlane cable picture transmission service.
- Images were transferred by submarine cable between London and New York.
- Pictures were coded for cable transfer and reconstructed at the receiving end on a telegraph printer.

## HISTORY OF DIP



- In 1921, photographic printing press improved the resolution and tonal quality of images.
- Bartlane system was capable of coding 5 distinct brightness levels.
- It increased to 15 by 1929.

## HISTORY OF DIP



- After 35 years of improvement in processing technique
- In 1964, Computer processing techniques were used to improve picture of moon transmitted by *Ranger 7*.
- This was the basis of modern image processing technique.

## HISTORY OF DIP

- Many of the techniques of digital image processing, in the 1960s *at the Jet Propulsion Laboratory, MIT, Bell Lab, University of Maryland,*
- satellite imagery, wire-photo standards conversion,
- Medical imaging, Videophone, Character recognition, and photograph enhancement.

## HISTORY OF DIP

Typical head slice CAT image

- 1970s: Digital image processing begins to be used in medical applications
- **1979:** Sir Godfrey N. Hounsfield & Prof. Allan M. Cormack share the Nobel Prize in medicine for the invention of tomography,
- the technology behind Computerised Axial Tomography (CAT) scans

**Godfrey N. Hounsfield**

**Prof. Allan M. Cormack**

## WHY IMAGE PROCESSING

Digital image processing focuses on two major tasks.

- Improvement of **pictorial information** for human interpretation.
- Processing of image data for **storage**, **transmission** and representation for autonomous machine perception.

## ADVANTAGES OF DIGITAL IMAGE

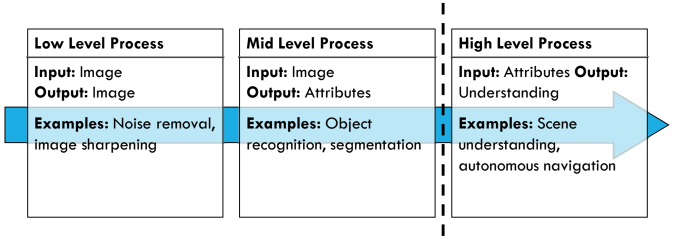
- Processing of digital image is **faster** and **cost effective**.
- It can be **effectively stored** and **transmitted** from one place to another.
- When suiting a digital image on can immediately see the **image is good or not.**
- Digital technique offers a plenty of store for versatile **image manipulation** .

## DISADVANTAGES OF DIGITAL IMAGE

- Misused of **copyright** has become easier because images can be copy from the internet by just clicking on the mouse.
- Digital images **can't be enlarge** on certain size without compromising on quality .
- The **memory required** for store and processing a good quality of digital image is **very high**.

# TYPOLOGY

"The continuum from image processing to computer vision can be broken up into low, mid and high-level processes"




**Low-level process: (DIP)**

- Primitive operations where inputs and outputs are images
- **Major functions**: image pre-processing like noise reduction, contrast enhancement, image sharpening, etc.

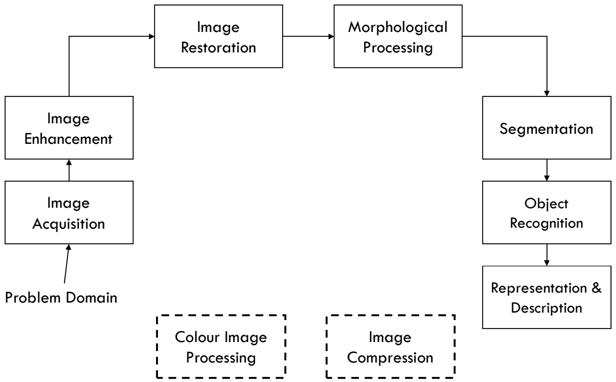
**Mid-level process (DIP and Computer Vision and Pattern Recognition)**

- Inputs are images, outputs are attributes (e.g., edges).
- **Major functions**: segmentation, description, classification / recognition of objects

**High-level process (Computer Vision)**

- Make sense of an ensemble of recognized objects; perform the cognitive functions normally associated with vision

# KEY STAGES IN DIGITAL IMAGE PROCESSING




# FUNDAMENTAL STEPS IN DIP

**Image Acquisition:**

- First process
- Involves image preprocessing viz. scaling

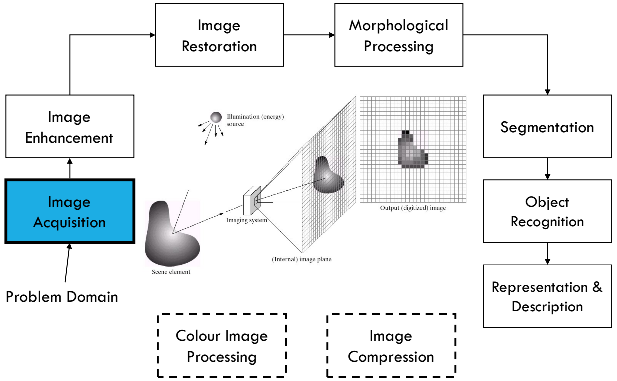
**Image Enhancement:**

- Process of image manipulation to make it more suitable for specific use
- Different images require different enhancement methods
- Subjective technique

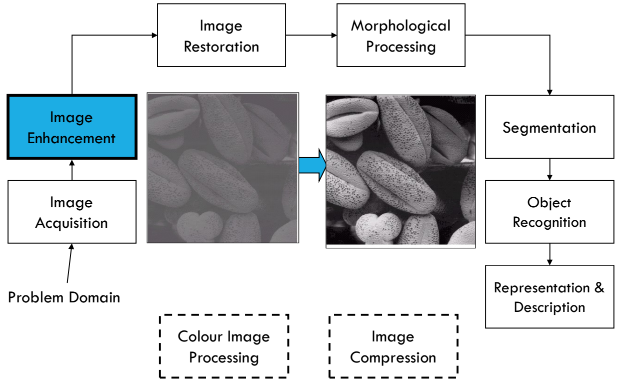
**Image Restoration:**

- Based on mathematical or probabilistic models of image degradation thus objective.

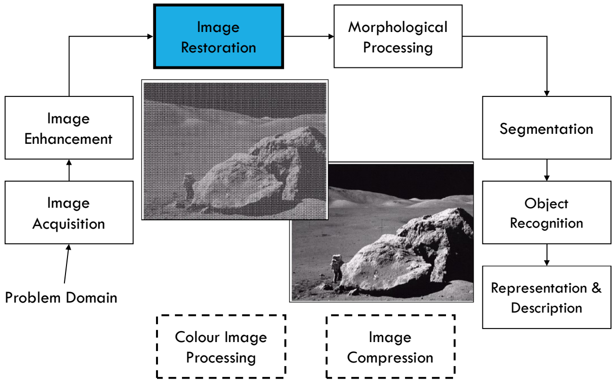
## KEY STAGES IN DIGITAL IMAGE PROCESSING: IMAGE AQUISITION




## KEY STAGES IN DIGITAL IMAGE PROCESSING: IMAGE ENHANCEMENT




## KEY STAGES IN DIGITAL IMAGE PROCESSING: IMAGE RESTORATION




## FUNDAMENTAL STEPS IN DIP

**Morphological Processing :**

- Deals with tools for extracting image components

**Segmentation:**

- Partition an image into constituent parts or objects.

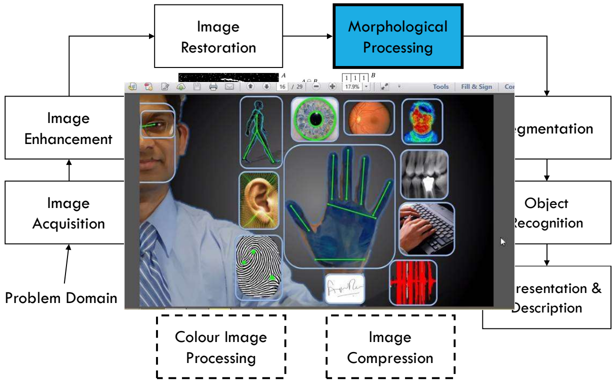
**Representation & description:**

- Follows output of segmentation with raw pixel data usually boundary information or regional description.

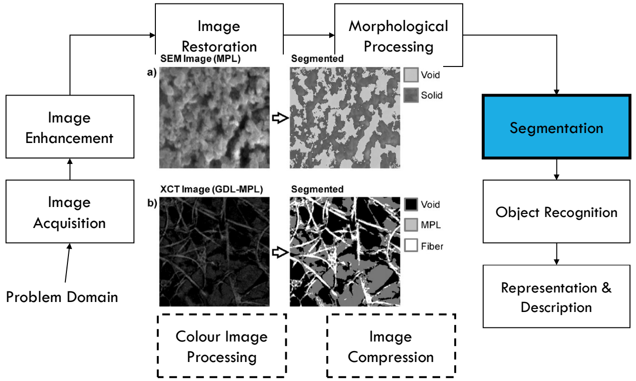
**Object recognition:**

- Process of assigning a label to an object based on its description.

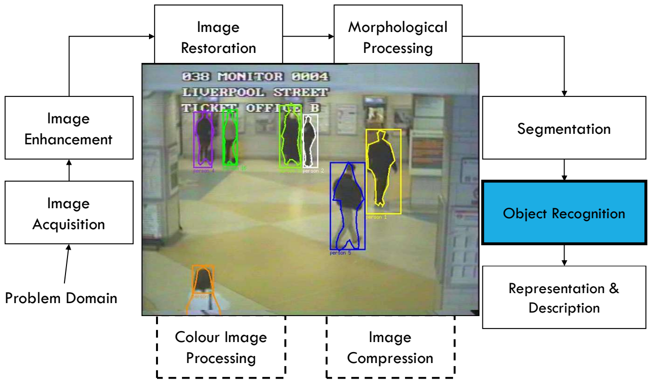
## KEY STAGES IN DIGITAL IMAGE PROCESSING: MORPHOLOGICAL PROCESSING



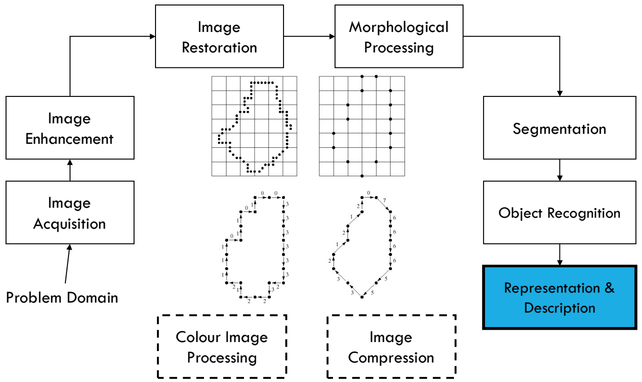

## KEY STAGES IN DIGITAL IMAGE PROCESSING: SEGMENTATION




## KEY STAGES IN DIGITAL IMAGE PROCESSING: OBJECT RECOGNITION




## KEY STAGES IN DIGITAL IMAGE PROCESSING: REPRESENTATION & DESCRIPTION



## FUNDAMENTAL STEPS IN DIP

**Color Image Processing:**

➢Gained importance due to increase use of internet

**Wavelets:**

➢Used mainly for image data compression & pyramidal representation where images are divided into smaller regions.

**Compression:**

➢Technique for reducing the storage required to save image, or bandwidth required to transmit it.

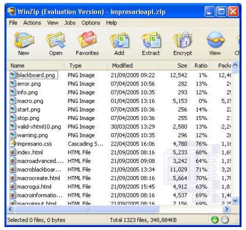
- ✓ JPEG (Joint Photographic Experts Group)
- ✓ TIF(Tagged Image File) or TIFF(Tagged Image File Format)
- ✓ PNG(Portable Network Graphics)
- ✓ GIF(Graphics Interchange Format)
- ✓ BMP(Bitmap image file)

## KEY STAGES IN DIGITAL IMAGE PROCESSING: IMAGE COMPRESSION

Image Restoration

Morphological Processing

Image Enhancement



Segmentation

Image Acquisition

Object Recognition

Problem Domain

Representation & Description

Colour Image Processing

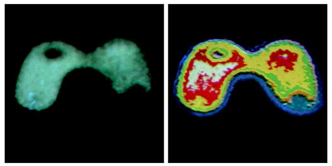
Image Compression

## KEY STAGES IN DIGITAL IMAGE PROCESSING: COLOUR IMAGE PROCESSING

Image Restoration

Morphological Processing

Image Enhancement



Segmentation

Image Acquisition

Object Recognition

Problem Domain

Representation & Description

Colour Image Processing

Image Compression

## APPLICATION OF DIP

# APPLICATIONS OF DIP

**1)Biological Research:**

- ✓ DNA typing and matching;
- ✓ Automatic counting and classification of cell structures in bone and tissue.


**2) Defence and Intelligence:**

Reconnaissance photo-interpretation of objects in

- ✓ Satellite images;
- ✓ Target acquisition and
- ✓ Missile guidance.

# APPLICATIONS OF DIP

**3) Document Processing**:

- ✓ Scanning,
- ✓ Archiving and transmission (fax);
- ✓ Automatic detection and recognition of printed text (postal sorting office, tax return processing, banking cheques).

**4) Law Enforcement Forensics:**

- ✓ Photo-ID kits,
- ✓ criminal photo-search,
- ✓ automatic fingerprint matching,
- ✓ DNA matching and fibre analysis

# APPLICATIONS OF DIP

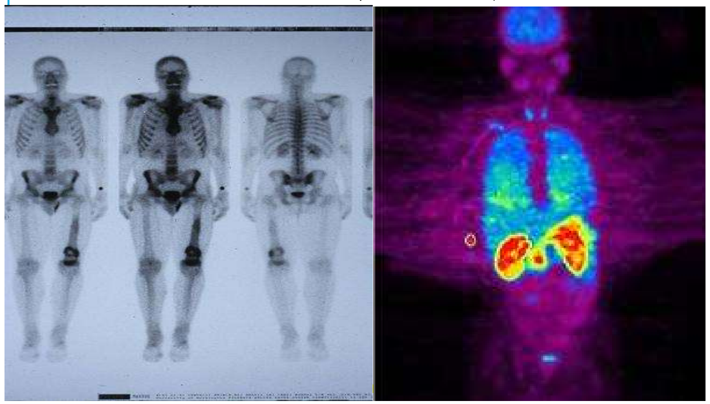
**5) Photography:**

- ✓ Altering colours,
- ✓ Zooming;
- ✓ Adding and subtracting objects to a scene;

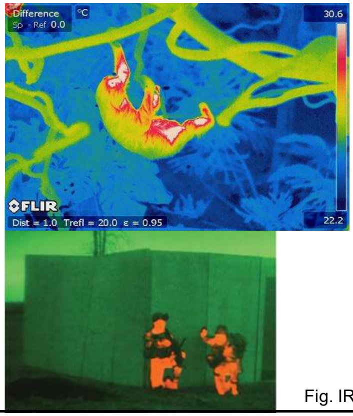
***6) Remote Sensing:***

- ✓ Land cover analysis (water, roads, cities and cultivation),
- ✓ vegetation features (water content and temperature) and crop yield analysis;
- ✓ 3-D terrain rendering from satellite or aircraft data (road and dam planning); fire and smoke detection.

# GAMMA-RAY IMAGING (MEDICAL)



## IR Imaging



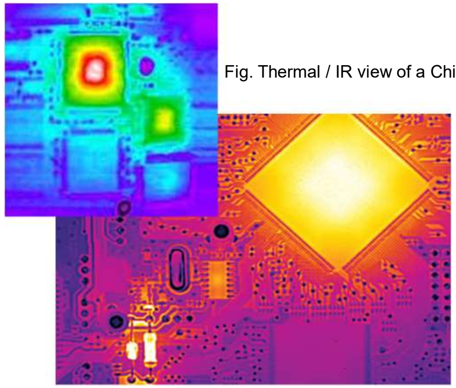
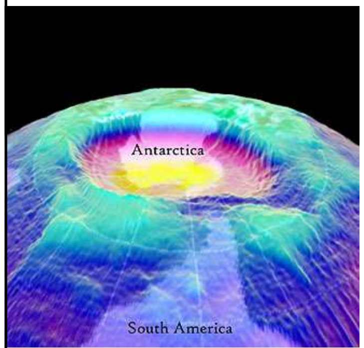



Fig. Thermal / IR view of a Chip

Fig. IR image of a sloth at night

## Remote Sensing


## UV imaging (Ozone)



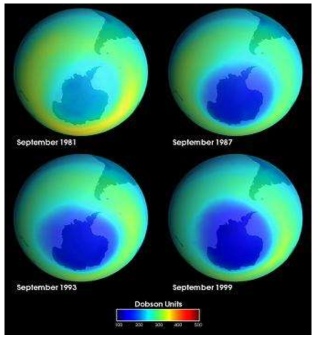



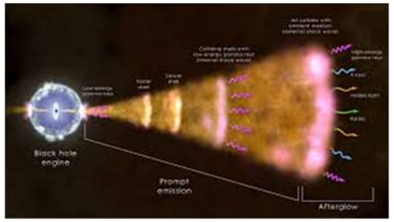

Fig. Detect ozone layer damage

## Remote Sensing

# APPLICATIONS OF DIP

**7) Space exploration and Astronomy:**

✓Satellite navigation and altitude control using star positions.




**8) Video and Film Special Effects:**

✓ Animation, and

✓Special effects (Star Wars).

## Seismic imaging (Earthquake)

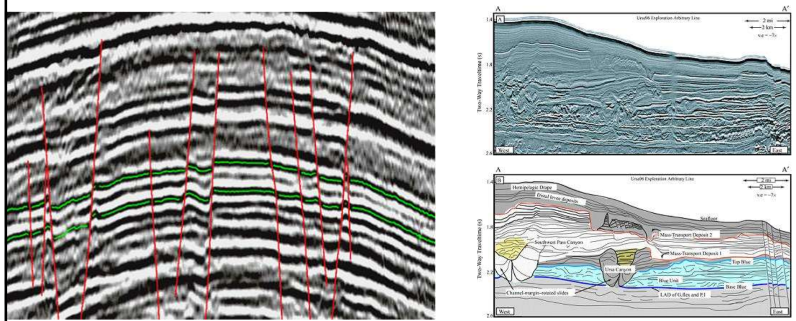
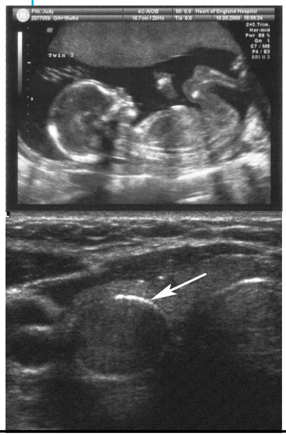


Fig. Detecting Earthquakes and its cause using cross sectional view

## ULTRASOUND IMAGING
## X-RAY IMAGING (MEDICAL)




# SUMARY

- Digital image processing made digital image can be noise free
- It can be made available in any desired format. (X-rays, photo negatives, improved image, etc)
- Digital imaging is the ability of the operator to post-process the image .It means manipulate the pixel shades to correct image density and contrast .
- Images can be stored in the computer memory and easily retrieved on the same computer screen .
- Digital imaging allows the electronic transmission of images to third-party providers