DIP deals with manipulation of digital images. It is a type of signal processing in which i/p is image & o/p may be image/characteristics/feature associated with that image. DIP focuses on developing a digital system that is able to perform processing on images.

DIP process involves Image aquisition, preprocessing, Segmentation, Representation & Description (Feature Extraction) & Recognition & Interpretation (img understanding) thereby enabling the scene analysis & understanding.

Digital Image: It is a representation of of 2-D image as a finite set of values, called picture elements or pixels. Actual image is a 2-D Array of function $F(x,y)$ where x & y are spatial co-ordinates (x,y). & the Amplitude of F at any pair of (x,y) is called as Intensity of the image at that point.

Digital Image is composed of a finite no. of elements, each of elements have a particular value at a particular location. These elements are referred to as picture elements, image elements & pixels.

"A pixel is a smallest addressable image element"

Types of an Image:

1) Binary Image:
It contain only 2-pixel values i.e, 0 & 1. Here 0 refers Black color & 1 refers white color. It is also known as Monochrome.

Ex: Black & White Images: The Image consisting of only Black & White color is called as Black & White Images.

Format: PBM (Portable Binary Map)

ii) 2, 3, 4, 5, 6 bit color Format:

The image with this color format not widely used today They were used in old times for old TV-displays or Monitors But each of these types have 2-gray levels. & hence has gray color unlike the Binary image.

In a 2-bit 4, in a 3 bit 8, In a 4 bit 16, In a 5 bit 32, 6 bit 64 different colors are present.

iii) 8 bit Color Format:

It is one of the famous Img. Format. It has 256 different shades of color in it. It is commonly known as Grayscale Image.

The range of colors in 8 bit vary from 0-255. where 0 stands for Black, & 255 stands for White, & 127 - Gray color.

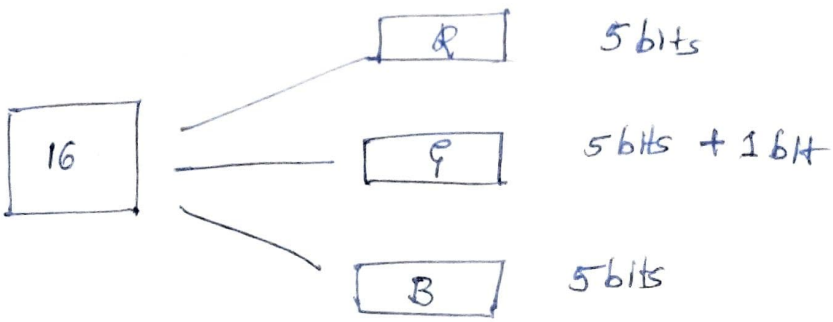
This format was used initially by early models of the O.S. UNIX & the early color Macintoshes.

The format of these image is PGM (portable Gray Map).

iv) 16-bit - Color Format:

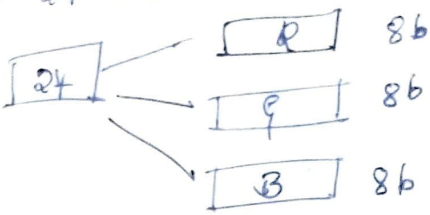
It has 65,536 different colors in it. It is also known as high-color format.

16-bit format is actually divided into further formats Red, Green, Blue (RGB-format).



v) 24 bit - colour - format: (True - colour - format):

Here 24 bits are distributed in 3-different formats of R, G, B

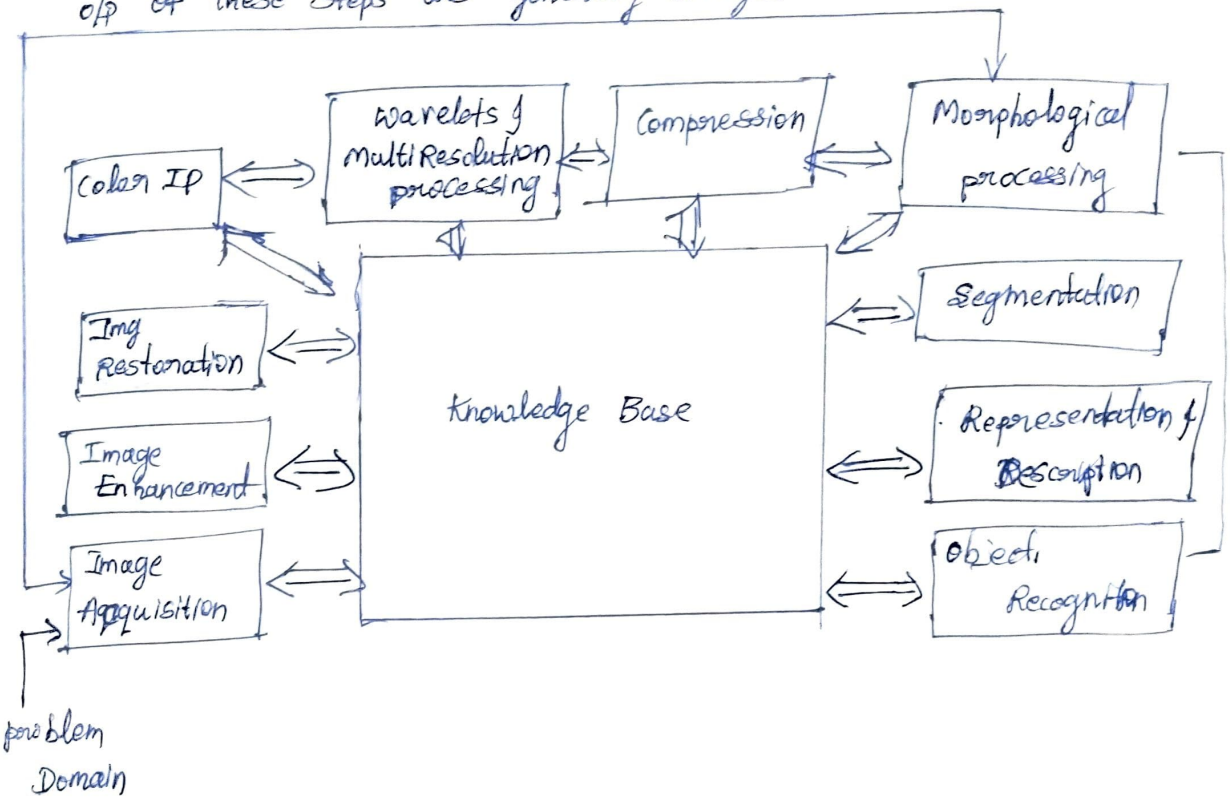


PPM - format (portable pixMap) which is supported in Linux

BMP (BitMap) - famous format in windows.

3] Phase of DIP / steps of DIP:

o/p of these steps are generally Images



i) Img. Acquisition:

It is the first step. In this stage, an image is given in the digital form. Generally, pre-processing such as scaling & colour-conversion (RGB to Gray or vice-versa) is done.

ii) Img. Enhancement:

In this stage details which are not know or we can say that Interesting features of an Img. is highlighted. such as Brightness, Contrast, ----.

* Used to extract some hidden details.

iii) Img. Restoration:

Here appearance of an img. is improved.

iv) Color Img. processing:

This includes color-Modeling, processing in digital domain, etc.

v) Wavelets & Multi-Resolution processing:

Here, Images represented in various degrees of resolution. Images are divided into smaller regions for data-compression & for the pyramidal-Representation.

vi) Compression:

It reduces the requirement storage of the img. It is very important storage, because it is very necessary to compress data for internet use.

vii) Morphological processing:

It deals with tools which are used for extracting the components of the image, which is useful in Representation & Description of the shape.

viii) Segmentation:

In this stage image is partitioned into its objects. It is most difficult task in DIP.

IX) Representation & Description:

It follow the o/p of the segmentation stage. The o/p is a raw pixel data which has all points of the region itself. To transform the raw data, Representation is the only Solution. Whereas description is used for extracting informations to differentiate one class of objects from another.

X) Object Recognition:

In this stage, the Label is assigned to the object, which is based on descriptors.

Knowledge Base: It is last stage in DIP. Important Infos of the image is located, which limits the searching process.

Linear Transformation :-

It is one of type of Gray-Level-Transformation, It is used for manipulation of an image so that the result is more suitable than the original for specific applications.

It includes Identity & Negative transformation

In Identity transformation, each value of the image is directly mapped to each other values of the o/p image.

-ve transformation is the opposite of identity transformation, here each value of the i/p image is subtracted from L-1 & mapped on into o/p image.

Scaling of an Image:

- Scaling operation increases/reduces size of an image.
- A scaling Transformation alters size of an object.

In the scaling process, we either compress or expand dimension of the object. Scaling operation can be achieved by multiplying each vertex coordinate (x, y) of the polygon by scaling factor S_x & S_y to produce the transformed coordinates as (x', y').

Rotating an Image:

Images can rotated to any degree clockwise/Anticlockwise we just need to define Rotation matrix using Rotation point, degree of Rotation & the scaling factor.

Img. Rotation is a common image processing routines with applications in matching, alignment & other image-based algorithm. An img. rotated by 45°. The o/p is the same size as the i/p. & the out of edge values are dropped.

cv2. INTER_AREA — is used for shrinking

cv2. INTER_CUBIC — is used for zooming

cv2. getRotationMatrix2D — Creates a Matrix needed for Transformation

5] Convert Colour Image to Gray Scale to Binary Img

Grayscaling is the process of converting an Image from other colorspace (eg. RGB, CMYK, HSV etc) to shades of Gray. It varies b/w complete Black & complete White.

Importance of Grayscaling:-

i) Dimension reduction: For. eg. In RGB images there are 3-colour channels & has 3-D while grayscaled images are single dim.

ii) Reduces model complexity: Consider training Neural article on RGB images of 10x10x3 pixel. The i/p layer will have 300 i/p nodes. On the other hand, the same Neural Network will need only 100 i/p nodes for grayscaled images.

iii) For other algorithms to work: There are many algorithms that are customized to work only on grayscaled images eg. Canny - Edge detection function pre-implemented in openCV library works on Gray-scaled images only.

Simple colour Img to Gray scale to Binary Img:

```
import opencv
fast_gray_img = cv2.imread('Alaska2.jpg', 0)  # Reading with Grayscale
cv2.imshow('Fastest_gray', fast_gray_img)
cv2.waitKey(0)

# Grayscale to Binary
retval, bin_img = cv2.threshold(fast_gray_img, 127, 255,
                                cv2.THRESH_BINARY)
cv2.imshow('BIN_Img', bin_img)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

Binary Image: It contain only 2-pixel elements i.e, 0 & 1.
where 0 - refers to Black & 1 - White. (Monochrome)

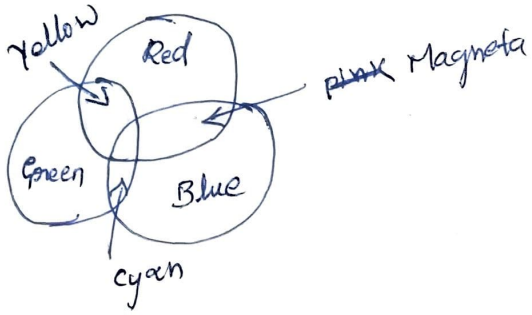
6] Develop a prgm to convert the given Color Img to different color-spaces.

⇒ Color spaces are way to represent the color-channels present in the Img. that gives the image that particular hue.
There are several different color-spaces & each has its own significance.

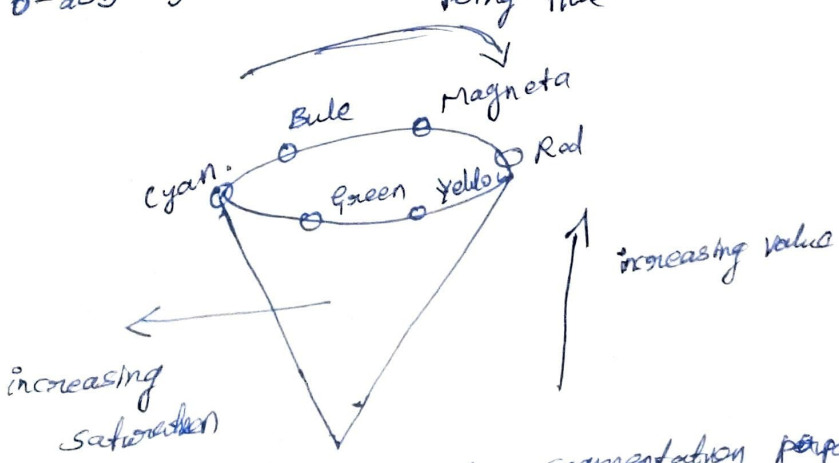
Some of the popular Color-spaces are RGB, CMYK, HSV, etc—.

BGR-color-space:

openCV's default color-space is RGB. However, it actually stores color in the BGR-format. It is an additive color model where different intensities of Blue, Green & Red give diff-shades of color



HSV-color-space: (Hue, Saturation, value) It stores color infos in a cylindrical representation of RGB-color points. It attempts to depicts the colors as perceived by the human eye.
Hue-values varies from 0-179, Saturation values varies from 0-255 & value varies from 0-255



It is mostly used for color-segmentation purpose.

CMyk-color-space: Unlike, RGB it is a subtractive color-space. The CMyk model works by partially or entirely masking colors on a lighter, usually white background. The ink reduces the light that would otherwise be reflected. Such a model is called "Subtractive", because inks "subtract" those colors Red, Green & Blue from white light

White – Red = cyan
White – green = Magneta
White – Blue = yellow

7] Sum & Mean of Images:

import cv2

1] sum of multiple Images.

```
import os

path = r'C:\Users\Sanjay-PC\DIP\DIP_Lab_Works\img_dow
imgs = []
files = os.listdir(path) #List

for file in files:
    fpath = 'path' + '\\' + file
    imgs.append(cv2.imread(fpath))

for i in range(len(files)):
    cv2.imshow(files[i], imgs[i])
cv2.waitKey(0)
cv2.destroyAllWindows()
```