Image

- pictures — graphics : hand drawn
  - Image : real world.
- pure black n white, grayscale (shades of grey) or color (no. of colors).
- Obj appears of certain color, ∴ it absorbs other color components from white light falling on it & reflects only light of frequencies specific to that color to our eyes.
- Image processing
  - Input (Scanner)
  - edit
  - Op (save img in file format).
- Image Types
  - Hard copy & Soft Copy.
  - Tone
    - Continuous : composed of varying tones / shades of colors
    - Halftone : subset of colors used ∴ all colors aren't possible. eg: newspaper, magazine
    - Bitone : 2 colors, black n white (no grey tones).
- Color Modes
  - 2 colors — Primary & Secondary. } Constitute a color mode
    - Primary colors in equal proportions.
    - Composite color : primary colors mixed in varying proportion (magenta, Cyan & Yellow).
  - RGB
  - CMYK.

① RGB Model

- inside a CRT, electron beams falling on red, green & blue phosphor dots produce corresponding colored lights & mix together in diff. proportions to produce lights of composite colors.
- proportion of color is determined by beam strength & measured in %age.
- eg: Orange color = 96% red, 40% G, 14% B
  ∴ 3 electron beams striking R,G,B phosphor shud have 96%, 40% & 14% of their max. intensities resp.
- additive model : 100% R + 100% G + 100% B = White.
  ↓ saturated.
- Magenta: red & blue; cyan: blue & green; yellow: green & red.
- describes behavior of light.

② CMYK model

- to specify colors of ink on paper.
- eg: blue spot on paper appears blue ∵ it absorbs other components of light & reflects only blue color to our eyes.
  - for RGB model, if red spot is mixed w a blue spot, magenta color wud be produced. But, red ink would try to absorb blue light reflected from blue ink & blue ink would try to absorb red light reflected from red ink & as a result no light comes, & the spot looks black.

↳ In this model, primary colors are cyan, magenta & yellow & when mixed in equal proportions produce black color.

↳ ∴ it is a subtractive model.

↳ ∵ of impurities, actual color is dark brown, ∴ pure black ink is also added. (K).

↳ complementary to RGB model.

↳ when inks are mixed with other inks, proportion & saturation vses.

↳ secondary colors are R (Magenta + Yellow), G (Yellow + Cyan), B (Cyan + Magenta).

- Device Dependency & Gamut.

↳ RGB or CMYK don't have universal or absolute color values.

↳ color indicated depends on physical characteristics of phosphor dots or ink.

↳ this differs among various devices, ∴ there is no absolute color.

↳ ∴ RGB & CMYK are device dependent models.

↳ total range of colors supported by each model is called gamut.

↳ RGB has larger gamut than CMYK model.

↳ all colors in RGB model can't be expressed in terms of CMYK model. Thus img. displayed on screen has variations in colors when printed on paper.

Camera + scanner → ppt ✓

- Device Independent color models.

↳ conveys color information in a way the human eye perceives them.

↳ interprets color information in terms of luminance & chrominance components.

↓

depicts brightness information in an image can regard to the color component.

- ↳ white (bright)
- ↳ black (dark)
- ↳ shades of grey.

↓

depict color information in diff. parts of the image.

↳ flat color can change in brightness.

↳ ① CIE $L^*a^*b^*$ Model

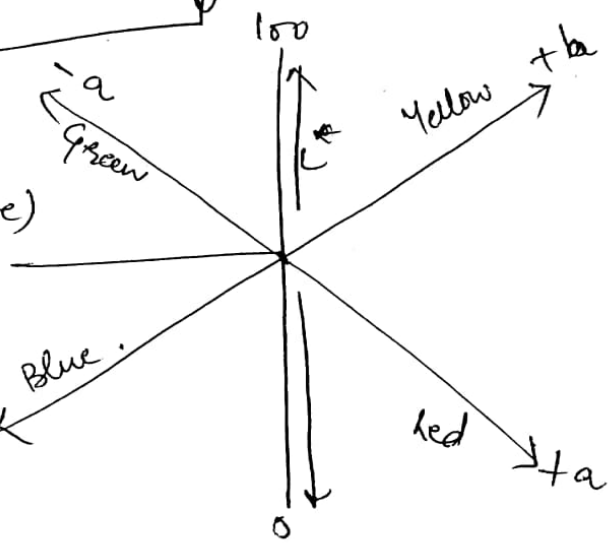
↳ International Committee on Illumination

↳ area b/w optical nerve & brain, retinal color stimuli are translated into distinctions b/w light & dark red & green, blue & yellow.

↳ specifies values ∈ 3 axes: L^*, a^* & b^*.

Central axes for lightness, value runs from 0 to 100 (black – white)

↳ zero is neutral grey for both a^* & b^*.



(2.) HSB model

hue, saturation, brightness

- **hue** — defines the color itself. eg: red is diff. from blue or yellow. Value of hue axis varies from 0° to 360°, beginning & ending @ red, thru green & blue.
- **saturation** — indicates degree to which the hue differs from a natural grey. Values run from 0%, @ is no color saturation to 100%. @ is fullest saturation of a given hue.
- **brightness** — indicates the level of illumination. Value run from 0% (black) to 100% (white). Colors ≥ 50% are dark, < 50% are light.

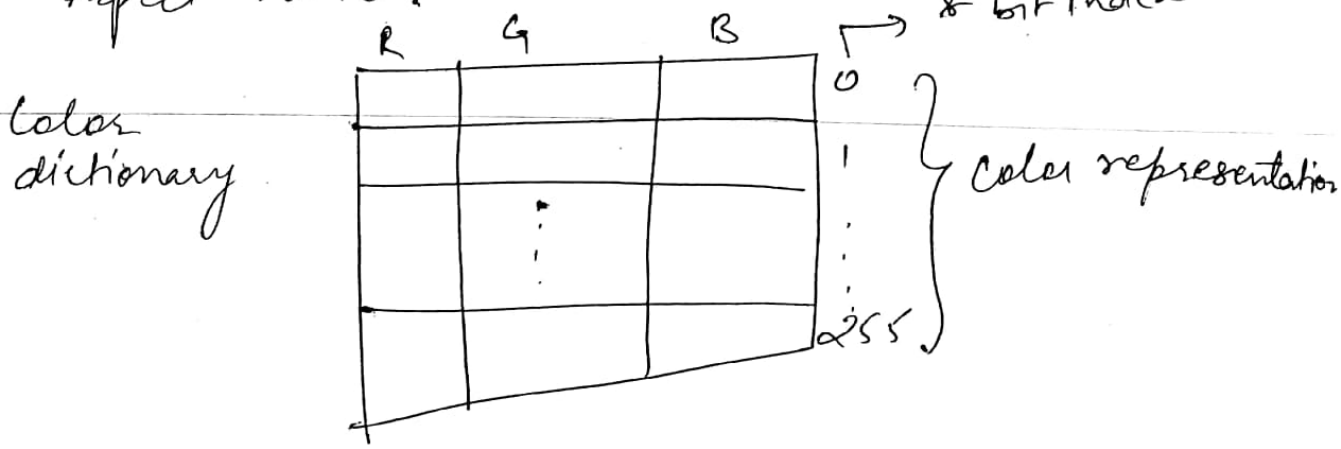
- File formats

Image Compression

- both images (graphical, computer generated) & digitized images (docs & pics) are displayed in the form of 2-D matrix of individual picture elements.
- graphical img is represented differently in the form of a pgm written in graphics pgming lang.
- lossless compression algo must be used for transferring graphical images.
- to transfer digitized images compression algos are applied!
  - combination of runlength encoding & statistical, ∴ lossless & transfer docs. like scanned docs & by fax m/cs.
  - combination of transform, differential & run length encoding.

① Graphics Interchange format (GIF)

- Is color images comprising 24 bit pixels are supported, 8 bits for each R, G, B.
- Is reduces the no. of possible colors by choosing 256 colors from a possible 2^{24}.
- Is 256 colors ⊂ 24 bit color value.
- Is rather than sending each pixel as 24 bit, 8-bit index to the table entry that matches the color is sent.
- Is table of colors can relate either to whole image (global color table) or portion of image (local " ").
- Is contents of table are sent along ⊂ compressed img data & other info like screen size & aspect ratio.



- LZW coding algo can be used to obtain further compression.
  - Basic color table is extended dynamically
  - occurrence of common strings of pixel values such as long strings of same color are detected & entered into color table after 256 colors.
  - to represent each string of pixel values, the corresponding string of 8-bit indices to the basic color table are used.
- GIF also allows an image to be stored & subsequently transferred over the n/w in an interlaced mode.
  - useful when transferring images over low bit rate channels
  - compressed image data is organized so that decompressed image is built up in a progressive way as the data arrives.
  - compressed data is divided into 4 grps, first contains 1/8 of total compressed image, second, a further 1/8, third, a further 1/4 & last remaining half.

(2) Tagged Image file format (TIFF)

- supports resolution of upto 48 bits, 16 bits each of R, G, B.
- transfers both digitized docs & imgs.
- uses a no. of different formats, represented by a code no., from uncompressed format (code no. 1) thru LZW (code no. 5).
- code no. 2, 3, 4 are for digitized docs.
- LZW table has basic color table of 256 colors & table can be extended to 4096 entries containing common strings of pixels in image.

(5) Digitized Docs.

- Scanned lines consist only of long string of white picture elements — pels or a mix of black pels & white pels.
- ITU-T standards
  - T2 (Grp 1) } rarely used now
  - T3 (Grp 2) }
  - T4 (Grp 3) – ⊂ modems ⊂ analog PSTN
  - T6 (Grp 4) – all-digital use ⊂ digital n/w ISDN
- tables of codewords were produced based on relative frequency of occurrence of no. of contiguous white & black pels found in a scanned line.
- tables are termination-codes & make-up codes
  - termination-codes: for white or black pels run length from 0 to 63 in steps of 1.
  - make-up: codewords for white or black pels run lengths ⊂ are multiples of 64 pel
- overscanning: all lines start ⊂ a min. of one white pel. ∴ receiver knows the first codeword always relates to white pels & then alternates b/w black & white.

↳ EOL code (end-of-line): termination of every scanned line.

↳ T4 coding is 1D coding, ∵ each scanned line is encoded independently.

↳ T6 coding: EOL code in Grp. 3 m/c's, at the end of each compressed line has an additional tag bit added. If it is 1, then T4 coding is used for coding next line, else T6 coding (modified modified READ) is used.

↳ 2D coding

↳ READ: relative element address designate

↳ it identifies black & white run-lengths by comparing adjacent scan lines.

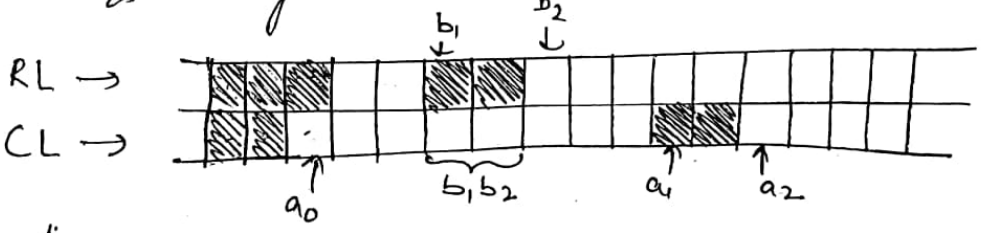
↳ it exploits the fact that most scanned lines differ from previous line by only a few pels.

↳ run-lengths associated to a line are identified by comparing the line contents known as coding line (CL), relative to the immediately preceding line, known as reference line (RL).

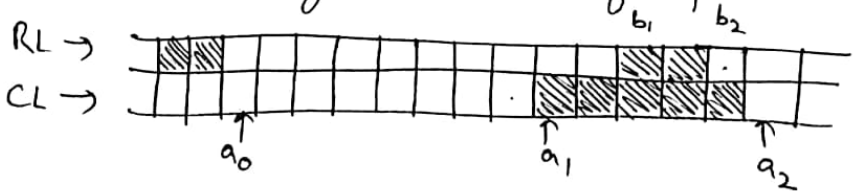
↳ We identify run lengths associated w a coding line as one of the 3 possibilities or modes relative to the reference line.

↳ 3 modes are identified by the pos'n of the next run length in the reference line ($b_1 b_2$) relative to the start & end of next pair of run lengths in coding line ($a_0 a_1$ & $a_1 a_2$).

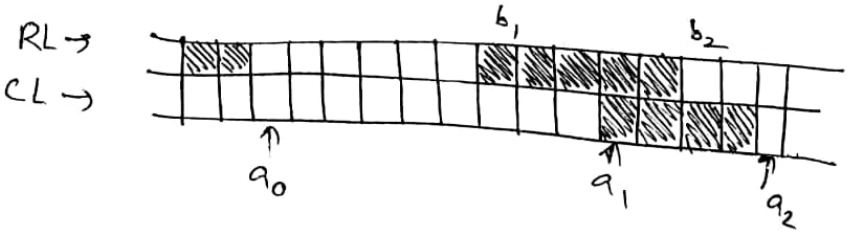
↳ Pass mode : when run length in the RL ($b_1 b_2$) is to the left of next run length in CL ($a_1 a_2$) i.e. b_2 is left of a_1. If the next pel on the coding line, a_1 is directly below b_2 then this is not pass mode



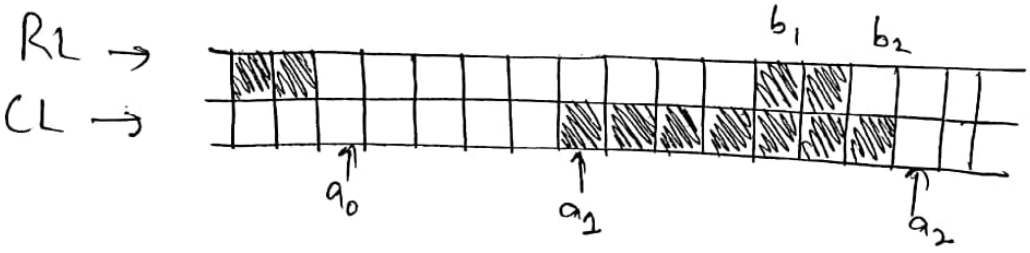
↳ Vertical Mode : when run length in the RL ($b_1 b_2$) overlaps the next run length in coding line ($a_1 a_2$) by a max. of plus or minus 3 pe



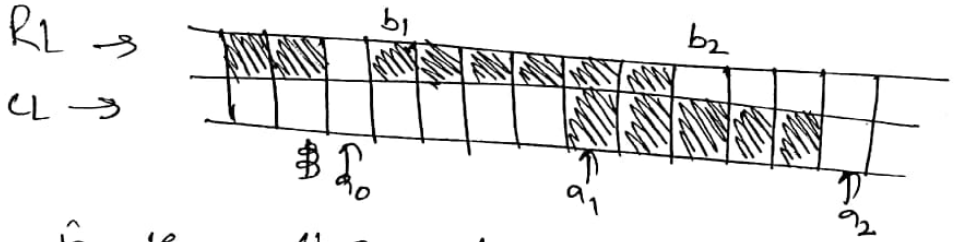
or



Horizontal mode: when run length in RL ($b_1 b_2$) overlaps run length ($a_1 a_2$) by more than plus or minus 3 pels.



or



- a_0 is the first pel of a new codeword & can be black or white.
- a_1 is the first pel to the right of a_0 with a diff. color
- b_1 is the first pel on the RL to the right of a_0 & diff. color
- b_2 is the first pel on the RL to the right of b_1 & a diff. color.

09760211845; 9999163593

(4) JPEG Image (Joint Photographers Expert Group) (5)

- Compression std for continuous tone gray scale or color images.
- uses a combination of DCT, quantization, runlength encoding & huffman encoding techniques.
- image compression ratio is 20:1.
- 4 modes
  - Sequential encoding: Simplest lossy mode, single scan, left to right & top to bottom.
  - Progressive encoding: encoding is done in multiple scans, lossy mode.
  - lossless encoding: no loss of data.
  - Hierarchial encoding: comprises multiple resolution levels & can be decompressed separately.

- (1) Block preparation:
  - img represented by one or more 2D array of pixel values
  - for continuous greyscale images or color images, color lookup table is used, & 8bit values for each pixel.
  - breaks each 2D array of img into individual 8×8 pixels per block.

(2.) Discrete Cosine Transform (DCT)

- Transform each block from spatial domain to frequency domain.
- Each block has 64 values representing amplitude of sampled signal.

$$a = f(x, y)$$

amplitude — 2 spatial dimensions

- After applying DCT, $c = g(f_x, f_y)$

respective signal freq. depicting luminance & color change.

This results in another 64 values, each representing a diff. DCT coefficient value.

(3) Quantization

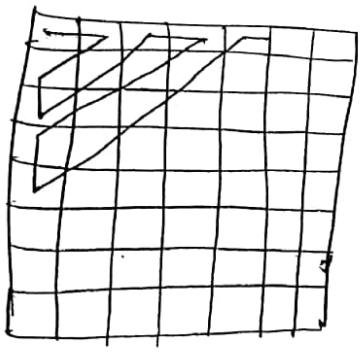
- dropping or setting to zero the higher spatial frequency coefficients in the transformed array whose amplitudes are less than a pre-defined threshold value.

- aims to reduce size of coefficients
- 8×8 quantization table.
- each element can be an integer value from 1 to 255.

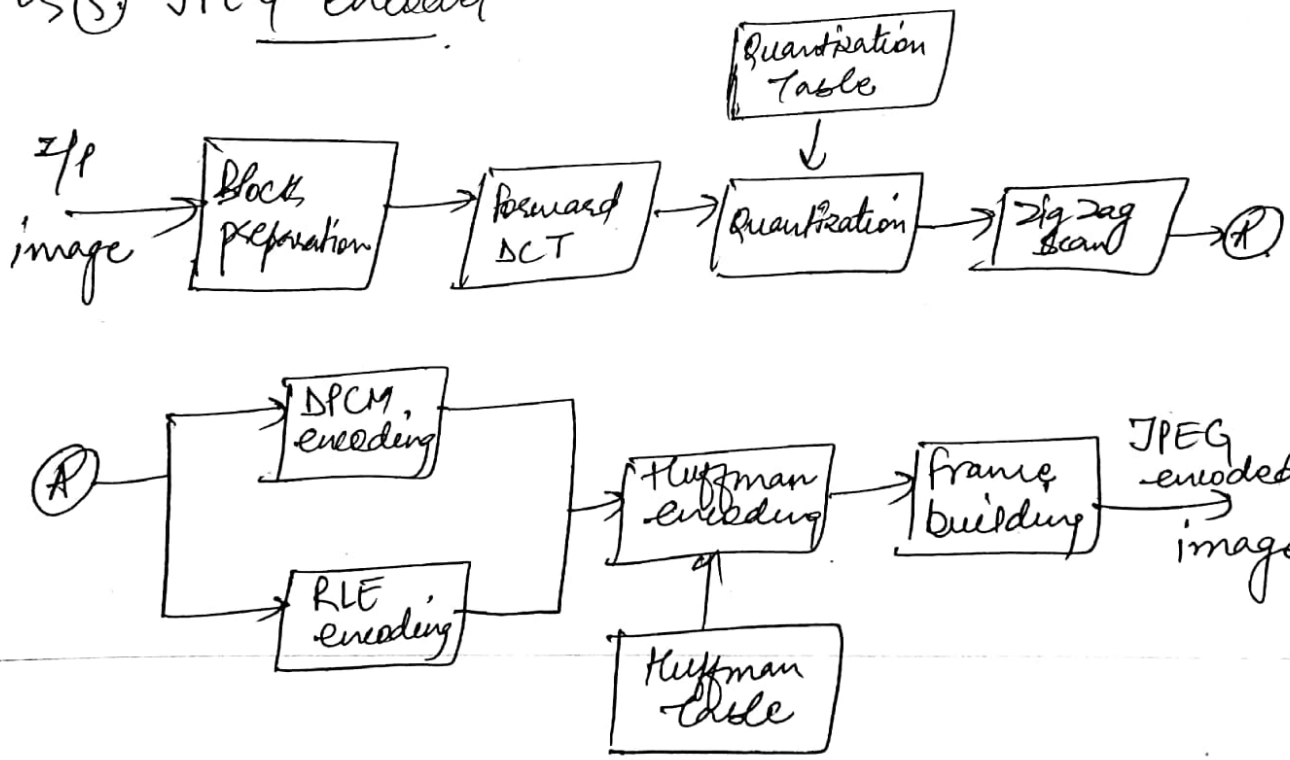
(4.) Zig-zag scan

- entropy encoding operating on 1-D string of values (vector).

↳ o/p is 2D array.
↳ to cluster together zero & non-zero values



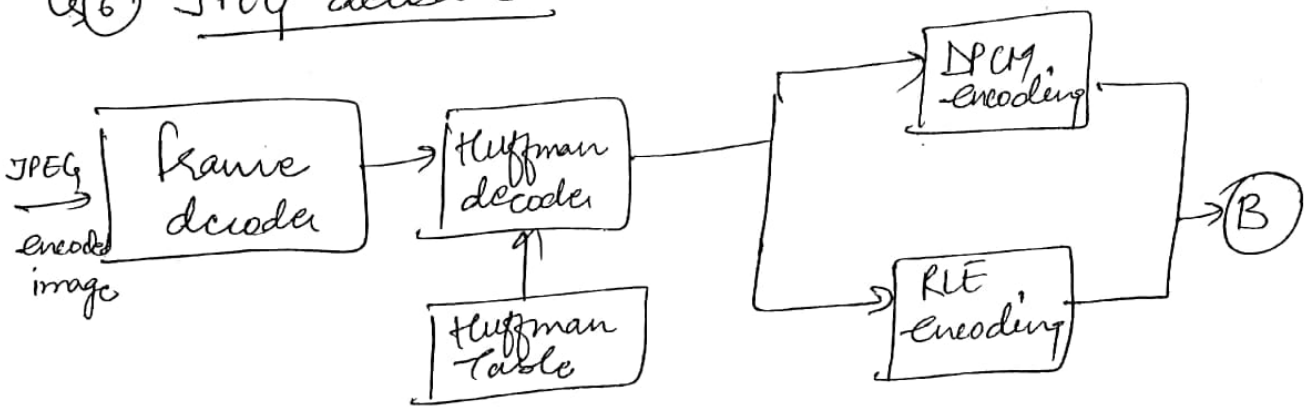
↳ (5) JPEG encoder

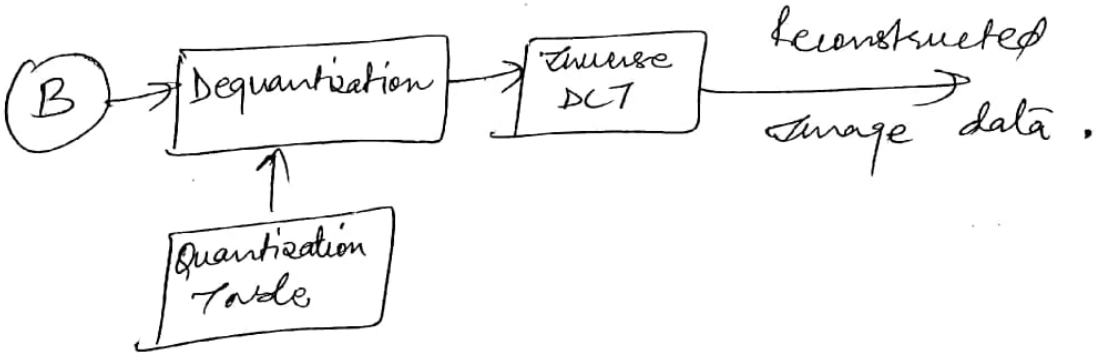


↳ DPCM encoding :- ∵ of small physical area covered by each block, DC coeff. vary slowly from one block to next. ∴ sequence of DC coeff. are encoded in this mode, i.e. diff b/w DC coeff of each block & adjacent block.

↳ RLE Encoding :- after quantization, some coeff. have reduced to zero. The remaining blocks need to be stored.

↳ (6) JPEG decoder :-





A = 0.5
B = 0.1
C = 0.3
D = 0.02
E = 0.1
F = 0.04