IMAGE Processing

Digital Image Fundas. :- Intro - origin - Steps in Digital image proces. - components - Elements of Visual perception

- Image sensing & Acquisition - Image sampling & quantization
- Relationships b/w pixels - Color Models.

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* IMAGE Processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is type of signal processing in which input is an image and output may be image or characteristic features associated with that image.

⇒ DIP :- Digital Image processing is a software which is used to manipulate the digital images by the use of computer system. It is also used to enhance the image, to get some important ~~function~~ information from it.

Eg:- Adope photoshop, MATLAB etc.

* It is also used in the conversion of signals from an image sensor into the digital images.

⇒ Digital Image processing is a software used for image processing eg:- Computer, graphics, signals, pixels, photography, camera mechanism etc.

DIP :- A Digital image is an image composed of picture elements, also known as pixels, each with finite, discrete quantities of ~~one~~ numeric representation for its intensity or gray level that is an output

* Origin :- Offers a collection of easy to use tools for our general Image Processing needs.

from its two-Dimensional functions. fed as input by its spatial co-ordinates denoted with x, y, on the x-axis & y-axis respectively.

Eg :- GIF, PNG, JPG, etc.

* Steps of Digital Image Processing :-

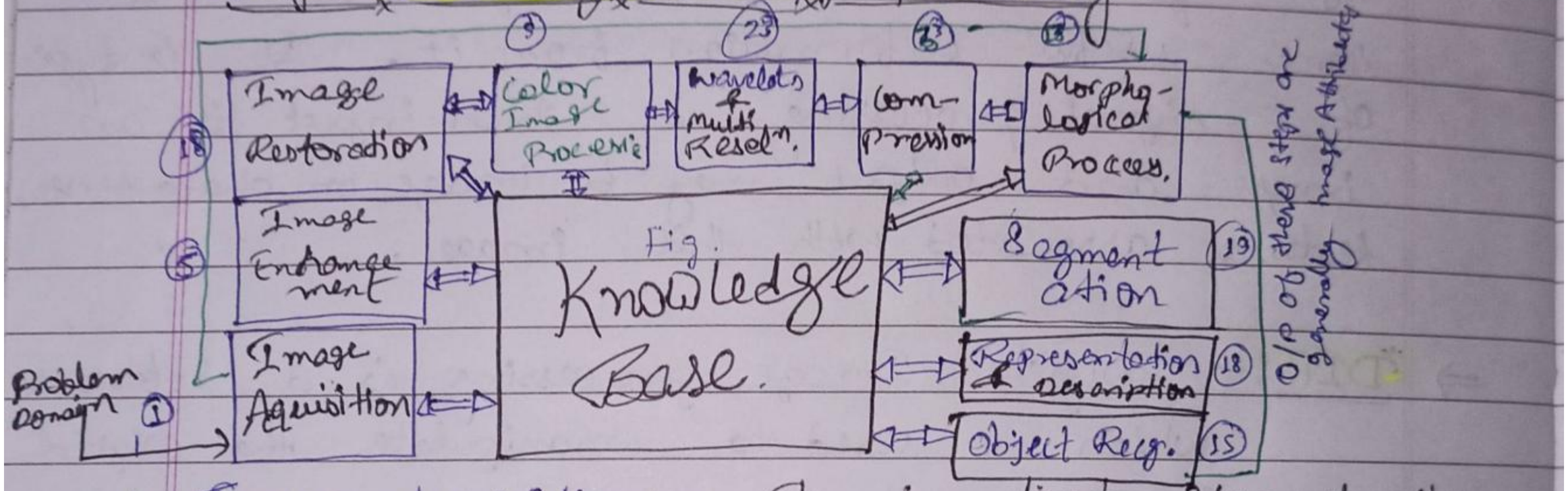


Fig.

1. Image Acquisition :- It is first step of the fundamental steps of DIP. Here an image is given in the digital form. Generally, in this stage, pre-processing such as scaling is done.

2. Image Enhancement :- It is the simplest and most attractive area of DIP. In this stage details which are not known, or we can say that interesting features of an image is highlighted. Such as brightness, contrast etc.

3. Image Restoration :- It is the stage in which the apperarance of an image is improved

4. Color Image processing :- It is a famous area because it has increased the

M
1

IMAGE Processing)

PAGE NO.: 10
DATE: / /

use of digital image on the internet. This includes color modeling, processing in Digital Domain etc...

5. Wavelets & multi-Resolution :- An image is represented in various degree of resolution. Image is divided into smaller regions for data compression & for the pyramidal Representation

6. Compression :- It is a technique which is used for reducing the requirement of storing an image. It is a very important stage because it is very necessary to compress data for Internet use.

7. Morphological Processing :- This stage deals with tools which are used for extracting the components of the image, which is useful in the representation & description of shape.

8. Segmentation :- An image is a partitioned into its objects. It is most difficult task in DIP. It is a process which takes a lot of time for the successful solⁿ of imaging problems which requires objects to indentify individually.

9. Representation & Description :- It follow the output of the segmentation stage. The output is a raw pixel data which has all points of the region itself.

To transform the raw data. Representation is the only soln. whereas description is used for extracting info. to differentiate one class of object from another.

10. Object Recognition:- The label is assigned to the object which is based on descriptors.

11. Knowledge Base:- Last stage in DIP, Here important info. of the image is located, which limits the searching processes. The knowledge base is very complex when the image database has a high-resol" satellite.

⇒ Components of Image P. Syst.

↳ It is the combination of the different elements involved in the Digital image processing.

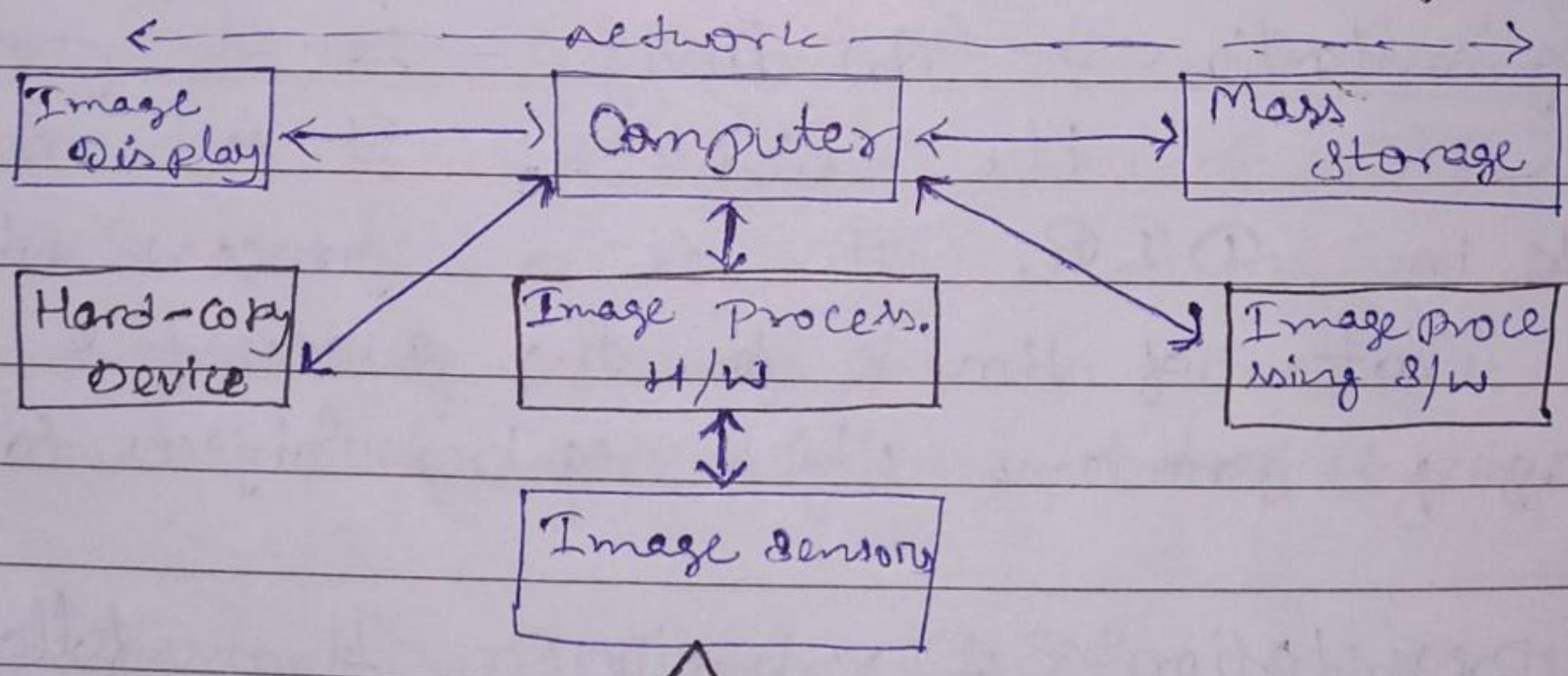


Image Display:-

It senses the intensity amplitude, co-ordinate & other features of the images & passes the result to the image processing H/W It include Problem Domain.

M/1

Components of Image Process.

PAGE NO.: 12
DATE: / /

- **Image processing H/W:-** It is the dedicated Hardware is that used to process the instruction obtained from the image sensors. It passes the result to general purpose computer.

- **Computer:-** It used in the image processing system is general purpose computer that is used by us in our daily life.

- **Image processing S/W:-** It is the software that includes all the mechanism & algo. that are used in image processing system

- **Mass Storage:-** Mass Storage stores the pixels of the images during the processing.

- **Hard copy Device:-** once the image is processed then it is stored in the hard copy device. It can be a pen drive or any external ROM Device.

- **Image display:-** It includes the monitor or display screen that displays the processing images

- **NetWork:-** NetWork is the connection of all the above elements of the image processing system.

ELEMENTS OF VISUAL PERCEPTION

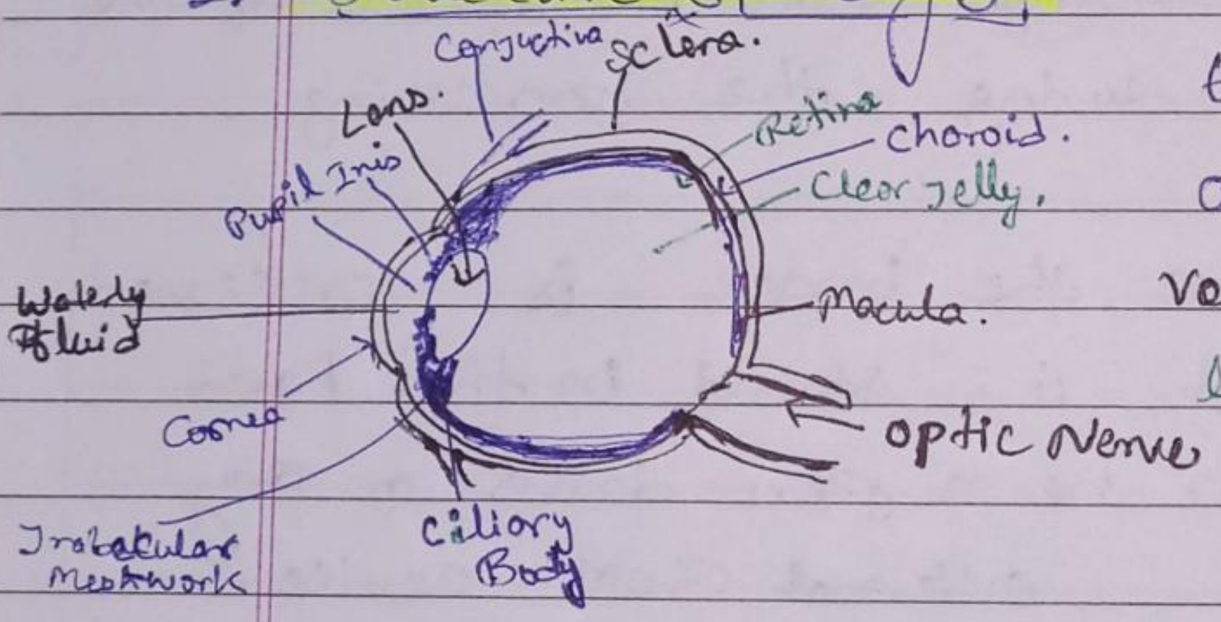
PAGE NO.:
DATE: / /

△ It is built on the foundation of mathematical & probabalistic formulation, But human intuition and analysis play the main role to make the selection is basically made on subjective visual judgements.

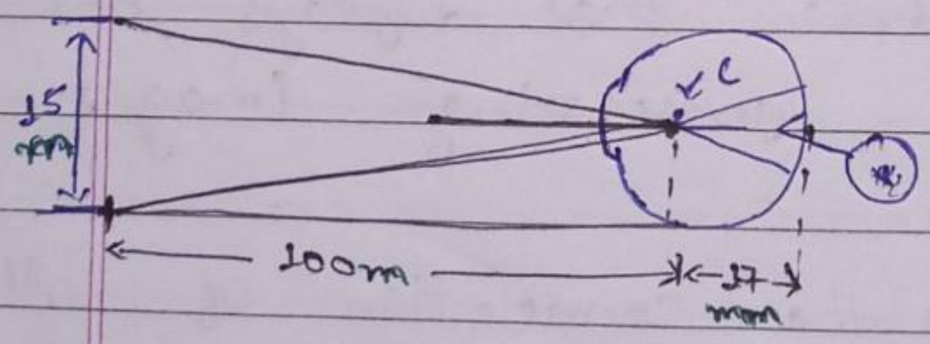
⟹ The eyes act as the sensor or camera, Neurons act as the connecting cable & brain acts as the processor.

* **Elements :-** 1. Structure of Eye
2. Image formation in the Eye
3. Brightness Adaption & Discrimination.

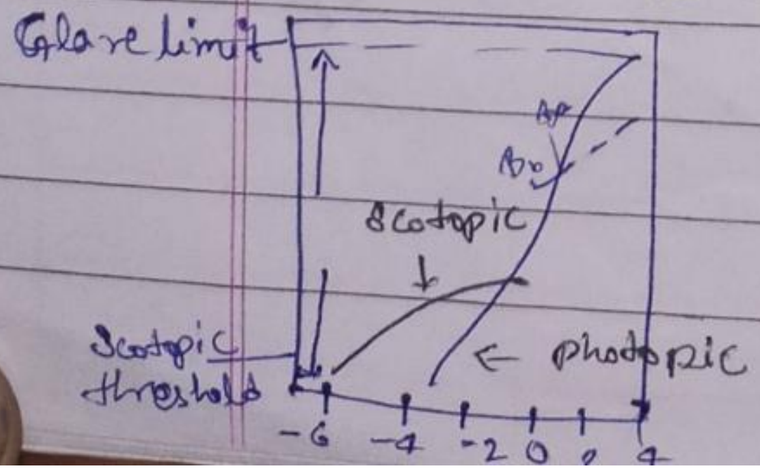
1. **Structure OF Eye :-** Human eye is a slighty asymmetrical sphere with an avg. ~~distance~~ diameter of the length 20mm to 25mm It has a volume of about 6.5cc. The eye is just like Camera. The external object is seen as the camera take the picture of any object.



2. **Image formation in the Eye :-** *When the lens of the eye focus an image of the outside world onto a light-sensitive membrane in the back of the eye, called retina the image is formed. The lens of the eye focuses light on the photoreceptive cells of the retina, Distance



*** 3. **Brightness Adaptation :-** Digital image are displayed as a discrete set of intensities. The eye ability to discriminate black & white at different intensity levels is an important consideration in presenting results.



M-1
I.P

Image Sampling & Quatization

PAGE NO.: 13
DATE: 29/05/22

• To create a digital image, We need to convert the continious sensed Data into Digital form.

↳ This process include 2 Processes:-

1). Sampling: Digitizing the co-ordinate Value is Called Sampling.

2). Quantization:- Digitizing the amplitude Value is called quantization.

Note - To convert a continios image f(x,y) into Digital form, we have to Sample the function in both co-ordinates & amplitude.

#	Sampling	V/S	Quantization
•	X-axis (time) - discretized		• x-axis (time) - continious.
•	y-axis (amplitude) - continious		• y-axis (amplitude) - Discretized
•	Sampling is done prior to the Quantization process		• Quntization is done after the Sampling process.
•	It Determines the spatial resolution of the digitized image		• It Determines the no. of grey levels in the digitized image
•	It reduces cc. to a series of tent poles over a time		• It reduce c.c. to a continious series of stair steps.
•	A single amplitude value is selected from different values of the time interval to represent it.		• Values representing the time interverls are rounded off to create a defined set of possible amplitude values.

M/1

IMAGE Sensing & Acquisition

PAGE NO.:
DATE: / /

* An Image Sensor or Imager is a Sensor that Detect & conveys information used to make an image. It does so by Converting the variable attenuation of light waves into signals, small bursts of current that convey the information.
→ The waves can be light or other electromagnetic radiation

* **Image Acquisition:-** It is the action of retrieving an image from a source, usually hardware system like cameras, sensors, etc.

Ex:- A Fax Machine may take several time to scan an entire page, but resulting image contains thousand of rows & column.

AM 1

Relationship Between pixels

PAGE NO.: 14
DATE: 29/05/

* Basic Relationships Between pixels :-

1. Neighborhood 2. Adjacency 3. Connectivity
4. Paths 5. Regions & Boundaries.

- **Definitions:-** $f(x, y)$: digital image
  Pixels: q, p
  Subset of pixels of $f(x,y)$: S

(1) The 4 diagonal neighbors of P are: $(N_D(P))$
$- (x+1, y+1), (x+1, y-1), (x-1, y+1), (x-1, y-1)$.

- $N_4(P) + N_D(P) \longrightarrow N_8(P)$: the 8-neighbors of P.

$(x-1, y-1)$	$(x, y-1)$	$(x+1, y-1)$
$(x-1, y)$	P	$(x+1, y)$
$(x-1, y+1)$	$(x, y+1)$	$(x+1, y+1)$

8-neighbors OF P:

$$N_8(P) = \{(x-1, y-1), (x, y-1), (x+1, y-1), (x-1, y), (x+1, y), (x-1, y+1), (x, y+1), (x+1, y+1)\}$$

⇒ Diagnal neighbors OF P:

$(x-1, y-1)$		$(x+1, y-1)$
	P	
$(x-1, y+1)$		$(x+1, y+1)$

$$N_D(P) = \{(x-1, y-1), (x+1, y-1), (x-1, y+1), (x+1, y+1)\}$$

(2) • The Adjacency consider three types:-

(a) - 4 - adjacency: two pixels p & q with value from V are 4-adjacent if q is in set $N_4(P)$

(b) - 8 - adjacency: p & q are 8-adjacent if q is in the set $N_8(P)$

(c) - m-adjacency:- p & q with values from V are m-adjacent if

- q is in $N_4(p)$ or - q is in $N_D(p)$ and set $N_4(D) \cap N_4(q)$ has no pixels with values from V.

* Mixed adjacency is a modification of 8-adjacency & is used to eliminate the multiple path connections that often arises when 8-adjacency is used.

```
0 1 1      0 1—1      0 1—1
0 1 0      0 1 0      0 1 *0
0 0 1      0 0 1      0 0 1
```

- Two image subsets S1 & S2 are adjacent if some pixels in S1 is adjacent to some pixel in S2.

(3) Connectivity:- It is adapted from neighborhood relation. Two pixels are connected if they are in the same class (i.e the same color or the same range of intensity) and they are neighbors of one another

* For p & q from the same class.
  - 4-Connectivity : p and q are 4-connected if $q \in N_4(p)$
  - 8-Connectivity: p and q are 8-Co.. if $q \in N_8(p)$
  - Mixed connectivity:- p and q are m-conn. if $q \in N_4(p)$ or $q \in N_D(p)$ & $N_4(p) \cap N_4(q) = \phi$

⇒ Connectivity b/w pixels is important because it is used in establishing boundaries of objects and components of regions in an image.

Note: JUMP
Next page

M-1
T.F II

I.P

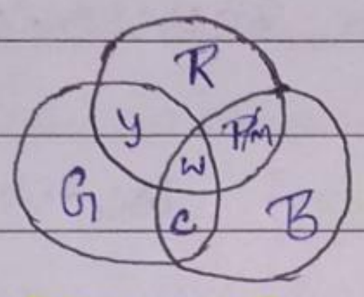
COLOR - MODEL

PAGE NO.: 15
DATE: / /

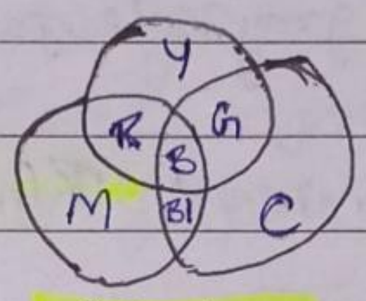
⇒ Different types of color Models are used in multiple fields like in hardware, in multiple - application of creating animation etc.

- RGB
- CMYK
- YIQ
- HSV

* **Primary color :-** It is the one which absorbs a primary color & reflects the other two.
- It can be added together to produce the secondary colors - magenta, cyan, yellow as below figure :-

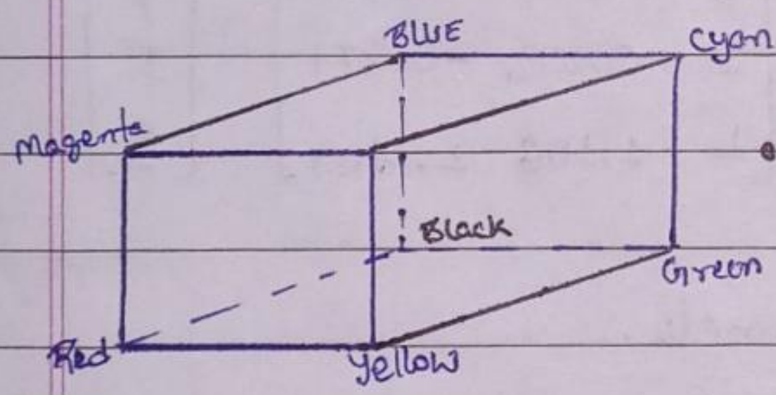


Primary color.



Secondary Color.

- **RGB :-** This model, each color appears in its primary components of Red, green & blue. It's based on Cartesian co-ordinate system.



• RGB CUBE

Application :- It is widely used in the representation & diplay of images in electronic system like computers & televisions.

- Used in web graphic. It also used in conventional photograph as well.

- **CMY :-** It contains the secondary colors, any secondary color when passed through White light will not reflect the color from which a combination of colors is made.

$$\begin{bmatrix} (-ve\ of\ Red) \\ (-ve\ of\ gm) \\ (-ve\ of\ Blue) \end{bmatrix} \begin{bmatrix} C \\ M \\ y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad \text{eq}^{n}$$

PAGE NO.:
DATE: / /

* **Application:-** 1. It is used in color printing as it uses colored inks.
2. It is used in most commercial printing like magazines, books, etc.

• **YIQ:-** Most widely used in television broadcasting. Y stands for luminance part & IQ stands for chrominance part. In the Black & white television, only the luminance part (Y) was broadcast. The Y value is similar to the grayscale part. Color Represented by IQ part.

⇒ Formula To convert RGB ⇄ YIQ & vice-versa.

• RGB to YIQ

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} \approx \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.5959 & -0.2746 & -0.3213 \\ 0.2115 & -0.5227 & 0.3112 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

• From YIQ to RGB

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 & 0.956 & 0.619 \\ 1 & -0.272 & -0.647 \\ 1 & -1.106 & 1.703 \end{bmatrix} \begin{bmatrix} Y \\ I \\ Q \end{bmatrix}$$

• **HSV:-** The image consists of three channels. Hue, Saturation & value are three channels.

This model doesn't use primary color directly. It uses color in the way humans perceive them. HSV colour when is represented by a cone.

* Red color 0 – 60° in HSV cone.
Yellow " 61 – 120° " "
Green " 121 – 180° " "
Cyan " 181 – 240° " "
Blue " 241 – 300° " "
Magenta " 301 – 360° " "

• This model is used in histogram equalization & converting grayscale image to RGB colour images.