DON BOSCO INSTITUTE OF TECHNOLOGY

(Affiliated to VTU, Belgaum and Approved by AICTE)

DEPARTMENT
OF
CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

LABORATORY MANUAL

DIGITAL IMAGE PROCESSING LABORATORY

(Effective from the academic year 2022 -2023)
(18AIL67)

SEMESTER – VI

DON BOSCO INSTITUTE OF TECHNOLOGY

Kumbalagodu Mysore Road, Bengaluru -560074.
Ph.: +91-80-28437028/29/30/Fax: +91-80-28437031
Website: www.dbit. co.in E mail.cse.aiml@dbit.co.in

DON BOSCO INSTITUTE OF TECHNOLOGY

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DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Vision and Mission of the Institution

Vision

"To impart quality education to cater the needs of Industries, Business Establishments, Research and Development Organizations, create Knowledgeable and competent Engineers ofglobal standard."

Mission

"To create Industry enabled Engineers manifesting in excellence with extraordinary progress, to give bright and challenging future for deserving students who are underprivileged."

Vision and Mission of the CSE(AI&ML) Department

Vision

"To promote partnership between the academic and industry sectors to bring to bring in a innovative ecosystem and being very beneficial to the whole society."

Mission

1. Artificial Intelligence and Machine Learning department intends to provide a major support to enable R&D contributing to the fundamental research in AI and ML
2. Commit to openness and inclusiveness in a collaborative and constructive spirit to boldly attack challenging problems with high social and economic impact
3. Initiate the education and training paying special attention two the necessary skills of the next generation workforce

Program Specific Outcomes (PSOs)

PSO1: Capable of identifying the appropriate data structure and algorithms to design, implement and test effective solutions for real-world and research problems.

PSO 2: Capable of excelling in a variety of programming/project competitions as well as technical challenges set out by professional societies.

PSO 3: Capable to gain knowledge in diverse areas of Computer Science and apply that to a successful career, entrepreneurship and higher education.

Program Educational Objectives (PEOs)

PEO1: Our graduates will have successful careers in the computer engineering field or be able to successfully pursue advanced degrees.

PEO2: Our graduates will have the ability to provide innovative solutions to real-world challenging problems by applying computer engineering principles.

PEO3: Our graduates will be able to communicate effectively, work collaboratively and exhibit high levels of professionalism and ethical responsibilities.

PEO4: Our graduates will be able to identify research gaps, engage in life long learning and be a successful entrepreneur.

Course Learning Objectives: This course will enable students to:

- Demonstrate the basic skills of image process
- Demonstrate the application development skills
- Design and develop the applications of images

Laboratory Outcomes: The student should be able to illustrate the following operations:

- Image Segmentation algorithm development
- Image filtering in spatial and frequency domain.
- Morphological operations in analyzing image structures

DIGITAL IMAGE PROCESSING LABORATORY WITH MINI PROJECT
(Effective from the academic year 2018 -2019)
SEMESTER – VI

Subject Code	18AIL67	**CIE Marks**	40
Number of Contact Hours/Week	0:2:2	**SEE Marks**	60
Total Number of Lab Contact Hours		**Exam Hours**	03

CREDITS – 2

Course Learning Objectives: This course will enable students to:

- Demonstrate the basic skills of image process
- Demonstrate the application development skills
- Design and develop the applications of images

Descriptions (if any): --

- Programming tools preferred: SCILAB, Python, Java or any other relevant platform.
- For Part A: Students must exhibit the results and its print copy to be attached to Lab record.
- For Part B: Real Time Images can be used to demonstrate the work.

During the practical exam: the students should demonstrate and answer Viva-Voce

Programs List: PART A	
1	Write a Program to read a digital image. Split and display image into 4 quadrants, up, down, right and left
2	Write a program to show rotation, scaling, and translation of an image.
3	Read an image, first apply erosion to the image and then subtract the result from the original. Demonstrate the differencein the edge image if you use dilation instead of erosion.
4	Read an image and extract and display low-level features such as edges, textures using filtering techniques
5	Demonstrate enhancing and segmenting low contrast 2D images.

PART B :MINI PROJECT

Student should develop a mini project and it should be demonstrated in the laboratory examination, Some of the projects are listed and it is not limited to:

- Recognition of License Plate through Image Processing
- Recognition of Face Emotion in Real-Time
- Detection of Drowsy Driver in Real-Time
- Recognition of Handwriting by Image Processing
- Detection of Kidney Stone
- Verification of Signature
- Compression of Color Image
- Classification of Image Category
- Detection of Skin Cancer
- Marking System of Attendance using Image Processing
- Detection of Liver Tumor
- IRIS Segmentation
- Detection of Skin Disease and / or Plant Disease
- Biometric Sensing System
- Mobile Phone Camera-based Light Communications
- Modeling of Perspective Distortion within Face Images &Library for Object Tracking
- Controlling of Intelligent Traffic Light & Image Processing
- Controlling of Pests in Agriculture Field with Image Processing

(**During the practical exam: the students should demonstrate and answer Viva-Voce**)

Laboratory Outcomes: The student should be able to illustrate the following operations:

 Image Segmentation algorithm development
 Image filtering in spatial and frequency domain.
 Morphological operations in analyzing image structures

Conduct of Practical Examination:

 Experiment distribution
o For laboratories having only one part: Students are allowed to pick one experiment from the lot with equal opportunity.
o For laboratories having PART A: Students are allowed to pick one experiment from PART A, with equal opportunity. The mini project from PART B to be run &exhibit the results also a report on the work is produced.
 Change of experiment is allowed only once and marks allotted for procedure to be made zero of the changed part only.
 Marks Distribution *(Subjected to change in accordance with university regulations)*
o) For laboratories having only one part – Procedure + Execution + Viva-Voce: 15+70+15 = 100 Marks
p) For laboratories having PART A and PART B
i. Part A – Procedure + Execution + Viva = 6 + 28 + 6 = 40 Marks
ii. Part B – Procedure + Execution + Viva = 9 + 42 + 9 = 60 Marks

CONTENTS

PROGRAM 1

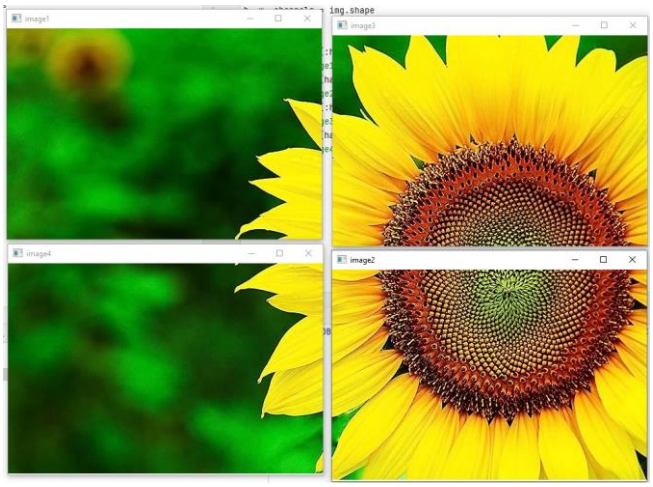
Write a Program to read a digital image. Split and display image into 4 quadrants, up, down, right and left

```
import cv2

img = cv2.imread(r'C:\Users\DBIT-R&D\Desktop\ip.jpg')

h, w, channels = img.shape
half = w // 2
half2 = h // 2
quadrant1 = img[:half2, :half]
cv2.imshow('image1', quadrant1)
quadrant2 = img[half2:, half:]
cv2.imshow('image2', quadrant2)
quadrant3 = img[:half2, half:]
cv2.imshow('image3', quadrant3)
quadrant4 = img[half2:, :half]
cv2.imshow('image4', quadrant4)

cv2.waitKey(0)
```

Results:

input:

output:

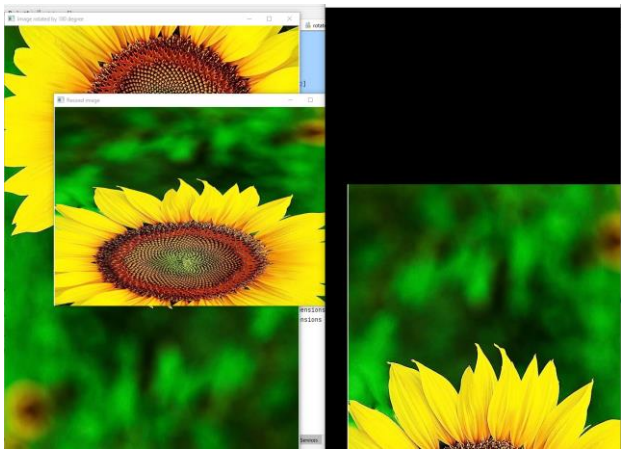


PROGRAM 2

Write a program to show rotation, scaling, and translation of an image.

```
import cv2
import numpy as np

# load the input image
img = cv2.imread(r'C:\Users\DBIT-R&D\Desktop\ip.jpg')

# rotate the image by 180 degree clockwise
img_cw_180 = cv2.rotate(img, cv2.ROTATE_180)

# display the rotated image
cv2.imshow("Input image", img)
cv2.imshow("Image rotated by 180 degree", img_cw_180)

print('Original Dimensions : ', img.shape)

width = 650
height = 450
dim = (width, height)

# resize image
resized = cv2.resize(img, dim, interpolation=cv2.INTER_AREA)

print('Resized Dimensions : ', resized.shape)

cv2.imshow("Resized image", resized)

tx = 50
ty = 400

h, w = img.shape[:2]

M_translate = np.float32([[1, 0, tx], [0, 1, ty]])

img_transformed = cv2.warpAffine(img, M_translate, (w, h))

cv2.imshow('Translated Image', img_transformed)

cv2.waitKey(0)
```

output:



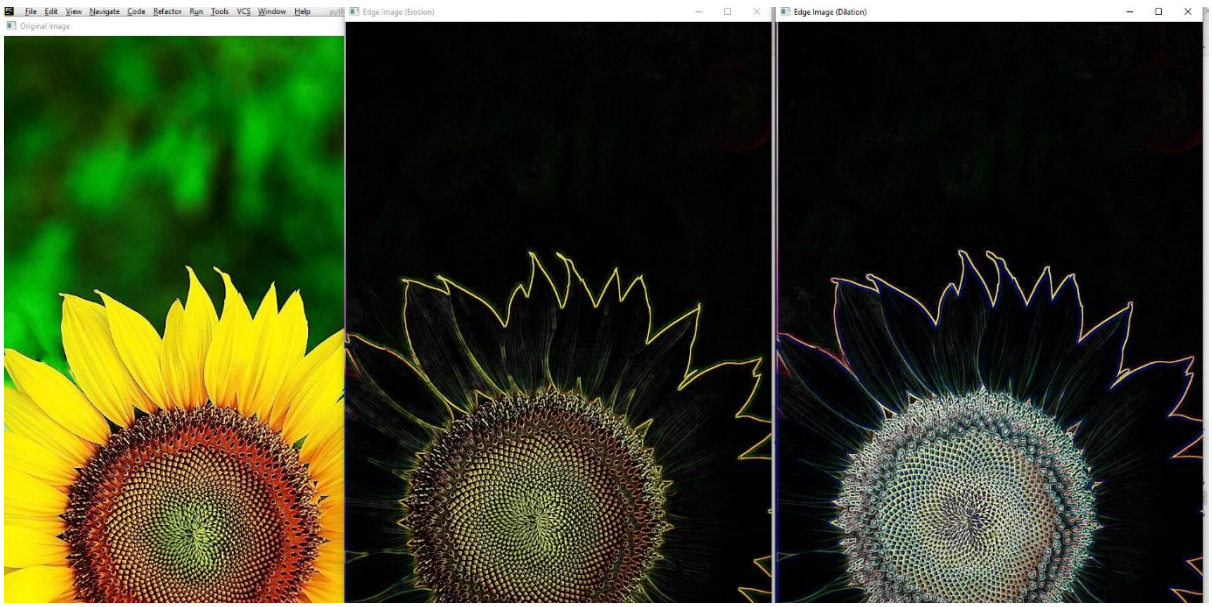
For rotation :
#cv2.ROTATE_90_CLOCKWISE
#cv2.ROTATE_180
#cv2.ROTATE_90_COUNTERCLOCKWISE

PROGRAM 3

Read an image, first apply erosion to the image and then subtract the result from the original. Demonstrate the difference in the edge image if you use dilation instead of erosion.

```
import cv2
import numpy as np
# Load the image
image = cv2.imread(r'C:\Users\DBIT-R&D\Desktop\ip.jpg')
# Define the erosion kernel and apply it to the image
kernel = np.ones((5, 5), np.uint8)
eroded_image = cv2.erode(image, kernel, iterations=1)
# Subtract the eroded image from the original image
edge_image = cv2.absdiff(image, eroded_image)
# Display the original image and edge image
cv2.imshow("Original Image", image)
cv2.imshow("Edge Image (Erosion)", edge_image)
# Apply dilation to the image
dilated_image = cv2.dilate(image, kernel, iterations=1)
# Subtract the dilated image from the original image
edge_image_dilation = cv2.absdiff(image, dilated_image)
# Display the edge image with dilation
cv2.imshow("Edge Image (Dilation)", edge_image_dilation)
# Wait for a key press and then close the windows
cv2.waitKey(0)
cv2.destroyAllWindows()
```

Output:

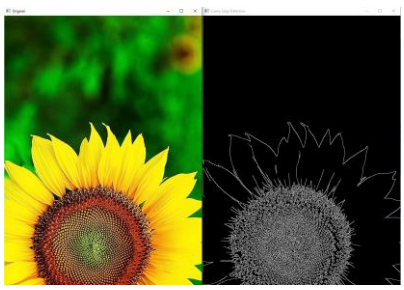


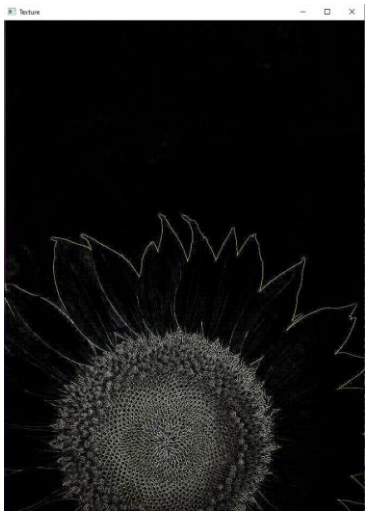
PROGRAM 4

Read an image and extract and display low-level features such as edges, textures using filtering techniques

```
import cv2
import numpy as np
# Read the original image
img = cv2.imread(r'C:\Users\DBIT-R&D\Desktop\ip.jpg')
# Display original image
cv2.imshow('Original', img)


# Convert to graycsale
img_gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
# Blur the image for better edge detection
img_blur = cv2.GaussianBlur(img_gray, (3, 3), 0)

# Sobel Edge Detection
sobelx = cv2.Sobel(src=img_blur, ddepth=cv2.CV_64F, dx=1, dy=0, ksize=5)  #
Sobel Edge Detection on the X axis
sobely = cv2.Sobel(src=img_blur, ddepth=cv2.CV_64F, dx=0, dy=1, ksize=5)  #
Sobel Edge Detection on the Y axis
sobelxy = cv2.Sobel(src=img_blur, ddepth=cv2.CV_64F, dx=1, dy=1, ksize=5)
# Combined X and Y Sobel Edge Detection
# Display Sobel Edge Detection Images
cv2.imshow('Sobel X', sobelx)

cv2.imshow('Sobel Y', sobely)

cv2.imshow('Sobel X Y using Sobel() function', sobelxy)


# Canny Edge Detection
edges = cv2.Canny(image=img blur, threshold1=100, threshold2=200)  # Canny
Edge Detection
# Display Canny Edge Detection Image
cv2.imshow('Canny Edge Detection', edges)

# Define the texture filter kernel
texture = np.array([[0, 1, 0], [1, -4, 1], [0, 1, 0]])
# Apply the texture filter to the image
texture_image = cv2.filter2D(img, -1, texture)
# Display the texture image
cv2.imshow('Texture', texture_image)

cv2.waitKey(0)
```

output:



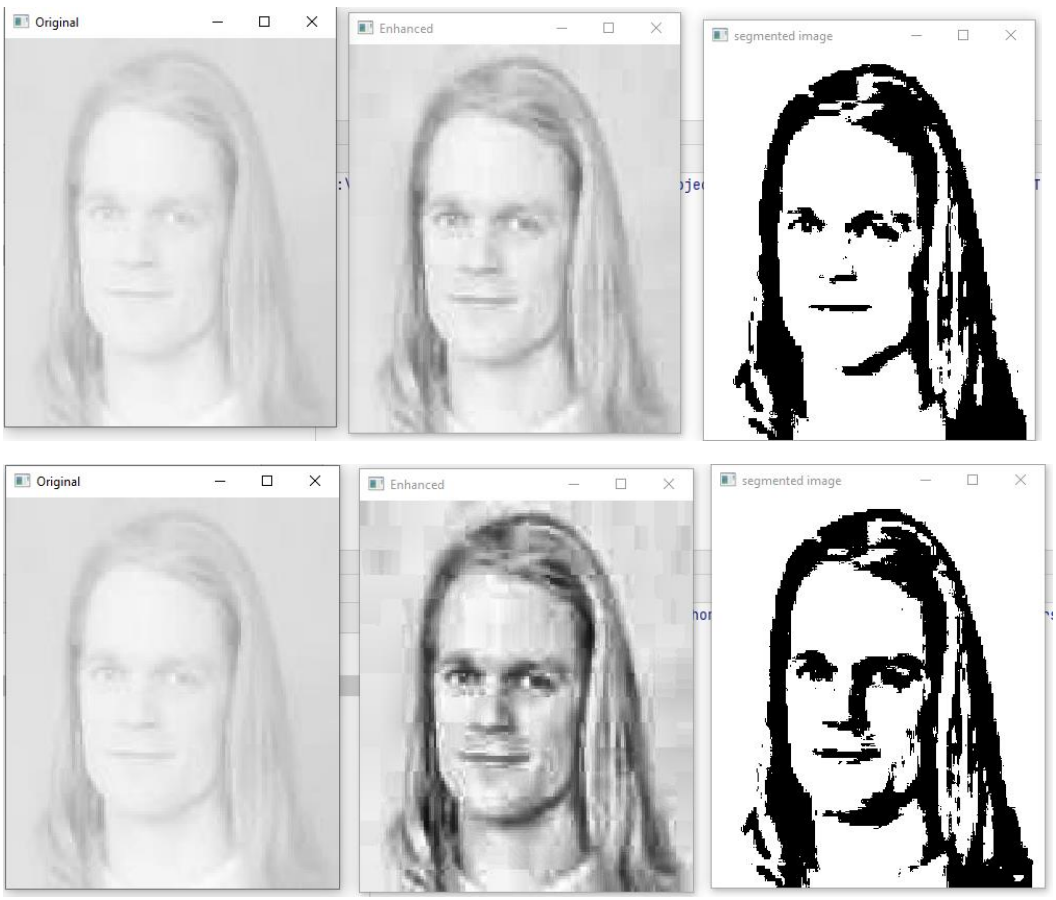


PROGRAM 5

Demonstrate enhancing and segmenting low contrast 2D images.

```
import cv2
import numpy as np
# Load the low contrast image
image = cv2.imread(r'C:\Users\DBIT-R&D\Desktop\low.jpg',
cv2.IMREAD_GRAYSCALE)
# Apply adaptive histogram equalization to enhance the contrast
clahe = cv2.createCLAHE(clipLimit=8.0, tileGridSize=(8,8))
enhanced_image = clahe.apply(image)
# Display the original and enhanced images
cv2.imshow('Original', image)
cv2.imshow('Enhanced', enhanced_image)
# Apply Otsu's thresholding to segment the image
_, threshold_image = cv2.threshold(enhanced_image, 0, 255,
cv2.THRESH_BINARY +
cv2.THRESH_OTSU)
# Display the thresholded image
cv2.imshow('segmented image', threshold_image)
# Wait for a key press and then close the windows
cv2.waitKey(0)
```

output:



PART B

Will be continued as Mini Project.

DIP Viva Questions :

1. What is Dynamic Range?

Ans: The range of values spanned by the grayscale is called the dynamic range of an image. The image will have high contrast if the dynamic range ishigh and the image will have a dull washed-out gray look if the dynamic range is low.

2. What do you mean by Color model?

Ans: A color model is a system used to describe a color. For example withRed, Green, and Blue (RGB) elements or Cyan, Magenta, Yellow, and Black(CMYK). A color space is a way of mapping real colors to the color model'sparticular values.

3. What are the types of light receptors?

Ans: There are two types of photoreceptors:

- cone photoreceptors
- rod photoreceptors

These cells function by sensing light and/or color and delivering themessage back to the brain through the optic nerve.

While cone photoreceptors detect color through bright light, rodphotoreceptors are sensitive to low-light levels.

Rods aid in night vision and identifying black and white hues.

Both cones and rods contain special proteins that assist in their functionality. The human eye contains more rod photoreceptors than conephotoreceptors.

4. What is Chromatic Adoption?

Ans: <Chromatic Adaptation= is most widely described as a dynamic mechanism of the human visual system to compensate for white point changes when viewing an object in different illuminations. If a white objectis viewed in different lighting (i.e., <bluer= daylight and incandescent lighting), the object retains its white appearance as long as the viewer is adapted= to the lighting.

5. What is meant by pixel?

Ans: A pixel is the smallest unit of a digital image or graphic that can bedisplayed and represented on a digital display device.
A pixel is also known as a picture element (pix = picture, el = element).

or

A pixel (short for picture element) is a single point or a tiny square in a graphic image stored in an ordered rectangular grid. It is the smallest element in a digital image. The more pixels used to represent an image, thecloser the result can resemble the analog original.

6. What is geometric transformation?

Ans: The geometric transformation of digital images is an important tool for modifying the spatial relationships between pixels in an image, and has become an essential element for the post-processing of digital images. This interactive tutorial explores the basic properties of geometric transformation, and how the algorithms involved in the mechanism of transformation can inüuence the ûnal appearance as well as the informationcontent of the transformed image

7. What is meant by mach band effect?

Ans: Mach band effect means the intensity of the stripes is constant. Therefore it preserves the brightness pattern near the boundaries, thesebands are called as Mach band effect.

8. Deûne Digital image?

Ans: A digital image is an image composed of picture elements, also knownas pixels, each with ûnite, discrete quantities of numeric representation for its intensity or gray level that is output from its two-dimensional functions fed as input by its spatial coordinates denoted with x, y on the x-axis and
y-axis, respectively.

9. What do you mean by Gray level?

Ans: The grey level or grey value indicates the brightness of a pixel. Theminimum grey level is 0. The maximum grey level depends on the digitization depth of the image.

10. What is meant by path?

Ans: The path can be deûned 4-,8-,m-paths depending on adjacency type.Let S be a subset of pixels in an image. Two pixels p and q are said to be connected in S if there exists a path between them consisting entirely of pixels in S

11. Explain what simultaneous contrast is?

Ans: Simultaneous contrast is a phenomenon that happens when two adjacent colors inüuence each other, changing our perception of these colors (more or less saturated, more or less bright). It can be observed bothwith different hues, or luminosities.

12. How cones and rods are distributed in the retina?

Ans: cones are in the range of 6-7 millionAnd rods
are in the range of 75-150 million

13. Deûne Brightness?

Ans: Brightness is the perceived intensity of light coming from a screen. Ona color screen, it is the average of the red, green, and blue pixels on the screen. Brightness is important to both color perception and battery life onmobile devices. It can be adjusted manually or automatically with sensors.

14. Deûne sampling and quantization?

Ans: Sampling means digitizing the coordinate value (x, y).Quantization means digitizing the amplitude value.
Several rods are connected to one nerve end. So it gives the overall picture ofthe image. This is also known as thin light vision

17. Differentiate photopic and scotopic vision?

Ans: Scotopic vision uses only rods to see, meaning that objects are visible, but appear in black and white, whereas photopic vision uses cones and provides the color. Mesopic vision is the combination of the two and is usedfor most scenarios.

18. Deûne Resolutions?

Ans: Image resolution describes the image's level of detail – higher resolution means more image detail. In digital imaging, the resolution isoften measured as a pixel count.

19. What are image translation and scaling?

Ans: Translation is a process of changing the position of an object in a straight line path from one coordinate location to another. Consider a pointP(x1, y1) to be translated to another point Q(x2, y2). If we know the point value (x2, y2) we can directly shift to Q by displaying the pixel (x2, y2).

20. What do you mean by shrinking digital images?

Ans: Shrinking may be viewed as under sampling. To shrink an image by onehalf, we delete every row and column. To reduce possible aliasing effect, it is a good idea to blue an image slightly before shrinking it.

21. Explain subjective brightness and brightness adaptation?

Ans: **Subjective brightness** means intensity as preserved by the human visual system. **Brightness adaptation** means the human visual system canoperate only from scotopic to glare limit. It cannot operate over the range simultaneously.

22. What are the steps involved in DIP?

Ans: the steps involved in DIP are :

- Image acquisition:
- Image Enhancement:
- Image Restoration:
- Morphological processing:
- Image segmentation
- Representation and Description:
- Recognition:
- Compression:

23. Do you know what Rectiûcation is in image processing?

Ans: Rectiûcation in Image Processing is a transformation process used toproject two-or-more images onto a common image plane.

- It corrects image distortion by transforming the image into a standardcoordinate system.
- It is used in computer stereo vision to simplify the problem of ûndingmatching points between images

24. What is meant by illumination and reüectance?

Ans: **Illumination** is the amount of source light incident on the scene. It isrepresented as i(x, y). **Reüectance** is the amount of light reüected by the object in the scene.

26. List the categories of digital storage?

Ans: categories of digital storage are:

- Short term storage for use during processing.
- Online storage for relatively fast recall.
- Archival storage for infrequent access.

27. What are the differences between Structural Patterns & Morphological Structural Element?

Ans: Structuring element is the matrix used to remove irregularities from theimage. (it can contain 0 or 1) Helps to analyse the noise and texture of image.Structural pattern can be a general pattern present all over the image

28. The type of Interpolation where for each new location the intensity ofthe immediate pixel is assigned is _____

Ans: **nearest neighbour interpolation**

Its called as Nearest Neighbour Interpolation since for each new location theintensity of the next neighbouring pixel is assigned.

29. Quantitatively, spatial resolution can be represented in the followingways :

- line pairs
- pixels
- dots

30. The smallest discernible change in intensity level is called

Ans: Intensity Resolution.

31. Write short notes on neighbors of a pixel?

Ans: The pixel p at co-ordinates (x, y) has 4 neighbors (ie) 2 horizontal and 2 vertical neighbors whose co-ordinates is given by (x+1, y), (x-1,y), (x,y-1), (x, y+1).This is called as **direct neighbors**. It is denoted by **N4(P).**

Four diagonal neighbors of p have co-ordinates:

(x+1, y+1), (x+1,y-1), (x-1, y-1), (x-1, y+1). It is denoted by **ND(4).**

Eight neighbors of p denoted by **N8(P)** is a combination of 4 directneighbors and 4 diagonal neighbors.

32. Specify the elements of the DIP system?

Ans: elements of the DIP system are :

- Image Sensors:
- Specialize image processing hardware:
- Computer:
- Software:
- Mass storage:
- Image display:
- Hardcopy devices:

- Networking:

33. The type of Interpolation where the intensity of the FOUR neighboringpixels is used to obtain the intensity of a new location is called ___ Ans: **nearest-neighbor interpolation.**

Bilinear interpolation is where the FOUR neighboring pixels are used to estimate intensity for a new location.

34. The transition between continuous values of the image function andits digital equivalent is called _____

Ans: **quantization.**

The number of quantization levels should be high enough for humanperception of ûne shading details in the image.

35. What are Hue and saturation?

Ans: Hue and saturation are properties of the colour. The main differencebetween them is that the **hue** is the purest form of the colour whereas **saturation** is the degree of brightness and dullness of a hue.

36. What is Luminance?

Ans: The luminance is basically the intensity of light which emits from a unitsurface area in a particular direction.

37. What is simultaneous contrast?

Ans: Simultaneous contrast is a visual perception phenomenon. The visual system is composed by mechanical, optical, chemical and electrical subsets.The evolution of the visual system didn't focus on precision, but rather on usefulness

Or

Simultaneous contrast is enhanced when adjacent colors are highly saturated; simultaneous contrast is weaker when adjacent colors are less saturated or more neutral. A saturated color will look even more so next to aless saturated color; a less saturated color will look even less so next to a highly saturated color.

38. What are recognition and Interpretation?

Ans: Recognition means is a process that assigns a label to an object basedon the information provided by its descriptors. Interpretation means assigning meaning to a recognized object.

39. Dynamic range of the imaging system is a ratio where the upper limitis determined by Saturation?

Ans: Here, we deûne the dynamic range of an imaging system to be the ratioof the maximum measurable intensity to the minimum detectable intensity level in the system. As a rule, the upper limit is determined by saturation andthe lower limit by noise, although noise can be present also in lighter intensities.

40. What tool is used in tasks such as zooming, shrinking, rotating, etc.? Ans:

Interpolation : It is the process of using known data to estimate valuesat unknown

locations.

41. How to increase the quality of an image?

- Filtering with morphological operators
- Histogram equalization
- Noise removal using a Wiener ûlter
- Linear contrast adjustment
- Median ûltering
- Unsharp mask ûltering
- Contrast-limited adaptive histogram equalization (CLAHE)
- Decorrelation stretch

42. What is Image Transform?

Ans: An image transform converts an image from one domain to another.Images are usually acquired and displayed in the spatial domain, in whichadjacent pixels represent adjacent parts of the scene.

43. Find the number of bits required to store a 256 X 256 image with 32 gray levels?

Ans: 32 gray levels = **25 = 5 bits 256 * 256 * 5 = 327680 bits**.

44. What is the weber ratio?

Ans: The ratio of increment of illumination to background of illumination iscalled as weber ratio.

If the ratio is small, then small percentage of change in intensity is needed (ie) good brightness adaptation. If the ratio is large, then large percentage ofchange in intensity is needed (ie) poor brightness adaptation.

45. For Dynamic range ratio the lower limit is determined by?

Ans: The dynamic range of the input signal is less straightforward, becausethe lower limit is determined by the amount of noise in the analog waveform, which could be inüuenced by environmental conditions or the gain setting of a variable-gain ampliûer that precedes the ADC.

46. List the applications of color models?

1. RGB model4 used for color monitors & color video camera
2. CMY model4used for color printing
3. HIS model4-used for color image processing
4. YIQ model4used for color picture transmission

47. Write the expression to ûnd the number of bits to store a digitalimage?

Ans: The number of bits required to store a digital image is

=>b=M X N X k

When M=N, this equation becomes

=>b=N^2k

48. Deûne subjective brightness and brightness adaptation?

Ans: **Subjective brightness** means intensity as preserved by the human visual system. **Brightness adaptation** means the human visual system canoperate only from scotopic to glare limit. It cannot operate over the range simultaneously.

49. Images quantized with insufûcient brightness levels will lead to theoccurrence of ___.

Ans: **Pixillation**

50. A continuous image is digitised at_____points.

Ans: **sampling points**

51. List the hardware-oriented color models?

Ans: the hardware oriented color models?

1. RGB model
2. CMY model
3. YIQ model
4. HSI model

52. What is the need for transformation?

Ans: Image Transform Transform methods in image processing . An imagetransform can be applied to an image to convert it from one domain to another.

53. Explain the types of connectivity?

Ans: Connected components, in a 2D image, are clusters of pixels with thesame value, which are connected to each other through either 4-pixel, or 8-pixel connectivity.

- 4-pixel connectivity would group all pixels that contact each other oneither of their four faces,
- while 8-pixel would group pixels that are connected along any face orcorner.

54. Give the formula for calculating D4 and D8 distance.

Ans: D4 distance (**city block distance**) is deûned by : **D4(p, q) = |x-s| + |y-t|**

D8 distance(**chess board distance**) is deûned by : **D8(p, q) = max(|x-s|, |y-t|)**.