Unit 1: Digital Image Processing Fundamentals

Q1. Consider a 3-bit gray scale image with dimension 128 × 128.
What will be possible range of values comprised by pixels in this image?
Q2. Consider a 16-bit gray scale image with dimension 10 × 10.
What will be possible range of values comprised by pixels in this image?
Q3. Consider following image:

10	05	03	07	09
06	14	15	07	00
06	14	15	15	00
09	09	11	11	00
07	07	10	10	01

I. What will be the range of values in its X-axis?
II. How many total bits are required to represent the given image in binary? (Consider uncompressed image)

Q4. Discuss image acquisition using i. A single sensor ii. A line sensor and iii. Array sensor.

Q5. Explain image acquisition process with sampling and quantization steps.

Q6. Define Spatial resolution.

Q7. Define Intensity resolution.

Q8. Comment on how much spatial resolution and intensity resolution is required for at least four different application scenarios.

Q9. Sketch digital coordinate system from world coordinates to pixel coordinates.

Q10. Illustrate digital camera pipeline and comment on simple model vs sophisticated model digital camera effects.

Q11. Compare CCD vs CMOS camera sensor.

Q12. Which factors affect the performance of digital cameras and how?

Q13. Distinguish color image and gray scale image with examples.

Q14. Enlist common image file formats.

Q15. If an image represented by the following matrix is scaled up by a factor of 2 in both X and Y direction, what will be the scaled image with
i. Nearest neighbor interpolation
ii. Bilinear interpolation

3	3	3	3	3
3	5	5	5	3
3	5	7	5	3
3	5	5	5	3
3	3	3	3	3

Q16. Consider the following image comprising 512 rows and 512 columns, How many total bits are required to represent the given image in binary?(Consider uncompressed image)

Q17. Which of the following image file formats is most suitable for cartoon style image?
(A) JPEG (B) TIFF (C) GIF (D) Exif

Q18. Which if the following image file formats is uncompressed lossless image?
(A) JPEG (B) TIFF (C) BMP (E) Exif

Q19. How PNG is different from GIF?

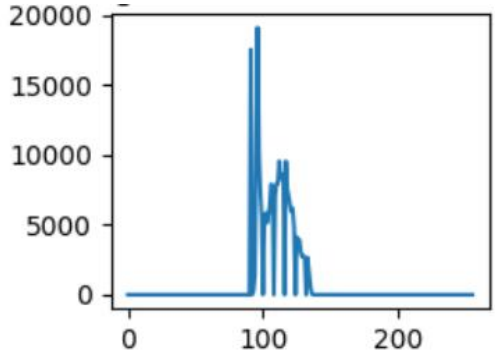
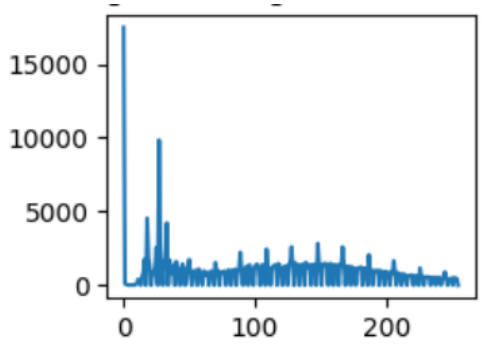
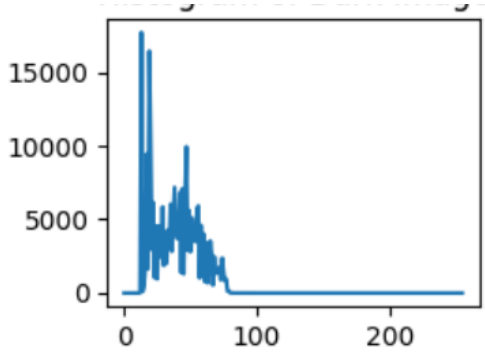
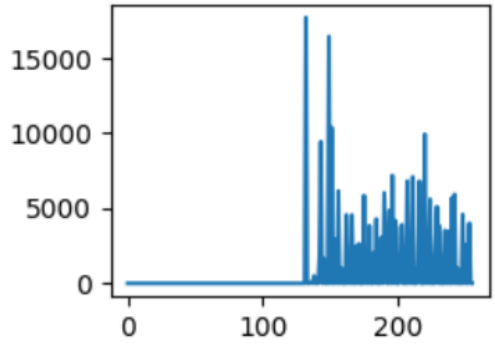
Q20. Which of the following format is used by PCB softwares?
(A) CGM (B) Gerber format (C) SVG (D) ESP

Q21. Which of the following formats is a compound format?
(B) CGM (B) Gerber format (C) SVG (D) ESP

Q22. Contrast bitmap images with vector images.

Unit 2: Segmentation of Grey level images

Q1. Match the following with reference to histograms of images:

1		A	Dark image
2		B	Light image
3		C	Low contrast image
4		D	High contrast image

Q2. Define histogram of an image.

Q3. For following transformation functions given in image i. and ii., Comment on whether these functions are suitable to perform histogram equalization with justification.

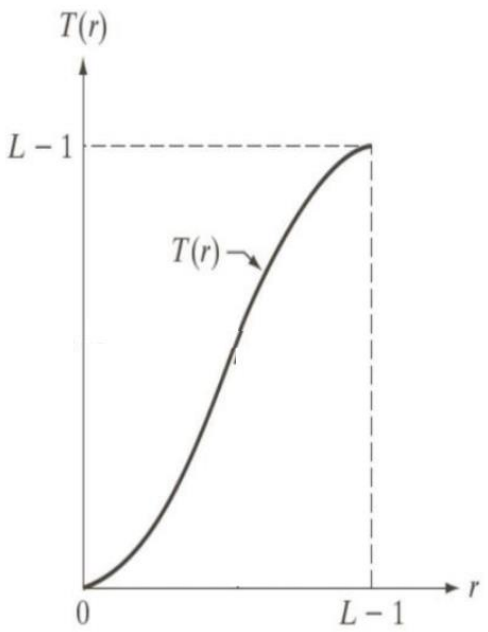


Image i.

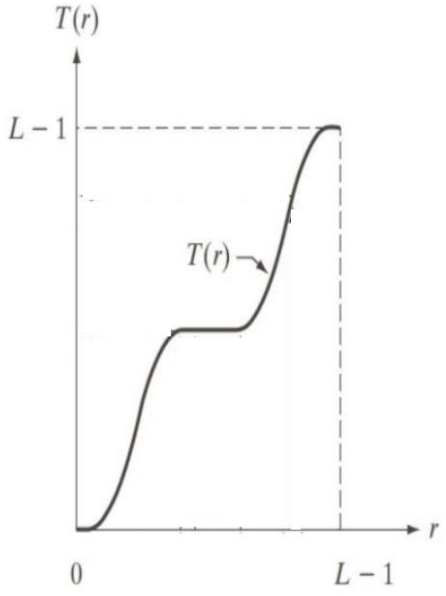


Image ii.

Q4. Perform Histogram Equalization on following image:

4	4	4	4	4
3	4	5	4	3
3	5	5	5	3
3	4	5	4	3
4	4	4	4	4

Q5. Perform Histogram Equalization on image with following details:

Gray Level	Number of Pixels
0	850
1	790
2	1023
3	656
4	122
5	81
6	245
7	329

Q6. Perform Histogram Matching on image with following details:

Gray Level	Number of Pixels
0	790
1	1023
2	850
3	656
4	329
5	245
6	122
7	81

As per Target image with following details:

Gray Level	Number of Pixels
0	0
1	0

2	0
3	614
4	819
5	1230
6	819
7	614

Q7. Enlist limitations of Global histograms.

Q8. Compare thresholding of image using Global histograms and local histograms.

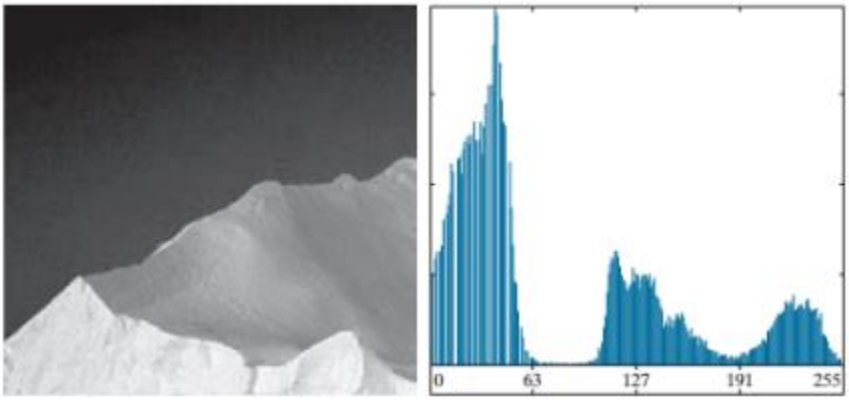
Q9. Discuss Bayesian classification of foreground and background pixels.

Q10. Write Otsu’s thresholding algorithm.

Q11. Find out threshold value using Otsu's method for given 3*3 image:

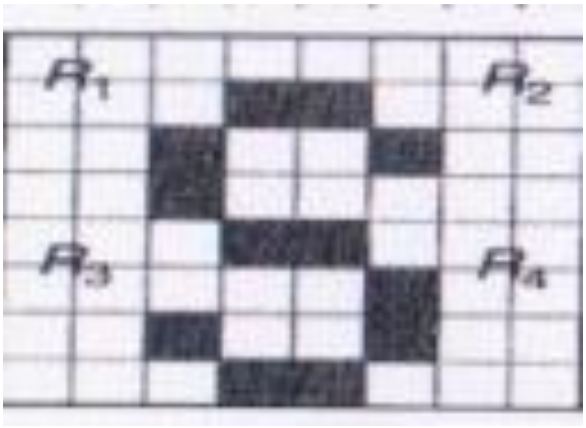
120	75	135
185	54	160
140	32	210

Q12. Apply multi-level thresholding using Otsu’s method on following image:



Q13. Explain Watershed algorithm with its limitations.

Q14. Segment following image using Region Splitting/Merging algorithm:



Q15. Consider an 8 * 8 image, the gray levels range from 0 to 7. segments this image using the region growing technique.
Assume
• Threshold = 2 (T<=2) and Seed pixel = 6
• Threshold = 3 (T<=3) and Seed pixel = 4

5	6	6	6	7	7	6	6
6	7	6	7	5	5	4	7
6	6	4	4	3	2	5	6
5	4	5	4	2	3	4	6
0	3	2	3	3	2	4	7
0	0	0	0	2	2	5	6
1	1	0	1	0	3	4	4
1	0	1	0	2	3	5	4

Q16. What are the limitations of region growing segmentation techniques?

Q17. What is the goal of segmenting an image?

Q18. Consider the following 3-bit grey scale image

3	1	2	3
1	7	6	4
2	1	7	5
0	1	5	6

When contrast enhancement using histogram equalization is used, to which intensity is the intensity 5 mapped to?

Q19. Consider two images I1 and I2 with dimensions 16 * 2 and 4 * 16 respectively. I1 consists of 16 background pixels and I2 consists of 4 background pixels. Rest pixels are foreground pixels. Suppose, a pixel is selected at random and is found to be a background pixel. What is the probability that the selected pixel is from image I2?

Unit 3: Detection of edges and lines in 2D images

Q1. Consider the following 3-bit grayscale image

0	1	2	3
4	5	6	7
0	1	2	5
4	1	5	6

What of the following can be the value when vertical Sobel operator and horizontal Sobel operator are applied on the orange colored pixel?

Q2. Consider the following 3-bit grayscale image

0	1	2	3
4	5	6	7
0	1	2	5
4	1	5	6

What of the following can be the value when vertical Prewitt operator and horizontal Prewitt operator are applied on the orange colored pixel?

Q3. Classify origins of edges in images.

Q4. Consider the following 3-bit grayscale image:

0	3	7	3	0
0	3	7	3	0
0	3	7	3	0
0	3	7	3	0

0	3	7		0

Calculate i. First order gradient in both X-axis and Y-axis.

Q5. What is the effect of noise image on gradients calculated on images and how it can affect extraction of edges from images?

Q6. How to solve the problem of noise present in images in edge detection using gradients?

Q7. Define derivative of Gaussian in X-axis and Y-axis.

Q8. Discuss criteria of an “Optimal edge detector”.

Q9. Q2. Consider the following 3-bit grayscale image

0	1	2	3
4	5	6	7
0	1	2	5
4	1	5	6

What of the following can be the value when Robert operators are applied on the orange colored pixel?

Q10. Explain in detail the Canny edge detector.

Q11. Write Canny edge detector algorithm.

Q12. Discuss Non-maximum Suppression.

Q13. Illustrate the edge linking with an example.

Q14. Explain in detail Hysteresis thresholding.

Q15. Explain in detail Line detection using Hough transform.

Q16. Explain in detail Ellipse detection using Hough transform.

Q17. Write an algorithm for Generalized Hough Transform.

Unit 4: Image Enhancement

Q1. Give classification of Image Enhancement operations.

Q2. Which of the following point processing operations is zero-memory operation?
(A) Image negative (B) Contrast Stretching (C) Lazy Man (D) Thresholding

Q3. Consider following 3-bit grayscale image:

1	5	7
2	3	0
0	1	4

Evaluate output image of Image negative operation applied on given image.

Q4. Consider following 4-bit grayscale image:

12	15	14
7	5	6
4	3	2

Evaluate output image of Image negative operation applied on given image.

Q5. Consider following 8-bit grayscale image:

200	215	255

0	127	0
100	50	180

Evaluate output image of Image negative operation applied on given image.

Q6. Consider following 8-bit grayscale image:

200	215	255
0	127	0
100	50	180

Evaluate output image of Thresholding operation applied on given image with global threshold value 111.

Q7. Consider following 8-bit grayscale image:

200	215	255
0	127	0
100	50	180

Evaluate output image of Contrast Stretching operation applied on a given image with following transformation function:

$$s = \ 0.5r\ for\ 0 \leq r \leqslant 100, 5r\ for\ 100 \leq r \leqslant 140, 0.5r\ for\ 140 \leq r \leq 255$$

Q8. Consider following 8-bit grayscale image:

200	215	255
0	127	0
100	50	180

Evaluate output image of Clipping operation applied on a given image with following transformation function:

$$s = \ 0.5r\ for\ 0 \leq r \leqslant 100, 5r\ for\ 100 \leq r \leqslant 140, 0\ for\ 140 \leq r \leq 255$$

Q9. Distinguish Log transformation and Power law transformation.

Q10. Consider following 8-bit grayscale image:

200	215	255
0	127	0
100	50	180

Evaluate output image of Gray Level operation applied on a given image with following transformation function:

$$s = \ 0\ for\ 0 \leq r \leqslant 100, 150\ for\ 100 \leq r \leqslant 140, 0\ for\ 140 \leq r \leq 255$$

Q11. Apply bitplane slicing following 3-bit grayscale image:

1	5	7
2	3	0

0	1	4

Sketch each of the bitplanes.

Q12. Explain gray level slicing and bit plane slicing with an example.

Q13. Demonstrate steps of operation of Spatial FIltering with an example.

Q14. Which of the following is most common approach to remove gaussian noise from image.

(A) Apply High Pass FIlter on image
(B) Apply Low Pass Filter on image
(C) Apply Band Pass Filter on an image
(D) Apply Band Stop Filter on an image

Q15. Define Smoothing Spatial FIlters.

Q16. Define Sharpening Spatial FIlters.

Q17. What is the effect changing mask size while performing spatial filtering?

Q18. Define max filter, min filter, median filter.

Q19. Consider following 8-bit grayscale image:

200	215	255
0	127	0
100	50	180

i. Apply 3*3 Spatial Law Pass Filter (Averaging Box Filter)
ii. Apply 3*3 Spatial High Pass Filter
iii. Apply 3*3 Min Filter
iv. Apply 3*3 Max Filter
v. Apply 3*3 Median Filter
on a given input image and generate output images while presenting steps of calculations.
(Note: Use Zero padding when required)

Q20. Compare performance of first order derivative and second order derivative for sharpening operation on images with an example.

Q21. Explain Unsharp Masking and High Boost Filtering.

Q22. Explain the process of filtering images in the frequency domain.

Q23. What is aliasing? How does it affect image quality.

Q24. Compare performance of Ideal, Butterworth and Gaussian Low pass filters.

Q25.Compare performance of Ideal, Butterworth and Gaussian High pass filters.

Q26. What is the effect of changing order of filter on output images while performing frequency domain filtering?

Q27. Which of the following filters never generates a Ringing effect in output images?
(A) Sixth order Ideal Filter (B) Sixth order Butterworth Filter (c) Sixth order Gaussian Filter (D) Sixth order Chebyshev Filter

Q28. Which of the following filters generates maximum Ringing effect in output images?
(A) Sixth order Ideal Filter (B) Sixth order Butterworth Filter (c) Sixth order Gaussian Filter (D) Sixth order Chebyshev Filter

Q29. Where are applications of Homomorphic filtering? Explain Homomorphic filtering with an example.

Q30. What are the applications of Notch filters?

Q31. Write an algorithm for performing adaptive median filtering.

Unit 5: Introduction to Computer Vision

Q1. Find the transformation of the line passing through the points □1 = (2, 0) and □2 = (1, −3).

Q2. Given a homography

□ = 1 1 −2
2 0 1
0 2 −1

Find the vanishing line.

Q3. Explain vanishing point with an example.

Q4. Which of the following statements are true?
a) The cosine angle between two lines are preserved under homography.
b) The circular points are fixed points under homography.
c) Colinearity is preserved under homography.
d) Affine group have 5 degree of freedom.

Q5.

Given a projection matrix $P = \begin{bmatrix} 1 & 0 & 1 & 10 \\ 2 & 1 & 2 & 3 \\ 1 & 0 & -1 & 1 \end{bmatrix}$, compute the vanishing point of a line in image coordinates with direction ratio $10 : 8 : 6$.

Q6.

Consider a projection matrix $P = \begin{bmatrix} 1 & 0 & 1 & 10 \\ 2 & 1 & 2 & 3 \\ 1 & 0 & -1 & 1 \end{bmatrix}$, find the camera center in homogeneous coordinates.

Q7.

Find out the direction of principal axis of the camera with projection matrix $P = \begin{bmatrix} 51 & 6 & -18 & 10 \\ -23 & 5 & 9 & 0 \\ 1 & 0 & 0 & 1 \end{bmatrix}$

Q8. Find out the direction of principal point of the camera with projection matrix P = $\begin{bmatrix} 51 & 6 & -18 & 10 \\ -23 & 5 & 9 & 0 \\ 1 & 0 & 0 & 1 \end{bmatrix}$

Q9.

Consider a projection matrix $P = \begin{bmatrix} 8 & 51 & 4 & 0 \\ 7 & 8 & 19 & 0 \\ 10 & -5 & 8 & 1 \end{bmatrix}$, compute the camera center C in world coordinates

Q10. Enlist applications of computer vision.

Q11. Explain Perspective Projection with an example image from world coordinates to pixel value in an image.

Q12. Compare Perspective Projection vs Orthographic Projection vs Weak Perspective Projection.

Q13. Consider given image:

For X=20, Y=50 and Z=50, Calculate height of the pole h.

Q14. Explain all 2D transformations in detail.

Q15. Discuss intrinsic and extrinsic camera parameters.

Unit 6. Feature detection and matching

Q1. Define measure of corner response for Harris corner
Q2. Explain working of Harris corner detector.
Q3. Discuss properties of Harris corner detector.