EC8093 DIGITAL IMAGE PROCESSING

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OBJECTIVES:

- To become familiar with digital image fundamentals
- To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study the image segmentation and representation techniques.
- To become familiar with image compression and recognition methods

UNIT I DIGITAL IMAGE FUNDAMENTALS **9**

Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - Color image fundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.

UNIT II IMAGE ENHANCEMENT **9**

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

UNIT III IMAGE RESTORATION **9**

Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering

UNIT IV IMAGE SEGMENTATION **9**

Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.

UNIT V IMAGE COMPRESSION AND RECOGNITION **9**

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.

TOTAL :45 PERIODS

OUTCOMES:

At the end of the course, the students should be able to:

- Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.
- Operate on images using the techniques of smoothing, sharpening and enhancement.
- Understand the restoration concepts and filtering techniques.
- Learn the basics of segmentation, features extraction, compression and recognition methods for color models.

TEXTBOOKS:

1 Rafael C. Gonzalez, Richard E. Woods, _Digital Image Processing‘, Pearson, Third Edition, 2010.

2 Anil K. Jain, _Fundamentals of Digital Image Processing‘, Pearson, 2002.

REFERENCES

1 Kenneth R. Castleman, _Digital Image Processing‘, Pearson, 2006.

2 Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, _Digital Image Processing using MATLAB‘, Pearson Education, Inc., 2011.

UNIT I

DIGITAL IMAGE FUNDAMENTALS

PART A

1.Define simultaneous contrast and mach band effect? (April/May 2015)

MACH BAND EFFECT: visual system tends to undershoot or overshoot around the boundary of regions of different intensities. The intensity of the stripes is constant, actually it perceive a brightness pattern that is strongly scalloped, especially near the boundaries. These seemingly scalloped bands are called *Mach bands* .This phenomenon, is called mach band effect.

SIMULTANEOUS CONTRAST : It is related to the fact that a region's perceived brightness does not depend simply on its intensity.

2.State mach band effect?(Nov/Dec 2015, May/June 2014,Nov/Dec2016)

Mach band effect means the intensity of the stripes is constant. Therefore it preserves the brightness pattern near the boundaries, these bands are called as machband effect.

3.Compare RGB and HSI color image model?(Nov/Dec 2014)

HIS color model used to describe by its hue, saturation and intensity, it is well suited for human interpretation .RGB color model appear in its primary spectral components of red, green and blue.

4.Define Hue and Saturation?(May/June 2014)

Hue is a color attribute that describes a pure color where saturation gives a measure of the degree to which pure color is diluted by white light.

5.How do you relate contrast and brightness?(April/May 2015, Nov/Dec 2012)

Brightness represents the perceived luminance. it is a subjective descriptor that is practically impossible to measure and it is one of the factors in describing color sensation.

Contrast: $\frac{\Delta f}{f} \approx$d(log f)$\approx \Delta c$ this equation says equal increment in the log of the luminance should be perceived to be equally different, the change in contrast ,c=$a_1 + a_2 \log f$ where $a_1 and\ a_2$ are constants is called contrast.

6.Define optical illusion and mach band.(May/June 2013)

Optical illusion is in which the eye fills in non existing information or wrongly perceives geometrical properties of objects

Mach band is not simple function of intensity which is based on visual system tends to overshoot or undershoot around the boundary of region of different intensities. These scalloped band are called mach band.

7.Mention the difference a monochrome and a grayscale image.(Nov/Dec 2013)

Monochrome Image	Grayscale Image
Any one of the color ie black or white	Combination of black and white
Values are 0 and 1	Values are 0 to 255 –gray scale intensity

8. List the application of color models?(Nov/Dec2018)

- RGB model-used for color monitors and color video camera
- CMY model- used for color printing
- YIQ model- used for color image processing
- HSI model- used for color picture transmission

9. Define Image?

An image may be defined as two dimensional light intensity function f(x, y) ,Where x and y denote spatial co-ordinate and the amplitude or value of f at any point (x, y) is called intensity or grayscale or brightness of the image at that point.

10.What is meant by pixel?

Digital image is composed of a finite number of elements each of which has a particular location or value. These elements are referred to as pixels or image elements or picture elements or pels elements.

11.Define Digital image?

When x, y and the amplitude values of f all are finite discrete quantities, we call the image digital image

12.Differentiate photopic and scotopic vision?(Nov/Dec2017, Nov/Dec2018)

The human being can resolve the fine details with these cones because each one is connected to its own nerve end. This are also known as bright light vision. Several rods are connected to one nerve end. So it gives the overall picture of the image. This is also known as thin light vision.

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13.Define subjective brightness and brightness adaptation?

Subjective brightness means intensity as preserved by the human visual system. Brightness adaptation means the human visual system can operate only from scotopic to glare limit. It cannot operate over the range simultaneously. It accomplishes this large variation by changes in its overall intensity.

14. What is simultaneous contrast?

The region reserved brightness not depend on its intensity but also on its background. All centre square have same intensity. However they appear to the eye to become darker as the background becomes lighter.

15.What is meant by illumination and reflectance?

Illumination is the amount of source light incident on the scene. It is represented as i(x, y).
Reflectance is the amount of light reflected by the object in the scene. It is represented by r(x,y).

16.Define sampling and quantization.(Nov/Dec 2017,April/May 2018)

Sampling means digitizing the co-ordinate value (x, y). Quantization means digitizing the amplitude value. Quantization involves representing the sampled data by a finite number of levels based on some criteria such as minimization of quantize distortion.

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

Gray Levels = 25 = 5 Bits

257256 * 5 = 327680 Bits.

18. Define checker board effect?(Nov/Dec2016)

Image size denotes the number of rows and columns. The digitization process of the spatial coordinates is known as image sampling, and the amplitude conversion of an intensity value to a digital representation is know as grey-level quantization. There is an interesting phenomenon known as the checkerboard effect.

19.When is fine sampling and coarse sampling used?(April/May 2017)

Fine sampling means large degree by the number of samples and discrete intensity levels used. Coarse sampling means less degree by the number of samples and less discrete intensity levels used.

20.What is the function of an image sensor? (April/May 2017)

The image sensor must capture incoming light, convert it into an electric signal, measure that signal and output it to supporting electronics.

21.Define spatial resolution. How it is represented quantitatively.(April/May 2019)

Spatial resolution is the smallest discernible detail in an image. Spatial resolution depends on the number of pixels. The principal factor determining spatial resolution is sampling.

22.List the color models involved in hardware.(April/May 2018)

RGB model,CMY model ,YIQ model and HSI model

PART B & C

1. **With necessary diagram explain how an Analog image is converted into Digital Image. (Nov/Dec2016,April/May2019)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing -Pg52

2. **What is Color model? What are its types? Explain RGB and HIS models with necessary diagram . (Nov/Dec2016)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing - Pg289,290

3. **Explain about three sensor arrangements for image sensing and Acquisition.(Nov/Dec2016,April/May 2018)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing-45

4. **Explain various distance measures used for image analysis. (Nov/Dec2016, Nov/Dec2018) .**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing -Pg66

5. **Explain the components of image processing system. (April/May 2017)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing -Pg28

6. **When do you prefer non-uniform sampling and quantization? Justify.(Nov/Dec 2014, April/May 2017)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing - 52

7. **Explain how color images are represented using HSI color space model . How an RGB model is represented using HIS format? Describe the transformation (April/May 2017, April/May2019)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing -Pg289

8. **What are the elements of an image processing system and describe its working? How this is used for weather forecasting applications? (Nov/Dec2017, Nov/Dec2018,April/May 2018,April/May2019)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing -Pg25

9. **Explain in detail about the phenomenon of image sampling? Illustrate how aliasing happens if sampling theorem is violated. (Nov/Dec2017)**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing -Pg52,62

10. **What is a frame buffer? Discuss the categories of digital storage for image processing applications.(8)(Nov/Dec 2012) (Nov/Dec 2014)**

    Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg42

11. **What is visual perception model and explain. How this is analogues to a DIP system.(8)(Nov/Dec 2014)**

    Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg34

Formula

Weber Ratio =(ΔIc /I).

Euclidean distance: $D_e(p,q) = \sqrt{(x-s)^2 + (y-t)^2}$

D4-distance (*city-block distance*) is defined as $D_4(p,q) = |x-s| + |y-t|$

D8-distance (*chessboard distance*) is defined as $D_8(p,q) = \max(|x-s|, |y-t|)$

Converting from RGB to HSI

$$H = \begin{cases} \theta & \text{if } B \le G \\ 360 - \theta & \text{if } B > G \end{cases}$$

$$\theta = \cos^{-1}\left\{\frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2 + (R-B)(G-B)]^{1/2}}\right\}$$

$$S = 1 - \frac{3}{(R+G+B)}[\min(R,G,B)]$$

$$I = \frac{1}{3}(R+G+B)$$

Converting from HSI to RGB

- RG sector: $0^\circ \le H < 120^\circ$

$$B = I(1-S)$$

$$R = I\left[1+\frac{S\cos H}{\cos(60^\circ - H)}\right]$$

$$G = 3I-(R+B)$$

UNIT II

IMAGE ENHANCEMENT

PART A

1. **What do you infer from multimodal histogram?(May/June 2012)**

   A multimodal distribution is a probability distribution with more than one peak, or "mode."

   - A distribution with two peaks or more is multimodal
   - A bimodal distribution is also multimodal, as there are multiple peaks.

2. **What are the types of image enhancement available?(Nov/Dec 2012)**

   - Spatial domain method
   - Frequency domain method

3. **What is histogram equalization?(Nov/Dec 2015)**

   It is defined as, the goal is to obtain a uniform histogram for the output image. It is different from continuous and discrete functions.

4. **What is a bit plane?(Nov/Dec 2013, Nov/Dec 2016)**

   Instead of highlighting gray level ranges, highlighting the contribution made to total image appearance by specific bits might be desired. Suppose that each pixel in an image is represented by 8 bits. Imagine that the image is composed of eight 1-bit planes, ranging from bit plane 0 for LSB to bit plane-7 for MSB.

5. **What is unsharp masking?(Nov/Dec 2016)**

   The Unsharp Mask filter sharpens edges of the elements without increasing noise or blemish The "unsharp" of the name derives from the fact that the technique uses a blurred, or "unsharp", negative image to create a mask of the original image.

6. **Define spatial averaging.(May/June 2014)**

   Spatial averaging each pixel in an image is replaced by a weighted average of its neighborhood pixel.

7. **What is contrast stretching?**

   Contrast stretching reduces an image of higher contrast than the original by darkening the levels below m and brightening the levels above m in the image.

8. What is meant by masking? (Nov/Dec2018)

Mask is the small 2-D array in which the values of mask co-efficient determine the nature of process. The enhancement technique based on this type of approach is referred to as mask processing.

9. Define histogram. (April/May2019)

The histogram of a digital image with gray levels in the range [0, L-1] is a discrete function h(rk)=nk. rk-kth gray level nk-number of pixels in the image having gray level rk.

10. Write the steps involved in frequency domain filtering. x+y

1. Multiply the input image by (-1) to center the transform.
2. Compute F(u,v), the DFT of the image from (1).
3. Multiply F(u,v) by a filter function H(u,v).
4. Compute the inverse DFT of the result in (3).
5. Obtain the real part of the result in (4). x+y
6. Multiply the result in (5) by (-1)

10. Difference between image enhancement and restoration.(April/May2017)

Image Enhancement: – A process which aims to improve bad images so they will "look" better. Image Restoration: – A process which aims to invert known degradation operations applied to images

Enhancement	**Restoration**
"Better" visual representation	Remove effects of sensing environment
Subjective	Objective
No quantitative measures	Mathematical, model dependent quantitative measures

11. Explain spatial filtering?

Spatial filtering is the process of moving the filter mask from point to point in an image. For linear spatial filter, the response is given by a sum of products of the filter coefficients, and the corresponding image pixels in the area spanned by the filter mask.

12. What is grey level slicing?

Highlighting a specific range of grey levels in an image often is desired. Applications include enhancing features such as masses of water in satellite imagery and enhancing flaws in x-ray images.

13. What is the purpose of image averaging?(Nov/Dec2018)

An important application of image averaging is in the field of astronomy, where imaging with very low light levels is routine, causing sensor noise frequently to render single images virtually useless for analysis.

14. Define Laplacian.

The laplacian of the two dimensional image f(x,y) is defined as

$$\nabla^2 f(x,y) = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

15. Define image subtraction.

The difference between 2 images f(x,y) and h(x,y) expressed as, g(x,y)=f(x,y)-h(x,y) is obtained by computing the difference between all pairs of corresponding pixels from f and h.

16. What is histogram specification?

The method used to generate a processed image that has a specified histogram is called histogram matching or histogram specification.

17. What is sharpening spatial filtering?

It is used to highlight fine detail in an image. It is used in electronic printing and medical imaging and in military.

18. What is use of smoothing spatial filter?

It is used for blurring and for noised reduction. Blurring is removed of small details from an image.

19. If all the pixel in an image are shuffled, will there be any changes in the histogram? justify your answer.(April/May2017)

If all the pixel in an image are shuffled, will there will not be any changes in the histogram of the image.A histogram gives only the frequency of occurrence of the gray level .

20. Whether two different image can have same histogram? Justify your answer. (Nov/Dec 2017)

Yes, there is a possibility that two different images can have the same histogram. here, we have taken original image if we flipped in the right/left direction. the histogram of original image and the flipped image are taken. Since the value of the pixel are not affected by a "flipping" operation, the histogram of the original image is same as the histogram of the flipped image

21. For an 8 bit image ,write the expression for obtaining the negative of the input image (Nov/Dec 2017,April/May2019))

NEGATIVE:S=l-1-r

22. Name the different types of derivative filters? (April/May2018)

Perwitt operators

Roberts cross gradient operators

Sobel operators

23. What is the need for transform? (April/May2018)

i.Fast computation e.g., convolution vs. multiplication for filter with wide support

ii. Conceptual insights for various image processing e.g., spatial frequency information (smooth, moderate change, fast change, etc.)

i. Obtain transformed data as measurement e.g., blurred images, radiology images (medical and astrophysics) iv. For efficient storage and transmission

PART B &C

1. **Perform histogram equalization of the image .(April/May2019)**

Gray level (rk)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
No.of pixel(Pk)	**6**	**8**	**11**	**12**	**3**	**5**	**15**	**6**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg88

2. **How is contrast stretching and intensity level slicing is performed on an image? Explain. (April/May2019)**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg78

3. **How low pass and high pass filtering is performed in frequency domain given in an image? Explain. (April/May2019, April/May2017)**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg180

4. **Apply spatial high pass filter for the mask ed pixel in the image. (April/May2019)**

$$\begin{pmatrix} 1 & 2 & 3 \\ 4 & \boxed{3} & 2 \\ 1 & \boxed{5} & 6 \end{pmatrix}$$

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg125

5. **Discuss about smoothing and sharpening spatial filtering in detail.(Nov/Dec2018)**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing – Pg119,125

6. **Write short notes on ideal Butterworth and Gaussian Filters.(Nov/Dec2018)**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg183

7. **Enumerate Discrete Fourier transform in detail.(April/May2018)**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg149

8. **What is histogram equalization? Discuss in detail about the procedure involved in histogram matching.(16)(Nov/Dec 2012,April/May2018,Nov/Dec2016)**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg91

9. **Explain gradient operator for image enhancement.(Nov/Dec2016)**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg88

10. Explain in detail the method for smoothening the image is frequency domain. (Nov/Dec2016)

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg167

11. Why histogram equalization is considered as an "idempotent operation".Perform histogram equalization of the image? (Nov/Dec2017)

$$\begin{bmatrix} 3 & 2 & 4 & 5 & 4 \\ 3 & 4 & 5 & 4 & 3 \\ 3 & 5 & 5 & 5 & 3 \\ 3 & 4 & 5 & 4 & 3 \\ 4 & 5 & 2 & 4 & 4 \end{bmatrix}.$$

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg88

12. Explain the following gray level transformation techniques in detail Image negative, Thresholding, Gray level slicing and Logarithmic transformation(Nov/Dec2017,April/May2017)

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg78

13. Illustrate the steps in histogram equalization of the image.(16)(Nov/Dec2013, Nov/Dec2016)

$$\begin{bmatrix} 4 & 4 & 4 & 4 & 4 \\ 3 & 4 & 5 & 4 & 3 \\ 3 & 5 & 5 & 5 & 3 \\ 3 & 4 & 5 & 4 & 3 \\ 4 & 4 & 4 & 4 & 4 \end{bmatrix}$$

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg88

14. Describe histogram equalization. Obtain histogram equalization for the following image segment of size 5×5?Write the inference on image segment before and after equalization.(16)(May/June2013)

$$\begin{bmatrix} 20 & 20 & 20 & 18 & 16 \\ 15 & 15 & 16 & 18 & 15 \\ 15 & 15 & 19 & 15 & 17 \\ 16 & 17 & 19 & 18 & 16 \\ 20 & 18 & 17 & 20 & 15 \end{bmatrix}$$

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg88

15. **Describe histogram equalization. Obtain histogram equalization for the following 8 bit image segment of size 5×5?Write the inference on image segment before and after equalization.(16)(April/May2015)**

$$\begin{bmatrix} 200 & 200 & 200 & 180 & 240 \\ 180 & 180 & 180 & 180 & 190 \\ 190 & 190 & 190 & 190 & 180 \\ 190 & 200 & 220 & 220 & 240 \\ 230 & 180 & 190 & 210 & 230 \end{bmatrix}$$

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg88

Formula:

Gray level Transformation: $g(x,y)=T[f(x,y)]$

Image Negatives: $s=(L-1)-r$

Log Transformation $s=c\log(1+r)$

Power Law Transformation $s=cr^{\gamma}$

Histogram: $$p_{out}(s)=\left[p_{in}(r)\cdot\frac{1}{p_{in}(r)}\right]_{r=T^{-1}(s)}=[1]_{r=T^{-1}(s)}=1, \qquad 0\le s\le 1$$

Linear Filtering with the Filter Mask

$$R = w(-1,-1)f(x-1,y-1) + w(-1,0)f(x-1,y) + \cdots + w(0,0)f(x,y) + \cdots + w(1,0)f(x+1,y) + w(1,1)f(x+1,y+1),$$

$$R = w_1 z_1 + w_2 z_2 + \ldots + w_{mn} z_{mn} = \sum_{i=1}^{mn} w_i z_i$$

Unsharp masking and high-boost filtering

$$f_s(x,y) = f(x,y) - \bar{f}(x,y)$$

$$f_{hb}(x,y) = Af(x,y) - \bar{f}(x,y)$$

The two-dimensional Fourier transform and its inverse

– Fourier transform (discrete case) DTC

$$F(u,v) = \frac{1}{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)e^{-j2\pi(ux/M+vy/N)}$$

for $u = 0,1,2,\ldots,M-1, v = 0,1,2,\ldots,N-1$

– Inverse Fourier transform:

$$f(x,y) = \sum_{u=0}^{M-1}\sum_{v=0}^{N-1} F(u,v)e^{j2\pi(ux/M+vy/N)}$$

for $x = 0,1,2,\ldots,M-1, y = 0,1,2,\ldots,N-1$

- u, v : the transform or frequency variables
- x, y : the spatial or image variables

The basic model for filtering in the frequency domain : G(u, v) = H (u, v)F (u, v)

Ideal Lowpass Filters (ILPFs) : D(u, v) = [(u - M / 2)2 + (v - N / 2)2]$^{1/2}$

Ideal Highpass Filters

$$H(u,v) = \begin{cases} 0 & \text{if } D(u,v) \le D_0 \\ 1 & \text{if } D(u,v) > D_0 \end{cases}$$

UNIT III

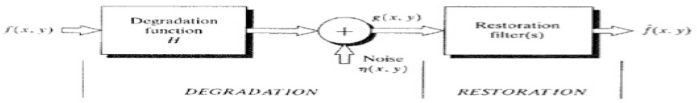
IMAGE RESTORATION

PART A

1. **How a degradation process is modeled? (NOV/DEC 2011,MAY/JUNE 2013, APR/MAY 2015,Nov/Dec2016)**

   The degradation process is modeled as a degradation function that together with an additive noise term operates on an input image F(x,y).

Model of the Image Degradation / Restoration Process



2. **Why the restoration is called as unconstrained restoration? (MAY/JUNE 2014, MAY/JUNE 2014,April/May2017)**

   In the absence of any knowledge about the noise ‗n', a meaningful criterion function is to seek an f^ such that H f^ approximates of in a least square sense by assuming the noise term is as small as possible.

   Where H = system operator. f^ = estimated input image. g = degraded image.

3. **What are the types of noise models?**

   - Guassian noise
   - Rayleigh noise
   - Erlang noise
   - Exponential noise
   - Uniform noise
   - Impulse noise

4. **Give the relation for Gamma noise and Exponential noise?(Nov/Dec2018)**

   Gamma noise: The PDF is P(Z)=ab zb-1 ae-az/(b-1) for Z>=0

0 for Z<0 ,mean μ=b/a, standard deviation _2=b/a2

Exponential noise The PDF is P(Z)= ae-az Z>=0

- Z<0 mean μ=1/a

  standard deviation _2=1/a2

5. **Give the relation for Uniform noise? (APR/MAY 2015)**

   Uniform noise: The PDF is

   P(Z)=1/(b-a) if a<=Z<=b

   0 otherwise mean μ=a+b/2

   standard deviation _2=(b-a)2/12

6. What is inverse filtering? (MAY/JUNE 2014)

The simplest approach to restoration is direct inverse filtering, an estimate F^(u,v) of the transform of the original image simply by dividing the transform of the degraded image G^(u,v) by the degradation function.

F^ (u,v) = G^(u,v)/H(u,v)

7. **What is meant by blind image restoration?**

An information about the degradation must be extracted from the observed image either explicitly or implicitly.This task is called as blind image restoration.

8. **What is segmentation? Write the applications of segmentation. (NOV/DEC 2013, NOV/DEC 2018)**

Segmentation subdivides on image in to its constitute regions or objects. The level to which the subdivides is carried depends on the problem being solved .That is segmentation should when the objects of interest in application have been isolated.

- Detection of isolated points.
- Detection of lines and edges in an image.

9. **How the derivatives are obtained in edge detection during formulation?(April/May2018)**

The first derivative at any point in an image is obtained by using the magnitude of the gradient at that point. Similarly the second derivatives are obtained by using the laplacian.

10. What is edge?

An edge isa set of connected pixels that lie on the boundary between two regions edges are more closely modeled as having a ramplike profile. The slope of the ramp is inversely proportional to the degree of blurring in the edge.

11. Give the properties of the second derivative around an edge? (APR/MAY 2015)

- The sign of the second derivative can be used to determine whether an edge pixel lies on the dark or light side of an edge.
- It produces two values for every edge in an image.
- An imaginary straightline joining the extreme positive and negative values of the second derivative would cross zero near the midpoint of the edge.

12. What is the principle of growing based image segmentation? (NOV/DEC2011,MAY/JUNE 2014)

Region growing is a procedure that groups pixels or subregions in to layer regions based on predefined criteria. The basic approach is to start with a set of seed points and from there grow regions by appending to each seed these neighbouring pixels that have properties similar to the seed.

13. Specify the steps involved in splitting and merging? (MAY/JUNE 2013, MAY/JUNE 2014)

Split into 4 disjoint quadrants any region Ri for which P(Ri)=FALSE. Merge any adjacent regions Rj and Rk for which P(RjURk)=TRUE. Stop when no further merging or splitting is positive.

14. tate the conditions to be met by the partitions in region based segmentation. (NOV/DEC 2011)

1. $P(R_i)$=TRUE for i=1,2,…n=Deals with the properties that must be satisfied by the pixels in a segmented region

2. $P(R_iUR_j)$=FALSE for i=j=The pixels in two adjacent regions should not have the same identity level.

15. Why geometric transformation are called so? (MAY/JUNE 2012, APR/MAY 2015))

Geometric transformation are used to restore the images that have already undergone geometric distortions. They recover the original image by modifying the spatial relationships between pixels in an image.

16. What is meant by wiener filter? (NOV/DEC 2012)

Wiener filtering is a method of restoring images in the presence of blur as well as noise.The aim is to approximate the original images that the mean square error between the original and approximated image is minimized.

17. Mention the drawbacks of inverse filtering. (NOV/DEC 2013,Nov/Dec2017)

Highly sensitive to noise and removal of blur caused by uniform linear motion.

18. Give the 3*3 mask to detect horizontal line in an image.(April/May2019)

Laplacian is used for detection of line, since it is sensitive to sudden changes and thin lines. Since the second derivative changes its sign on a line it creates a “double line effect” and it must be handled. Second derivative can have negative results andv we need to scale the results

−1	−1	−1
2	2	2
−1	−1	−1

Horizontal

19. How an image is segmented using thresholding?(April/May2019)

Threshold technique is one of the important techniques in image segmentation. This technique can be expressed as: T=T[x, y, p(x, y), f(x, y]

Where T is the threshold value.

x, y are the coordinates of the threshold value point.p(x,y) ,

f(x,y) are points the gray level image pixels

Threshold image g(x,y) can be define: $g(x,y)=\begin{cases} 1 & if\ f(x,y) > 1 \\ 0 & if\ f(x,y) \leq 0 \end{cases}$

20. How the discontinuity is detected in an image using segmentation(April/May2018)

Segmentation algorithms generally are based on 2 basic properties of gray level values:

1. Discontinuity - isolated points, lines and edges of image
2. Similarity - thresholding, region growing, region splitting and merging.

Detection of Discontinuities :

Point detection, Line detection, Edge detection, Combined detection, Edge linking and boundary detection

21. Which filter will be effective in minimizing the impact of salt and pepper noise in an image?(Nov/Dec2017)

Salt-and-pepper noise is a form of noise sometimes seen on images. It is also known as impulse noise. This noise can be caused by sharp and sudden disturbances in the image signal. It presents itself as sparsely occurring white and black pixels. An effective noise reductionmethod for this type of noise is a median filter or a morphological filter.For reducing either salt noise or pepper noise, but not both, a contraharmonic mean filter can be effective.

PART B & C

1. **Derive a wiener filter for image restoration and specify its advantages over inverse filter.(April/May2017, April/May2018, April/May2019)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg262

2. **Relate region splitting and merging technique for image segmentation with suitable examples. .(April/May2017)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg615

3. **What is the objective of image segmentation? Explain any one of the region based image segmentation technique in detail. Mention two applications of image segmentation. (Nov/Dec2017, Nov/Dec2016)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg612

4. **Describe the image restoration technique of inverse filtering. Why inverse filtering approach fails in the presence of noise ? (Nov/Dec2017, April/May2018)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg261

5. **Summarize the process of edge linking using Hough transform. (Nov/Dec2016)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg587

6. **Explain adaptive filter. What are the two levels of adaptive median filtering algorithms?(April/May2018)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg237

7. **Explain in detail about various Mean filter.(Nov/Dec2018)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg231

8. **Explain about the process of edge linking and boundary detection in detail. (Nov/Dec2018)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg585

9. **Explain the principle of region splitting and merging in detail. (Nov/Dec2018)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg615

10. **Discuss the behavior of first and second order derivative for a step and ramp edge. (April/May2019)**

    Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg568

11. **How an image is segmented using region growing technique?Explain. .(April/May2019)**

    Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg613

Formula

Spatial domain representation of the degraded image:

$$g(x,y) = h(x,y) \star f(x,y) + \eta(x,y)$$

Frequency domain representation:

$$G(u,v) = H(u,v)F(u,v) + N(u,v)$$

Gaussian (*Normal*) Noise

PDF of a Gaussian random variable z: $p(z) = \frac{1}{\sqrt{2\pi\sigma}} e^{-(z-\bar{z})^2/2\sigma^2}$

Rayleigh Noise

$$p(z) = \begin{cases} \frac{2}{b}(z-a)e^{(z-a)^2/b} & \text{for } z \geq a \\ 0 & \text{for } z < a \end{cases}$$

Mean: $\bar{z} = a + \sqrt{\pi b/4}$ Variance: $\sigma^2 = \frac{b(4-\pi)}{4}$

Erlang (Gamma) Noise

$$p(z) = \begin{cases} \frac{a^b z^{b-1}}{(b-1)!} e^{-az} & \text{for } z \geq 0 \\ 0 & \text{for } z < 0 \end{cases} \qquad a > 0$$

b positive integer

Mean: $\bar{z} = \frac{b}{a}$ Variance: $\sigma^2 = \frac{b}{a^2}$

Exponential Noise

$$p(z) = \begin{cases} ae^{-az} & \text{for } z \geq 0 \\ 0 & \text{for } z < 0 \end{cases}$$

(cf. Erlang noise with $b = 1$)

$a > 0$

Uniform Noise

$$p(z) = \begin{cases} \frac{1}{b-a} & \text{if } a \le z \le b \\ 0 & \text{otherwise} \end{cases}$$

Mean: $\bar{z} = \frac{a+b}{2}$ Variance: $\sigma^2 = \frac{(b-a)^2}{12}$

Bipolar impulse noise (salt-and-pepper)

$$p(z) = \begin{cases} P_a & \text{for } z = a \\ P_b & \text{for } z = b \\ 0 & \text{otherwise} \end{cases}$$

$P_a = P_b \Rightarrow$ *unipolar* noise

Arithmetic mean filter $\hat{f}(x,y) = \frac{1}{mn} \sum_{(s,t)\in S_{x,y}} g(s,t)$

Geometric mean filters $\hat{f}(x,y) = \left[\prod_{(s,t)\in S_{x,y}} g(s,t) \right]^{\frac{1}{mn}}$

Harmonic mean filter $\hat{f}(x,y) = \frac{mn}{\sum_{(s,t)\in S_{x,y}} \frac{1}{g(s,t)}}$

Contraharmonic mean filter $\hat{f}(x,y) = \frac{\sum_{(s,t)\in S_{x,y}} g(s,t)^{Q+1}}{\sum_{(s,t)\in S_{x,y}} g(s,t)^{Q}}$

Median filter $\hat{f}(x,y) = \text{median}\{g(s,t)\}_{(s,t)\in S_{xy}}$

Max filter: $\hat{f}(x,y) = \max\{g(s,t)\}_{(s,t)\in S_{xy}}$

Useful for finding the brightest points in an image

Min filter: $\hat{f}(x,y) = \min\{g(s,t)\}_{(s,t)\in S_{xy}}$

Midpoint filter $\hat{f}(x,y) = \frac{1}{2}\left[\max\{g(s,t)\}_{(s,t)\in S_{xy}} + \min\{g(s,t)\}_{(s,t)\in S_{xy}}\right]$

Inverse Filtering:

$$\hat{F}(u,v) = \frac{G(u,v)}{H(u,v)}$$

$$\hat{F}(u,v) = \frac{G(u,v)}{H(u,v)} = F(u,v) + \frac{N(u,v)}{H(u,v)}$$

Wiener filtering:

$$\begin{aligned}\hat{F}(u,v) &= \left[\frac{H^*(u,v)S_f(u,v)}{S_f(u,v)\left|H(u,v)\right|^2 + S_\eta(u,v)}\right]G(u,v)\\ &= \left[\frac{H^*(u,v)}{\left|H(u,v)\right|^2 + S_\eta(u,v)/S_f(u,v)}\right]G(u,v)\\ &= \left[\frac{1}{H(u,v)}\,\frac{\left|H(u,v)\right|^2}{\left|H(u,v)\right|^2 + S_\eta(u,v)/S_f(u,v)}\right]G(u,v)\end{aligned}$$

UNIT IV

IMAGE SEGMENTATION

PART A

1. **What is image compression?(Nov/Dec 2018)**

   Image compression refers to the process of redundancy amount of data required to represent the given quantity of information for digital image. The basis of reduction process is removal of redundant data.

2. **What is an image pyramid?(Nov/Dec2016)**

   An image pyramid is a collection of images - all arising from a single original image - that are successively down sampled until some desired stopping point is reached.. There are two common kinds of image pyramids:

   Gaussian pyramid: Used to down sample images

   Laplacian pyramid: Used to reconstruct an up sampled image from an image lower in the pyramid (with less resolution)

3. **State whether the given Huffman code 0, 10, 01, 011 for the symbol a1,a2,a3,a4 is uniquely decodable or not? (Nov/Dec2016)**

   Since the symbol for a1=0 and a2=01 are having zero as the first bit, it is not uniquely decodable.

4. **What is run-length coding?(April/May2017, MAY/JUNE 2014, NOV/DEC 2015)**

   Run-length Encoding or RLE is a technique used to reduce the size of a repeating string of characters. This repeating string is called a *run*; typically RLE encodes a run of symbols into two bytes, a symbol and count.

5. **What are the operations performed by error free compression? (April/May2017)**

   Error free compression or Lossless compression is achieved by Reducing Interpixel redundancy and Reducing Coding Redundancy.

6. **Mention the conditions for function to be called as wavelets.(Nov/Dec2017)**

   - The function integrates to zero or its Fourier transform is zero at the origin
   - The function is square integrable or has finite energy
   - The Fourier transform must satisfy the admissibility condition

7. When a code is said to be "prefix code"? Mention one advantage of prefix code. (Nov/Dec2017)

A prefix code is a type of code system distinguished by its possession of the "prefix property", which requires that there is no whole code word in the system that is a prefix (initial segment) of any other code word in the system.

For example, a code with code words {9, 55} has the prefix property; a code consisting of {9, 5, 59, 55} does not, because "5" is a prefix of "59" and also of "55"

Advantages: A prefix code is a uniquely decodable code: given a complete and accurate sequence, a receiver can identify each word without requiring a special marker between words.

8. What is Data Compression?

Data compression requires the identification and extraction of source redundancy. In other words, data compression seeks to reduce the number of bits used to store or transmit information.

9. What are two main types of Data compression?(April/May2018)

Lossless compression can recover the exact original data after compression. It is used mainly for compressing database records, spreadsheets or word processing files, where exact replication of the original is essential.

Lossy compression will result in a certain loss of accuracy in exchange for a substantial increase in compression. Lossy compression is more effective when used to compress graphic images and digitised voice where losses outside visual or aural perception can be tolerated.

10. What is the need for Compression? (NOV/DEC 2011, MAY/JUNE 2012,MAY 2013,MAY/JUNE2014)

In terms of storage, the capacity of a storage device can be effectively increased with methods that compress a body of data on its way to a storage device and decompresses it when it is retrieved. In terms of communications, the bandwidth of a digital communication link can be effectively increased by compressing data at the sending end and decompressing data at the receiving end.

At any given time, the ability of the Internet to transfer data is fixed. Thus, if data can effectively be compressed wherever possible, significant improvements of data throughput can be achieved. Many files can be combined into one compressed document making sending easier.

11. What are different Compression Methods?(April/May2018)

Run Length Encoding (RLE) Arithmetic coding Huffman coding and Transform coding.

12. Define is coding redundancy? (NOV/DEC 2015)

If the gray level of an image is coded in a way that uses more code words than necessary to represent each gray level, then the resulting image is said to contain coding redundancy.

13. Define interpixel redundancy?

The value of any given pixel can be predicted from the values of its neighbors. The information carried by is small. Therefore the visual contribution of a single pixel to an image is redundant. Otherwise called as spatial redundant geometric redundant or

14. Define compression ratio.

Compression Ratio = original size / compressed size: 1

15. Define psycho visual redundancy?

In normal visual processing certain information has less importance than other information. So this information is said to be psycho visual redundant.

16. Define source encoder

Source encoder performs three operations

- Mapper -this transforms the input data into non-visual format. It reduces the interpixel redundancy.
- Quantizer - It reduces the psycho visual redundancy of the input images .This step is omitted if the system is error free.
- Symbol encoder- This reduces the coding redundancy .This is the final stage of encoding process.

17. What is Variable Length Coding?

Variable Length Coding is the simplest approach to error free compression. It reduces only the coding redundancy. It assigns the shortest possible codeword to the most probable gray levels.

18. Define Huffman coding. (MAY/JUNE 2012, MAY/JUNE 2013)

Huffman coding is a popular technique for removing coding redundancy. When coding the symbols of an information source the Huffman code yields the smallest possible number of code words, code symbols per source symbol.

19. Define arithmetic coding

In arithmetic coding one to one corresponds between source symbols and code word doesn‘t exist where as the single arithmetic code word assigned for a sequence of source symbols. A code word defines an interval of number between 0 and 1.

20. What is bit plane Decomposition?

An effective technique for reducing an image‘s interpixel redundancies is to process the image‘s bit plane individually. This technique is based on the concept of decomposing multilevel images into a series of binary images and compressing each binary image via one of several well-known binary compression methods.

21. What are the coding systems in JPEG?

- A lossy baseline coding system, which is based on the DCT and is adequate for most compression application.
- An extended coding system for greater compression, higher precision or progressive reconstruction applications.a lossless independent coding system for reversible compression.

22. Define Lossless and lossy compression. (APR/MAY 2015)

- Lossless compression: Error free compression is the only acceptable means of data reduction, there is no loss of data. It is applicable to both binary and gray-scale image. They normally provide compression ratio ranging from 2 to 10.
- Lossy compression: It can achieve high rates of compression.But they reduce the accuracy of the reconstruction images by producing some distortions.

23. List the advantages of transform coding.(Nov/Dec2018)

Transform coding is a mathematical operation that converts a large set of highly correlated pixels into a smaller set of uncorrelated coefficients. Transformation is very useful tool in image processing. It is used to transform the image data in time domain to frequency domain. By transforming the data into frequency domain, the spatial redundancies in time domain can be minimized. The energy of the transformed data is mainly condensed in the low frequency region, and is represented by a few transform coefficients.

24. State the advantages of wavelets.(April/May2019)

- Wavelets have non-uniform frequency spectra which facilitate multi-scale analysis.
- The multi –resolution property of the wavelet transform can be used to exploit the fact that the response of the human eye is different to high and low frequency components of an image.
- DWT can be applied to an entire image without imposing block structure as used by the DCT,thereby reducing blocking artifact.

25. Define the objective fidelity criterias used for assessment in image compression.

The fidelity criterion can be broadly classified into (i) objective fidelity criterion and (ii)subjective fidelity criterion. When the level of information loss can be expressed as a function of the original or input image and the compressed and subsequently decompressed output image is said to be based on an Objective fidelity criteria.

PART B &C

1. Explain Wavelet coding system.(April/May2019)

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg 372

2. **Construct the Huffman code for the word "ILLUSION". (April/May2019)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg 440

3. **What is Lossless Predictive coding ?Expalin. (April/May2019, Nov/Dec2018)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg456

4. **Explain JPEG based image compression technique. (April/May2019)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg492

5. **Define compression and explain the general compression system model.(Nov/Dec2018)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg421

6. **Explain about Image compression standards in detail.(Nov/Dec2018,Nov/Dec2016)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg492

7. **With the neat block diagram, explain transform based on image compression scheme. Also give two valid reasons for the choice of "Discrete Cosine Transform" in JPEG image compression model. (April/May2018, Nov/Dec2017,April/May2017)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg467

8. **Explain the need for image compression. How Vector Quantization approach is used for compression? (April/May2018,Nov/Dec2016)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg459

9. **Construct Huffman code for the word "BABY'. Also compute the efficiency of Huffman code. (Nov/Dec2017)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg440

10. **Encode the sentence 'I LOVE IMAGE PROCESSING" using arithmetic coding procedure. (April/May2017)**

    Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg440

11. **Explain two dimensional discrete wavelet transform (DWT) and State the basic concepts of subband coding. (Nov/Dec2016)**

    Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg375, 354

12. **Encode the word a1, a2, a3, a4 using arithmetic code and generate the tag for the given symbol with probabilities. a1=0.2, a2=0.2, a3=0.4, a4=0.2. (Nov/Dec2016)**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg440

13. **Design a coder which a source emits letters from an alphabet A={k1,k2,k3,k4,k5} with probabilities P(k1)=p(k3)=0.2,P(k2)=0.4, P(k4)= P(k5)=0.1.Find a Huffman code for this source and the redundancy.**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg440

14. **Construct Huffman code for the word "COMMITTEE". Also compute the efficiency of Huffman code?**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg440

15. **Show the mathematical analysis of following Multi resolution expansion: Series expansion, Scaling functions and Wavelet functions. (T1-Pg 363)**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg363

Formula

Relative Data Redundancy: $R_D = 1 - \frac{1}{C_R}$

- C_R *refers to the compression ratio and is defined by:* $C_R = \frac{n_1}{n_2}$

$$L_{avg} = \sum_{k=1}^{L-1} l(r_k) p_r(r_k)$$

- ***Peak Signal to Noise Ratio (PSNR) – in decibel (dB):***

$$PSNR = 10\log_{10}\frac{(2^B-1)^2}{e_{MSE}}$$

B is the number of bits used for each pixel. (i.e.8 bits)

$$(for\ 8-bit\ images \Rightarrow PSNR = 10\log_{10}\frac{(255)^2}{e_{MSE}} = 20\log_{10}\frac{255}{e_{RMSE}}$$

- ***The mean-square signal-to-noise-ratio:***

$$SNR_{ms} = \frac{\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\hat{f}(x,y)^2}{\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\left[\hat{f}(x,y)-f(x,y)\right]^2}$$

$$E = -\sum_{j=1}^{J} P(a_j)\log P(a_j)$$

UNIT V

IMAGE COMPRESSION AND RECOGNITION

PART A

1. Define representation. Mention its types.

Representation is defined as the process of characterizing the quantity represented by each pixel. It is used to change the output of segmentation which is a raw pixel data in to a form suitable for further computer processing.

Two Types:

1.Boundary Representation 2. Regional Representation

2. What are chain codes?(April/May2017)

Chain codes are used to represent a boundary by using a connected sequence of straight –line segments with specified length and direction. In this Representation, each segment of different direction is given a different number.

3. Define convex hull.

A set 'A' is said to be convex if the straight line joining any two points in 'A' lies entirely within 'A'. The convex hull, H of an arbitrary set S is defined as the smallest convex set containing S.

4. What is meant by Thinning or Skeletonizing? (Nov/Dec2016)

A skeletonizing is a graph representation of the structural shape of a plane region,which is a regional representation. The process of generating skeletons is known as Thinning or Skeletonizing.

5. Mention the types of descriptors.

1. Boundary descriptors
2. Regional descriptors
3. Relational descriptors.

6. Give any four simple descriptors used to describe the boundary of a region.

1. Length 2.Diameter 3.Major and Minor axis 4.Eccentricity

7. **What is texture? (Nov/Dec2016)**

Texture content is an important quantity used to describe a region. The texture of a region provides measures of properties such as smoothness, coarseness and regularity.

8. Define entropy.

Entropy is defined as a measure of variability of an image. It is one of the measure of texture.

9. Define topological description.

Topology is defined as the study of properties of an image which are not affected by any deformation such as stretching, rotation. These properties will change only when there is tearing of the image. Using such properties to describe an image is called topological description.

10. What are the approaches used to describe the texture?

1. Statistical approaches: Used to characterize the texture as smooth,coarse grainy
2. Structural approaches: Based on the arrangement of image primitives.
3. Spectral approaches: Based on the properties of the fourier spectrum

11. Define cellular complex.

The set of cells enclosing a digital boundary ,described in the previous paragraphs is called cellular complex.

12. What is merging techniques.

Merging techniques based on average error or other criteria have been applied to the problem of polygon approximation.

13. Explain splitting techniques.

One approach to boundary segment splitting is to subdivide a segment successively into two parts until a specified criterion is satisfied .

14. Define signature.

A signature is a 1-D functional representative of a boundary and may be generated in various ways . One of the simplest is to plt the distance from centroid to the boundary as a function of angle.

15. Define convex deficiency .

The convex hull H of an arbitrary set S the smallest convex set containing S. The set difference H-S is called the convex deficiency.

16. What is circularity ratio?

It is defined as the ratio of area of a region to the are of a circle having the same perimeter .

17. Define topological descriptor. .(April/May2018)

Topology is the study of properties of a figure, that are unaffected by any deformation as long as there is no joining of the figure .It is also called rubber sheet distortion.

18. Define minutiae.

The fingerprint recognition is based on the interrelationship of print features.

19. Define Bayes classifier.

The classifier that minimizes the total average loss.

20. What is mean by neural network.

The essence of the material that follows is the use of multitude of the elemental nonlinear computing elements organized as networks reminiscent of the way in which neurons are believed to the interconnected in the brain.

21. Define pattern and pattern class. (April/May2017,Nov/Dec2017,April/May2018)

A pattern is a quantitative or structural description of an objective or some other entity of interest in an image. A pattern class is a family of patterns that share some common properties .Pattern classes are denoted w1, w2, ----wm, where M is the number of classes.

22. Obtain the 4 directional chain code for the shapes how in figure1. The dot in the figure represents the starting.(Nov/Dec2017)

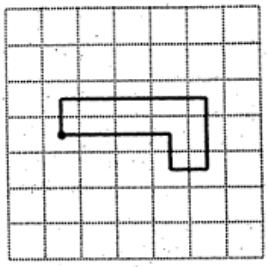


Figure 1

The chain code is 100003321222

23. Define training pattern and training set.(April/May2018,April/May2019)

The patterns used to estimate the parameters are called training patterns, and a set of such patterns from each class is called a training set.

24. What are the demerits of chain code?(Nov/Dec2018)

- The resulting chain code tends to be quite long.
- Any small disturbance along the boundary due to noise cause changes in the code that may not be related to the shape of the boundary.

25. Give the formula for diameter of boundary.(Nov/Dec2018)

The diameter of a boundary B is defined as Diam (B) =max [D (pi, pj)] i, j D-distance measure pi, pj-points on the boundary

26. What is Euler number.(April/May2019)

The Euler number is a measure of the topology of an image. It is defined as the total number of objects in the image minus the number of holes in those objects. You can use either 4- or 8-connected neighborhoods. This example computes the Euler number for the circuit image, using 8-connected neighborhoods.

PART B&C

1. **Explain in detail any two boundary representation scheme and illustrate with examples. (Nov/Dec2016)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg796

2. **Explain image recognition based on matching.(Nov/Dec2016)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg903

3. **Explain in detail about object recognition techniques based on matching. (April/May2017)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg903

4. **What is Boundary descriptor? Explain in detail.(April/May2017)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg815

5. **Write short on the following image representation techniques i) Chain code and ii) Polygonal approximation. (Nov/Dec2017,April/May2018,April/May2019)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing – Pg644,646

6. **Mention different techniques for the representation of shapes in a digital image. Explain the principle behind " Fourier Descriptor" based shape representation. (Nov/Dec2017)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing – Pg644,655

7. **Explain about Signature and Boundary segment? (ov/Dec2018)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing – Pg648,649

8. **Explain about pattern and pattern classes in detail.(Nov/Dec2018)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg693

9. **What regional descriptors are used to represent an image?Expalin.(April/May2019)**

   Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg822

10. **How patterns are recognized based on matching? Explain. .(April/May2019)**

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg861

11. What is texture?How texture features are extracted in an image. (April/May2019)

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg665

12. Explain in detail about topological feature.

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg661

13. Discuss about shape number.

Ref Book : Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing –Pg654

Reg. No. : | | | | | | | | | | | |

Question Paper Code : 80593

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Sixth Semester

Electronics and Instrumentation Engineering

IT 6005 — DIGITAL IMAGE PROCESSING

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is Machband Effect?
2. Define Checker Board Effect.
3. What is meant by bit plane slicing?
4. What is unsharp masking?
5. State the causes of degradation in an image?
6. What do you understand by Mexican hat function?
7. What is an image pyramid?
8. State whether the given Huffman code 0, 10, 01, 011 for the symbols a1, a2, a3, a4 is uniquely decodable or not?
9. What is Skeletonizing?
10. Define texture.

PART B — (5 × 16 = 80 marks)

11. (a) (i) With necessary diagrams explain how an Analog image is Converted into digital image. (8)

(ii) What is meant by image sensing? Explain in detail the construction and operation of various image acquisition devices. (8)

Or

(b) (i) What is a color model? What are its types? Explain RGB and HSI models with necessary diagrams. (12)

(ii) Explain the various distance measures used for image analysis. (4)

12. (a) (i) Briefly discuss about histogram equalization technique. (8)

(ii) Perform histogram equalization of the image. (8)

$$\begin{bmatrix} 4 & 4 & 4 & 4 & 4 \\ 3 & 4 & 5 & 4 & 3 \\ 3 & 5 & 5 & 5 & 3 \\ 3 & 4 & 5 & 4 & 3 \\ 4 & 4 & 4 & 4 & 4 \end{bmatrix}.$$

Or

(b) (i) Explain in detail the method for smoothening the image in frequency domain. (10)

(ii) Explain Gradient operators for Image Enhancement. (6)

13. (a) (i) Apply order statistics filters on the selected pixels in the image.

(ii) Explain how wiener filter is used for image restoration. (8)

$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & 1 & 2 \\ 1 & 4 & 5 \end{bmatrix}$$

Or

(b) (i) Explain the process of edge linking using Hough transform. (8)

(ii) Explain region based segmentation techniques. (8)

14. (a) (i) Explain two dimensional Discrete Wavelet Transform (DWT). (8)

(ii) Encode the word $a_1\ a_2\ a_3\ a_4$ using arithmetic code and generate the tag for the given symbol with probabilities.

$a_1 \rightarrow 0.2, a_2 \rightarrow 0.2, a_3 \rightarrow 0.4, a_4 \rightarrow 0.2$ (8)

Or

(b) What is the need for image compression? Explain image compression standards in detail. (16)

15. (a) Explain in detail any two boundary representation schemes and illustrate with examples. (16)

Or

(b) Explain image recognition based on matching. (16)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 72044

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Sixth/Seventh Semester

Information Technology

IT 6005 — DIGITAL IMAGE PROCESSING

(Common to Biomedical Engineering, Computer Science and Engineering, Electronics and Communication Engineering, Instrumentation and Control Engineering, Mechatronics Engineering, Medical Electronics, Electronics and Instrumentation Engineering)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. When is fine sampling and coarse sampling used?

2. What is the function of an image sensor?

3. Differentiate between image enhancement and restoration.

4. If all the pixels in an image are shuffled, will there be any change in the histogram? Justify your answer.

5. Why the restoration is called as unconstrained restoration?

6. Define region growing.

7. What is run length coding?

8. What are the operations performed by error free compression?

9. Does the use of chain code compress the description information of an object contour?

10. What is meant by pattern classes?

PART B — (5 × 16 = 80 marks)

11. (a) Explain the components of image processing system.

Or

(b) (i) Discuss the effects of non uniform sampling and quantization. (8)

(ii) Explain how color images are represented using HSI color space model. (8)

12. (a) Explain the various enhancement techniques performed in spatial domain.

Or

(b) If a low pass filter is formed that averages the 4-neighbours of a point (x, y) but excludes point (x, y) itself. Find the equivalent filter function $H(u, v)$ in the frequency domain. Show that it is a low pass filter.

13. (a) Derive a Wiener filter for image restoration and specify its advantages over inverse filter.

Or

(b) Explain region splitting and merging technique for image segmentation with suitable examples.

14. (a) With a neat block diagram, explain transform based Image compression scheme. Also give two valid reasons for the choice of "Discrete Cosine Transform" in JPEG image compression standard.

Or

(b) Encode the sentence 'I LOVE IMAGE PROCESSING' using arithmetic coding procedure.

15. (a) Explain in detail about the object recognition techniques based on matching.

Or

(b) Explain the various boundary descriptors in detail with a neat diagram.

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 50755

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017
Sixth/Seventh Semester
Information Technology
IT6005 – DIGITAL IMAGE PROCESSING
(Common to : Biomedical Engineering/Computer Science and Engineering/ Electronics and Communication Engineering/Electronics and Instrumentation Engineering/Instrumentation and Control Engineering/Machatronics Engineering/ Medical Electronics)
(Regulations 2013)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. Distinguish between photopic and scotopic vision.
2. Define the term "Quantization".
3. Whether two different images can have same histogram ? Justify your answer.
4. For an eight bit image, write the expression for obtaining the negative of the input image.
5. Mention two drawbacks of inverse filter.
6. Which filter will be effective in minimizing the impact of "salt and pepper" noise in an image ?
7. Mention the conditions for function to be called as wavelets.
8. When a code is said to be "prefix code" ? Mention one advantage of prefix code.

9. Obtain the 4 directional chain code for the shape shown in figure 1. The dot in the figure represents the starting point.

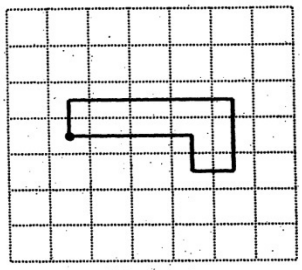


Figure 1

10. Define pattern and pattern class.

PART – B (5×16=80 Marks)

11. a) What are the elements (components) of digital image processing system ? Explain the function of each element in detail.

(OR)

b) Explain in detail about the phenomenon of image sampling. Illustrate how aliasing happens if sampling theorem is violated.

12. a) Why histogram equalization is considered as an "idempotent operation" ?

Perform histogram equalization of the image $\begin{bmatrix} 3 & 2 & 4 & 5 & 4 \\ 3 & 4 & 5 & 4 & 3 \\ 3 & 5 & 5 & 5 & 3 \\ 3 & 4 & 5 & 4 & 3 \\ 4 & 5 & 2 & 4 & 4 \end{bmatrix}$.

(OR)

b) Explain the following gray level transformation techniques in detail

i) Image negative

ii) Thresholding

iii) Gray level slicing and

iv) Logarithmic transformation.

13. a) What is the objective of image segmentation ? Explain any one of the region based image segmentation technique in detail. Mention two applications of image segmentation.

(OR)

b) Describe the image restoration technique of inverse filtering. Why inverse filtering approach fails in the presence of noise ?

14. a) Construct Huffman code for the word "BABY". Also compute the efficiency of Huffman code.

(OR)

b) With a neat block diagram, explain transform based image compression scheme. Also mention different modes in JPEG compression standard.

15. a) Write short on the following image representation techniques

i) Chain code and

ii) Polygonal approximation.

(OR)

b) Mention different techniques for the representation of shapes in a digital image. Explain the principle behind "Fourier Descriptor" based shape representation.

Question Paper Code : 41286

01/061 A

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018
Sixth/Seventh Semester
Information Technology
IT6005 – DIGITAL IMAGE PROCESSING
Common to : Biomedical Engineering/Computer Science and Engineering/ Electronics and Communication Engineering/Electronics and Instrumentation Engineering/Instrumentation and Control Engineering/Mechatronics Engineering/Medical Electronics
(Regulations 2013)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Elucidate on Quantization.
2. List color models involved in hardware.
3. Necessitate the need for transform.
4. Name the different types of derivative filters in DIF
5. How the derivatives are obtained in edge detection during formulation ?
6. How the discontinuity is detected in an image using segmentation ?
7. What are two main types of Data compression techniques in DIP ?
8. What are different compression methods in image coding ?
9. Define training pattern and training set.
0. Enumerate topological feature.

PART – B (5×13=65 Marks)

11. a) Describe the fundamental steps in image processing ?

(OR)

b) With a neat diagram explain image sensing and acquisition and also explain image acquisition using sensor arrays.

12. a) Enumerate Discrete Fourier Transform in detail.

(OR)

b) What is histogram equalization ? Discuss in detail about the procedure involved in histogram matching.

13. a) Explain adaptive filter. What are the two levels of adaptive median filtering algorithms ?

(OR)

b) i) What is inverse filtering ? Explain. 7

ii) Explain Wiener filtering for image restoration. 6

14. a) Explain how compression is achieved in transform coding and explain about DCT.

b) Explain the need for image compression. How Vector quantization approach i used for compression ?

15. a) Explain chain code in detail with an example.

Or

b) Discuss about polygonal approximations with an example.

PART C

(1×15=15 Marks)

16. a) Justify why histogram processing is called as an efficient tool for graphical representation of the total distribution in a digital image.

(OR)

b) Discuss homomorphic filtering and explain in detail how it is used in correcting non-uniform illumination in images.

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 20729

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Seventh Semester

Information Technology

IT 6005 – DIGITAL IMAGE PROCESSING

(Common to Electronics and Communication Engineering, Biomedical Engineering, Computer Science and Engineering, Electronics and Instrumentation Engineering, Instrumentation and Control Engineering, Mechatronics Engineering, Medical Electronics)

(Regulations 2013)

(Also Common to PTIT 6005 — Digital Image Processing – for B.E. Part-Time – Sixth Semester – Electronics and Communication Engineering – Regulations 2014)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List the applications of color models.
2. Differentiate photopic and scotopic vision.
3. What is the purpose of image averaging?
4. Define masking.
5. Give the relation for Gamma noise and Exponential noise.
6. What is segmentation? Write the applications of segmentation.
7. What is image compression?
8. List the advantages of transform coding.
9. Mention the demerits of chain code.
10. Give the formula for diameter of boundary.

PART B — (5 × 13 = 65 marks)

11. (a) Briefly discuss about the elements of Digital Image Processing system.

Or

(b) Discuss in detail about the relationships between pixels.

12. (a) Discuss about Smoothing and Sharpening Spatial Filtering in detail.

Or

(b) Write short notes on ideal Butterworth and Gaussian Filters.

13. (a) Explain in detail about various Mean filters.

Or

(b) Explain about the process of edge linking and boundary detection in detail.

14. (a) Define Compression and explain the general compression system model.

Or

(b) Explain in full detail about Lossless predictive coding.

15. (a) Write short notes on following :

(i) Signatures

(ii) Boundary Segments.

Or

(b) Describe in detail about Patterns and Pattern Classes.

PART C — (1 × 15 = 15 marks)

16. (a) Explain the principle of Region splitting and merging in detail.

Or

(b) Explain about Compression Standards in detail.

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 53226

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Sixth/Seventh Semester

Information Technology

IT 6005 — DIGITAL IMAGE PROCESSING

(Common to Biomedical Engineering/Computer Science and Engineering/ Electronics and Communication Engineering/Electronics and Instrumentation Engineering/Instrumentation and Control Engineering/ Mechatronics Engineering/Medical Electronics)

(Regulation 2013)

(Also common to PTIT 6005 – Digital Image Processing for B.E. (Part-Time) Sixth Semester – Electronics and Communication Engineering – Regulation 2014)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define spatial resolution. How it is represented quantitatively?
2. What is the memory required to store a 512*512 RGB image of 8 bit resolution?
3. What is histogram? How is it generated for an image
4. How negative of an image is obtained?
5. Give the 3 × 3 mask to detect horizontal line in an image.
6. How an image is segmented using thresholding?
7. State the advantages of Wavelets.
8. Define the objective fidelity criterias used for assessment in image compression.
9. What is Euler number?
10. Distinguish between pattern and pattern class.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Derive 2D sampling theorem and describe proper reconstruction of an image. (8)

(ii) Discuss the fundamental steps in digital image processing. (5)

Or

(b) (i) How an image is quantized? Explain. What is the effect on the image quantization levels if it is reduced? (7)

(ii) What is HSI color model? How an RGB image is converted into HSI? Explain. (6)

12. (a) (i) Perform histogram equalization of the image (8)

Gray levels r_k	0	1	2	3	4	5	6	7
No.of pixels p_k	6	8	11	12	3	5	15	6

(ii) How contrast stretching and intensity level slicing is performed on an image? Explain. (5)

Or

(b) (i) How low-pass and high-pass filtering is performed in frequency domain given an image? Explain. (8)

(ii) Apply spatial high-pass filter for the marked pixels in the image. (5)

$$\begin{pmatrix} 1 & 2 & 3 \\ 4 & \boxed{3} & 2 \\ 1 & \boxed{5} & 6 \end{pmatrix}$$

13. (a) (i) How image restoration is performed using Wiener filter? Explain. (8)

(ii) Apply a suitable filter for the marked pixels in the image, which is corrupted by salt and pepper noise. (5)

$$\begin{pmatrix} 2 & 4 & 6 \\ 4 & 255 & \boxed{0} \\ 3 & \boxed{255} & 6 \end{pmatrix}$$

Or

(b) (i) Discuss the behavior of first and second order derivatives for a step and ramp edge. (8)

(ii) How an image is segmented using region growing technique? Explain. (5)

14. (a) (i) Explain Wavelet coding system. (5)

(ii) Construct the Huffman code for the word "ILLUSION" (8)

Or

(b) (i) What is Lossless predictive coding? Explain. (6)

(ii) Explain JPEG based image compression technique. (7)

15. (a) (i) How to represent boundaries using chain code? Explain. (7)

(ii) What is texture? How texture features are extracted in an image? (6)

Or

(b) (i) What regional descriptors are used to represent an image? Explain. (6)

(ii) How patterns are recognized based on matching? Explain. (7)

PART C — (1 × 15 = 15 marks)

16. (a) Design a system for recognition of number plates in vehicles using image processing techniques. Suggest a suitable algorithm for each step.

Or

(b) Design a system for detecting driver drowsiness using image processing techniques. Suggest a suitable algorithm for each step.
