DEPARTMENT OF ECE

EC 708 DIGITAL IMAGE PROCESSING

(7^{TH} SEMESTER)

2 MARKS

UNIT 1

DIGITAL IMAGE FUNDAMENTALS

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

2. What is Dynamic Range?

The range of values spanned by the gray scale is called dynamic range of an image. Image will have high contrast, if the dynamic range is high and image will have dull washed out gray look if the dynamic range is low.

3. What do you meant by Color model?

A Color model is a specification of 3D-coordinates system and a subspace within that system where each color is represented by a single point.

4. List the hardware oriented color models and List the applications of color models?

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

1. RGB model--- used for color monitor & color video camera
2. CMY model---used for color printing
3. HIS model----used for color image processing

5. What is Hue & saturation?

Hue: hue is an attribute associated with the dominant wavelength in a mixture of light waves.It represents the dominant color as perceived by the observer.

Saturation:It represents relative purity or the amount of white light mixed with hue.the degree of saturation depends on the amount of white light added.

Red+white=pink

Violet +white =lavender

6. What is meant by pixel?

A 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.

7. What are the steps involved in DIP?

1. Image Acquisition
2. Preprocessing
3. Segmentation
4. Representation and Description
5. Recognition and Interpretation

8. Specify the elements of DIP system and Explain the categories of digital storage?

1. Image Acquisition
2. Storage
3. Processing
4. Display

1. Short term storage for use during processing.
2. Online storage for relatively fast recall.
3. Archical storage for infrequent access.

9. What is meant by machband effect and simultaneous contrast?

*Machband 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.

*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

10. Define weber ratio

The ratio of increment of illumination to background of illumination is called as weber ratio.(ie) _i/i

If the ratio (_i/i) is small, then small percentage of change in intensity is needed (ie) good brightness adaptation.

If the ratio (_i/i) is large , then large percentage of change in intensity is needed (ie) poor brightness adaptation.

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

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

12. Write the expression to find the number of bits to store a digital image?

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

13. What is Image Transform and what are the applications

An image can be expanded in terms of a discrete set of basis arrays called basis images. These basis images can be generated by unitary matrices. Alternatively, a given NxN image can be viewed as an N^2x1 vectors. An image transform provides a set of coordinates or basis vectors for vector space.
Applications:
1) To reduce band width
2) To reduce redundancy
3) To extract feature.

15.What is the need for transform?

The need for transform is most of the signals or images are time domain signal (ie) signals can be measured with a function of time. This representation is not always best. For most image processing applications anyone of the mathematical transformation are applied to the signal or images to obtain further information from that signal.

16. What do you meant by Zooming and shrinking of digital images?

Zooming may be viewed as over sampling. It involves the creation of new pixel locations and the assignment of gray levels to those new locations.

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

17.What is photoconductive principle?

According to this principle the resistance of the target material decreases when exposed to light.vidicon camera works on this principle

18.what is image lag?

The time delay in establishing a new signal current in the camera to follow the rapid changes in the target illumination is called image lag or lag. The two types of lag are

1.Photoconductive Lag
2.Capacitive Lag

18. **Define Resolutions?**

Resolution is defined as the smallest number of discernible detail in an image.
Spatial resolution is the smallest discernible detail in an image and gray level resolution refers to the smallest discernible change is gray level

19. Differentiate photopic and scotopic vision?

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

20. 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.

UNIT 3

IMAGE RESTORATION

1.What is meant by Image Restoration?

Restoration attempts to reconstruct or recover an image that has been degraded by using a clear knowledge of the degrading phenomenon.

2. What are the two properties in Linear Operator?

Additivity

Homogenity

3. Explain additivity property in Linear Operator?

$H[f_1(x,y)+f_2(x,y)]=H[f_1(x,y)]+H[f_2(x,y)]$

The additive property says that if H is the linear operator,the response to a sum of two is equal to the sum of the two responses

5. What is concept algebraic approach?

The concept of algebraic approach is to estimate the original image which minimizes a predefined criterion of performances.

6. What are the two methods of algebraic approach?

o Unconstraint restoration approach

o Constraint restoration approach

7.Why the restoration is called as unconstrained restoration?

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

8.What are the three methods of estimating the degradation function?

1. Observation
2. Experimentation
3. Mathematical modeling.

9.What is inverse filtering?

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)

10. What is pseudo inverse filter?

It is the stabilized version of the inverse filter.For a linear shift invariant system with frequency response H(u,v) the pseudo inverse filter is defined as

H(u,v)=1/(H(u,v) H=/0

0 H=0

11.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.

12.Give the difference between Enhancement and Restoration?

Restoration attempts to reconstruct or recover an image that has been degraded by using a clear knowledge of the degrading phenomenon.

The objective of enhancement technique is to process an image so that the result is more suitable than the original image for a particular application.

13.What is a weiner filter?

It removes the blur and noise. Blur effect can be removed by LPF/HPF. Wiener filter is called as an optimum or least mean square filter.

Minimum mean square error

f – Original image

$\hat{f}$ – Reconstructed image

14.What are the two approaches for blind image restoration?

Direct measurement

Indirect estimation

15. What is meant by Direct measurement?

In direct measurement the blur impulse response and noise levels are first estimated from an observed image where this parameter are utilized in the restoration .

16. What is blur impulse response and noise levels?

Blur impulse response: This parameter is measured by isolating an image of a suspected object within a picture.

Noise levels: The noise of an observed image can be estimated by measuring the image covariance over a region of constant background luminence.

17. What is meant by indirect estimation?

Indirect estimation method employ temporal or spatial averaging to either obtain a restoration or to obtain key elements of an image restoration algorithm.

18.what are geometric transformations?

The transformations used for image restoration are called geometric transformations.they modify the spatial relationship between the pixels.the two basic operation of the geometric transformations are Spatial transformation and gray level interpolation

19.what is spatial transformations?

These are methods based on the arrangement of pixels in the image.the transformations may be expressed as

$X'=r(x,y)$

Y’=s(x,y)

Where r(x,y) and s(x,y) are spatial transformations to produce the image g(X’,Y’)

20.what is gray level interpolation?

Gray-level interpolation deals with the assignment of gray levels to pixels in the spatially transformed image

UNIT 4
IMAGE SEGMENTATION

1. What is segmentation?

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.

2. Write the applications of segmentation.

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

3. What are the three types of discontinuity in digital image?

Points, lines and edges.

4. How the derivatives are obtained in edge detection during formulation?

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.

5. Write about linking edge points.

The approach for linking edge points is to analyze the characteristics of pixels in a small neighborhood (3x3 or 5x5) about every point (x,y)in an image that has undergone edge detection. All points that are similar are linked, forming a boundary of pixels that share some common properties.

6. What are the two properties used for establishing similarity of edge pixels?

(1) The strength of the response of the gradient operator used to produce the edge pixel.

(2) The direction of the gradient.

7. 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.

8. Give the properties of the second derivative around an edge?

* 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.

9. Define Gradient Operator?

First order derivatives of a digital image are based on various approximation of the 2-D gradient. The gradient of an image f(x,y) at location(x,y) is defined as the vector

Magnitude of the vector is
$\_f=mag(\_f)=[Gx^2+Gy^2]^{1/2}$
$\_(x,y)=\tan^{-1}(Gy/Gx)$
$\_(x,y)$ is the direction angle of vector _f

10. What is meant by object point and background point?

To execute the objects from the background is to select a threshold T that separate these modes. Then any point (x,y) for which f(x,y)>T is called an object point. Otherwise the point is called background point.

11. What is global, Local and dynamic or adaptive threshold?

When Threshold T depends only on f(x,y) then the threshold is called global . If T depends both on f(x,y) and p(x,y) is called local. If T depends on the spatial coordinates x and y the threshold is called dynamic or adaptive where f(x,y) is the original image.

12. Define region growing?

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?

This method is a top-down approach. In this method the whole image is divided into various regions and the process is continued until the criteria are satisfied. The splitting criteria are based on the difference.

i.e. if $Q(R_i)$ = false (difference), then split is done.
if $Q(R_i)$ = true(similarity), then stop the process.
Where Q is a predicate and R_i is the region.
After splitting if $R_i \cap R_j \neq 0$, then similarity is said to exist between R_i and R_j and they are merged together until no similarity exists.

14. What is meant by markers?

An approach used to control over segmentation is based on markers.
marker is a connected component belonging to an image. We have internal markers, associated with objects of interest and external markers associated with background.

15.What is region growing?

This method moves from lower level to higher level. So it can be said to be a bottom-up approach. From the entire image, some pixels are selected based on some criteria and these pixels are said to be as the seed pixels. Then these seed pixels are compared with other pixels in the image. If they are similar then the pixel is added with the seed. Thus the region grows until saturation is reached. Thus the region growing method group the pixels or sub regions into large regions based on predefined criteria.

16.What are the application of region splitting method?

(i)Medical image analysis

(ii)Defect identification

17.What is a catchment basin?

The set of points at which a drop of water ,if placed at any of these points would fall with certainity to a single minimum is called catchment basin or watershed basin

18.What are watershed lines?

The lines formed by points at which the water would be equally likely to fall to more than one such minimum are called watershed lines or divide lines.

19.What is the basic principle of operation in dam construction ?

Dilation is the basic principle of operation in dam construction.dilation means expansion.

20.What are the various masks used to find the gradient?

- Sobel masks
- Roberts masks
- Laplacian masks
- prewitt masks

UNIT 5
IMAGE COMPRESSION

1. What is image compression?

Image compression refers to the process of minimizing the number of bits required to represent an image The basis of reduction process is removal of redundant data
.

2. 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.

3. What are two main types of Data compression?

• 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.

4. What is the need for Compression?

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.

5. What are different Compression Methods?

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

6. What is run length coding?

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 count and a symbol. RLE can compress any type of data regardless of its information content, but the content of data to be compressed affects thecompression ratio. Compression is normally measured with the compression ratio

7. Define compression ratio.

Compression Ratio = original size / compressed size

8.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.

9. Define Huffman coding

• 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.

10.What are the coding systems in JPEG?

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

11. What is JPEG?

The acronym is expanded as "Joint Photographic Expert Group". It is an international standard in 1992. It perfectly Works with color and grayscale images
,

12.What are the basic steps in JPEG?

The main steps in JPEG encoding are

i) Color transformation
ii) Sub sampling the color information
iii) Tiling and DCT
iv) Quantization
v) Zig zag ordering and Run length encoding
vi) Entropy encoding
vii)

13.Define I-frame

I-frame is Intraframe or Independent frame. An I-frame is compressed independently of all frames. It resembles a JPEG encoded image. It is the reference point for the motion estimation needed to generate subsequent P and P-frame.

14.. Define P-frame

P-frame is called predictive frame. A P-frame is the compressed difference between the current frame and a prediction of it based on the previous I or P-frame

15.. Define B-frame

B-frame is the bidirectional frame. A B-frame is the compressed difference between the current frame and a prediction of it based on the previous I or P-frame or next P-frame. Accordingly the decoder must have access to both past and future reference frames.:

16.What is arithmetic coding?Give its advantages &disadvantages

Arithmetic coding provides error free compression Instead, an entire sequence of source symbols is assigned a symbol arithmetic codeword. The codeword itself defines an interval of real numbers between 0 & 1.

Advantages of arithmetic coding:

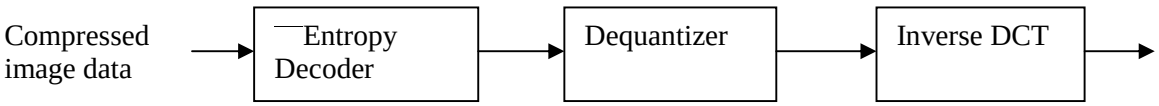
1.Advantageous for small alphabet size and highly skewed probabilities.
2.Easy to implement a system with multiple arithmetic codes
3.Easy to adapt arithmetic codes to changing input statistics.
4.The most important advantage of arithmetic coding is its flexibility: it can be used in conjunction with any model that can provide a sequence of event probabilities.
5. The other important advantage of arithmetic coding is its optimality.

Disadvantages of arithmetic coding:

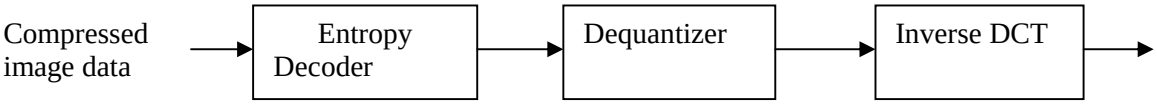
1. The main disadvantage of arithmetic coding is that it tends to be slow.
2. Other codings are faster because the model is represented directly in the data structures.

17.Draw the block diagram for JPEG encoder and decoder

encoder



decoder



18.What is JPEG 2000?

JPEG 2000 is an image compresion standard and coding system. The JPEG 2000 is an advanced version of the JPEG standard . In JPEG standard ,discrete cosine transform is used , which is replaced in JPEG 2000 by discrete wavelet transform

19.Draw the block diagram for intra frame encoder and decoder?

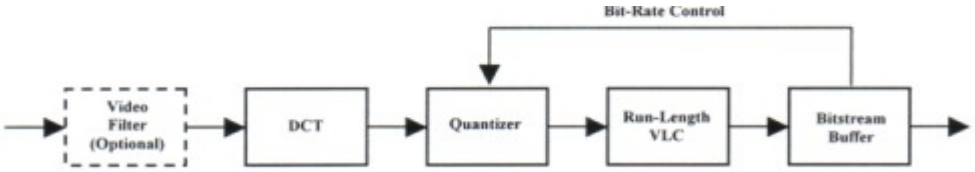


Figure 1: Intra Frame Encoder

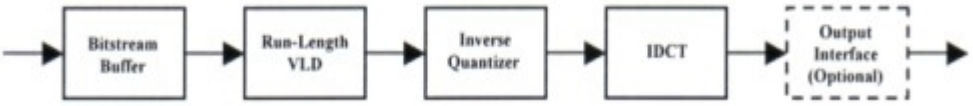


Figure 23: Intra Frame Decoder

20.What is vector quantization?

Vector Quantization is a process by which several signal samples are grouped together to form block of data (vectors) and is mapped into a digital sequence.The number of blocks depend on the accuracy required.

The block diagram of vector quantization is as follow