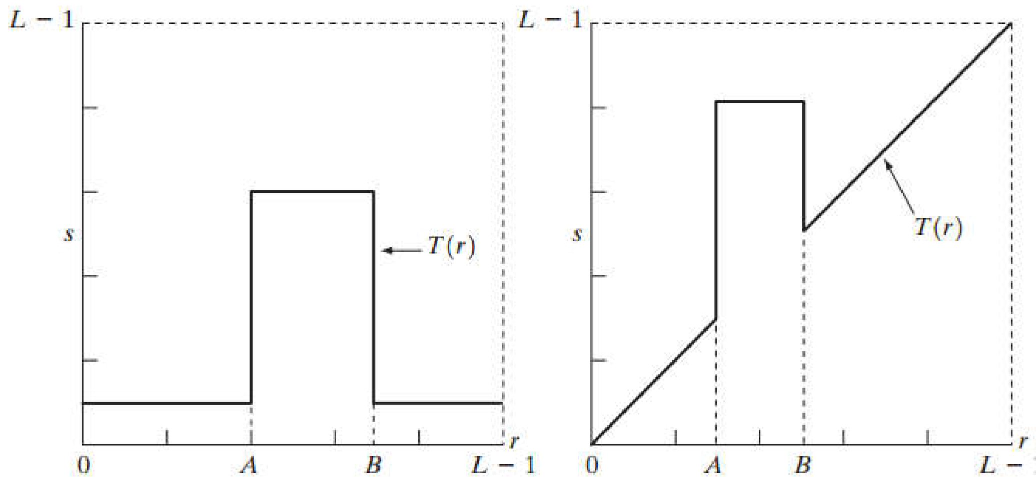
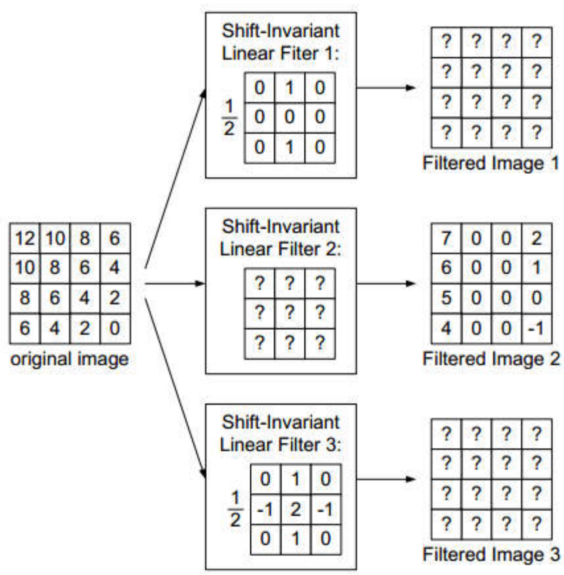
Question for exam 1:

1.what is the name of this transformation and explain how it works?



2.

3. A 4×4 gray-scale original image passes through three spatial linear shift-invariant filters, resulting in three filtered images



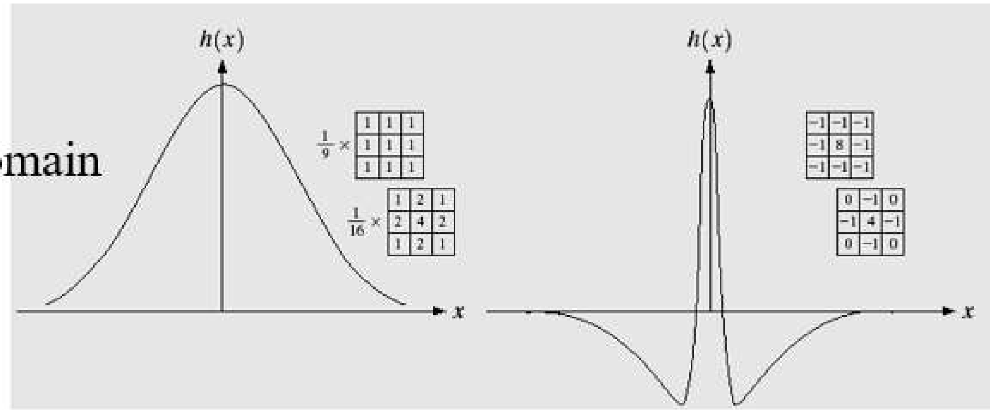
(*a*) Compute Filtered Image 1 (Use zero-padding of the original image).

(*b*) Compute Filtered Image 3 (Use zero-padding of the original image).

(*c*) Based on relationship between Filtered Image 1, Filtered Image 2, and Filtered Image 3, determine the filter coefficients in Shift-Invariant Linear Filter 2.

3.Im not sure but something was in the exam like explain low and high pass filter and give one example for exch one?

spatial domain



Low-pass high-pass

4.

Question: how can we operate on the frequency components of illumination and reflectance?

Answer:

Frequency Domain: Homomorphic Filtering

Recall that the image is formed through the multiplicative illumination-reflectance process:

$$f(x,y) = i(x,y)r(x,y)$$

where *i(x,y)* is the illumination and *r(x,y)* is the reflectance component

Question: how can we operate on the frequency components of illumination and reflectance?

Recall that: $FT[f(x,y)] \neq FT[i(x,y)]\, FT[r(x,y)]$

Let's make this transformation:

$$z(x,y) = \ln(f(x,y)) = \ln(i(x,y)) + \ln(r(x,y))$$

Then $FT[z(x,y)] = FT[\ln(f(x,y))] = FT[\ln(i(x,y))] + FT[\ln(r(x,y))]$ *or*

$$Z(u,v) = F_i(u,v) + F_r(u,v)$$

Z(u,v) can then be filtered by a *H(u,v),* i.e.

$$S(u,v) = H(u,v)Z(u,v) = H(u,v)F_i(u,v) + H(u,v)F_r(u,v) \qquad 4.17$$

$$s(x, y) = \Im^{-1}\{S(u, v)\} = \Im^{-1}\{H(u, v)F_i(u, v)\} + \Im^{-1}\{H(u, v)F_r(u, v)\}. \quad (4.5\text{-}6)$$

By letting

$$i'(x, y) = \Im^{-1}\{H(u, v)F_i(u, v)\} \quad (4.5\text{-}7)$$

and

$$r'(x, y) = \Im^{-1}\{H(u, v)F_r(u, v)\}, \quad (4.5\text{-}8)$$

Eq. (4.5-6) can be expressed in the form

$$s(x, y) = i'(x, y) + r'(x, y). \quad (4.5\text{-}9)$$

Finally, as $z(x, y)$ was formed by taking the logarithm of the original image $f(x, y)$, the inverse (exponential) operation yields the desired enhanced image, denoted by $g(x, y)$; that is,

$$\begin{aligned} g(x, y) &= e^{s(x,y)} \\ &= e^{i'(x,y)} \cdot e^{r'(x,y)} \\ &= i_0(x, y)r_0(x, y) \end{aligned} \quad (4.5\text{-}10)$$

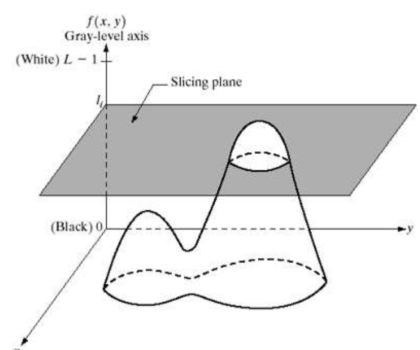
where

$$r_0(x, y) = e^{r'(x,y)} \qquad i_0(x, y) = e^{i'(x,y)} \quad (4.5\text{-}11)$$ 4.18

5.there was a question about pseudocolor image processing and we were given this figure and we had to explain the method.

Chapter 6

Color Image Processing: **Intensity slicing**



assign different colors to levels above and below the slicing plane

usually, several levels are used.

FIGURE 6.18 Geometric interpretation of the intensity-slicing technique.

6. explain wiener filter?

Image Restoration: Wiener Filtering

Remark:

Inverse and pseudo-inverse filtering reverse the effects of system only; but can do nothing about the random noise in the signal.

Alternative Solution: Wiener Filtering

Wiener filtering has been successfully used to filter images corrupted by noise and blurring. The idea of Wiener filtering is to find the "best" estimate of the true input $u(m,n)$ from the observed image $v(m,n)$ by modeling the input and output images as random sequences.

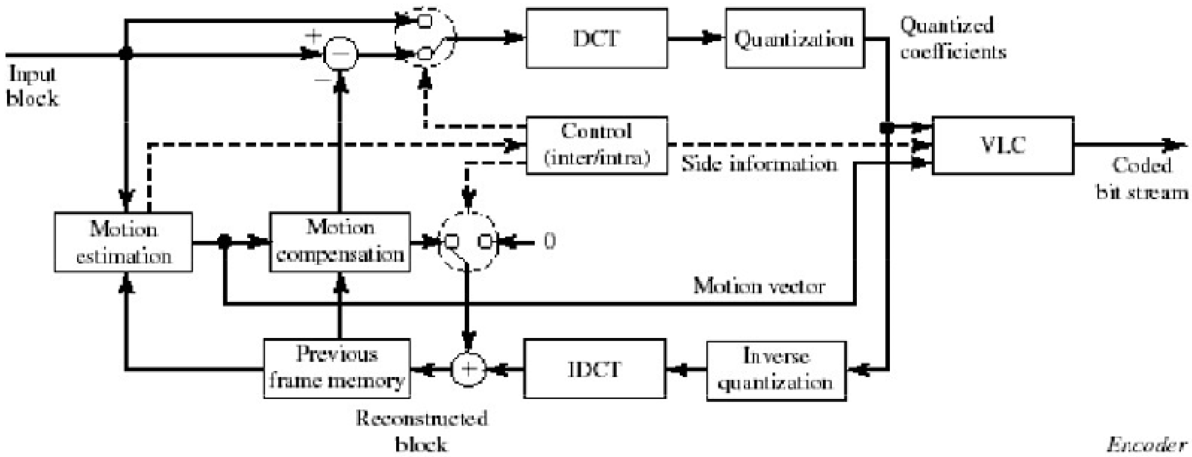
"best" in the mean square error sense.

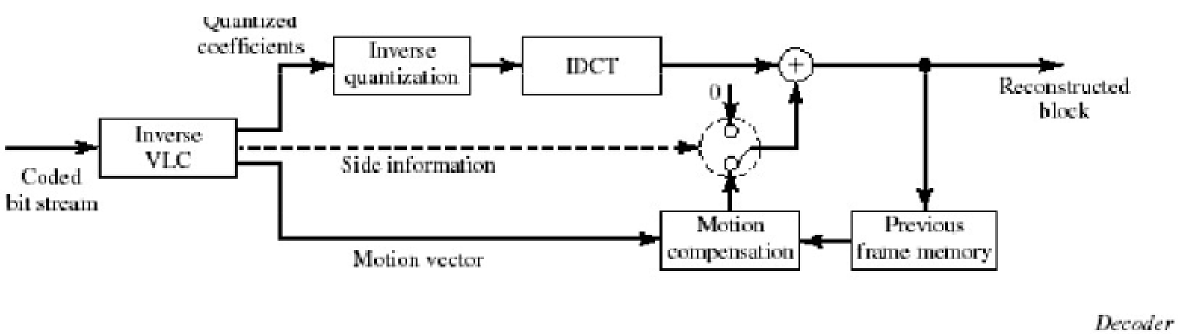
Image Restoration: Wiener Filtering

Interpretation of the Wiener Filter

- In the absence of blur, H=1, the Wiener filter becomes a smoothing filter (work it out)
- When there is no noise, the Wiener filter reduces to the inverse filter (work it out)
- When both noise and blur are present, the Wiener filter seeks a compromise between: lowpass noise smoothing, and highpass deblurring; the result is a bandpass filter. However, deblurring decreases rapidly as the noise power increases. Experiment with this!

7.draw the block diagram of encoder or decoder (I don't remember which one was asked)? And explain each block briefly?





Question for third exam:

1. a and b part: what is the name of this transformation and explain how it works?

C to F part:

First and Last Name: ______________

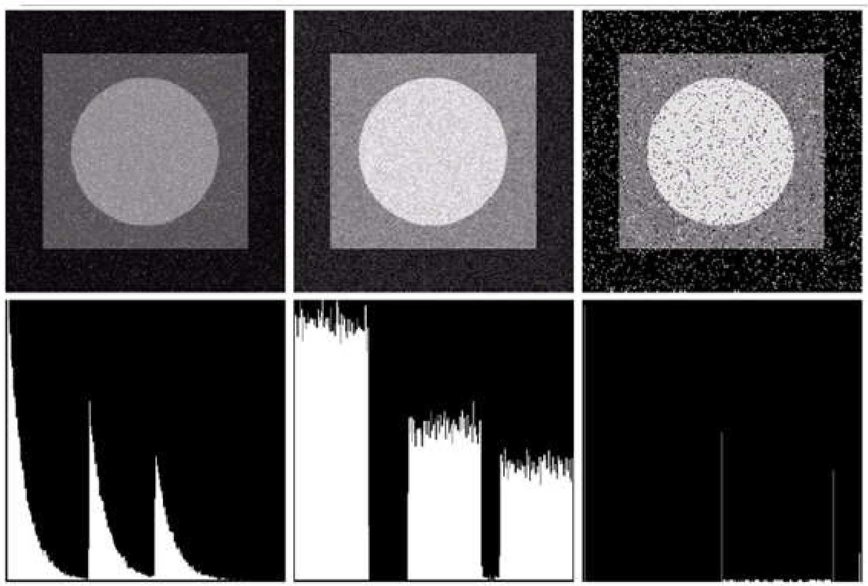
c. What will be the effect of applying histogram equalization to a dark image?
Ans: The intensity values in the output image will be spread to the entire range of intensity values. The contrast of the image will be increased.

d. What is histogram matching? How is it related to histogram equalization?
Ans: Histogram matching is the process of transforming the histogram of a reference image to be as similar as possible to a given target image histogram. Histogram matching can be accomplished by applying histogram equalization twice, one to the reference image and one to the target image. Then, use the inverse transform of the reference image histogram equalization to map points from the equalized reference image histogram to the original target image histogram.

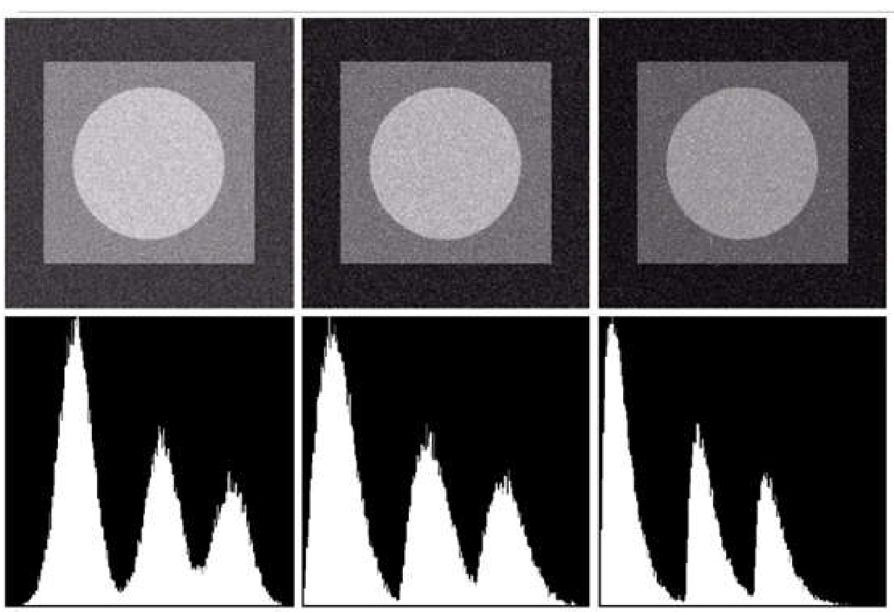
e. In which cases is zero-padding necessary when applying DFT?
Ans: Zero padding must be used to compute linear convolution and avoid mixing in the case of circular convolution. Zero padding is also necessary for implementing fast DFT (FFT) in which the input signal is padded with zero to have a length that is a power of 2.

f. In a given application an averaging mask is applied to input images to reduce noise, and then a Laplacian mask is applied to enhance small details. Would the result be the same if the order of the operations were reversed?
Ans: Yes since both operations are linear.

2.we have and image and we add guassian, uniform and impulse noise.draw the histogram of each noisy image.



Exponential Uniform Salt & Pepper



Gaussian Rayleigh Gamma

3.write the expression for bandreject filters ?

Bandreject filters remove or attenuate a band of frequencies about the origin of the Fourier transform. An ideal bandreject filter is given by the expression

$$H(u,v) = \begin{cases} 1 & \text{if } D(u,v) < D_0 - \dfrac{W}{2} \\ 0 & \text{if } D_0 - \dfrac{W}{2} \le D(u,v) \le D_0 + \dfrac{W}{2} \\ 1 & \text{if } D(u,v) > D_0 + \dfrac{W}{2} \end{cases} \tag{5.4-1}$$

where $D(u,v)$ is the distance from the origin of the centered frequency rectangle, as given in Eq. (4.3-3), W is the width of the band, and D_0 is its radial center. Similarly, a Butterworth bandreject filter of order n is given by the expression

$$H(u,v) = \frac{1}{1 + \left[\dfrac{D(u,v)W}{D^2(u,v) - D_0^2}\right]^{2n}} \tag{5.4-2}$$

and a Gaussian bandreject filter is given by

$$H(u,v) = 1 - e^{-\frac{1}{2}\left[\frac{D^2(u,v) - D_0^2}{D(u,v)W}\right]^2}. \tag{5.4-3}$$

4 and 5:

Problem 3. (10 points)

How can we apply the Fourier Transform to a 2D signal f(x,y) by using 1D FT? Write the mathematical expression to derive F(u,v) (the FT of f(x,y)) using 1D FT.

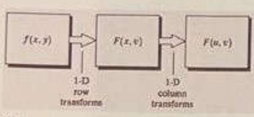


FIGURE 4.35 Computation of the 2-D Fourier transform as a series of 1-D transforms.

Separability

The discrete Fourier transform in Eq. (4.2-16) can be expressed in the separable form

$$\begin{aligned} F(u,v) &= \frac{1}{M}\sum_{x=0}^{M-1} e^{-j2\pi ux/M}\,\frac{1}{N}\sum_{y=0}^{N-1} f(x,y)e^{-j2\pi vy/N} \\ &= \frac{1}{M}\sum_{x=0}^{M-1} F(x,v)e^{-j2\pi ux/M} \end{aligned} \tag{4.6-14}$$

where

$$F(x,v) = \frac{1}{N}\sum_{y=0}^{N-1} f(x,y)e^{-j2\pi vy/N}. \tag{4.6-15}$$

Problem 4. (9 points)

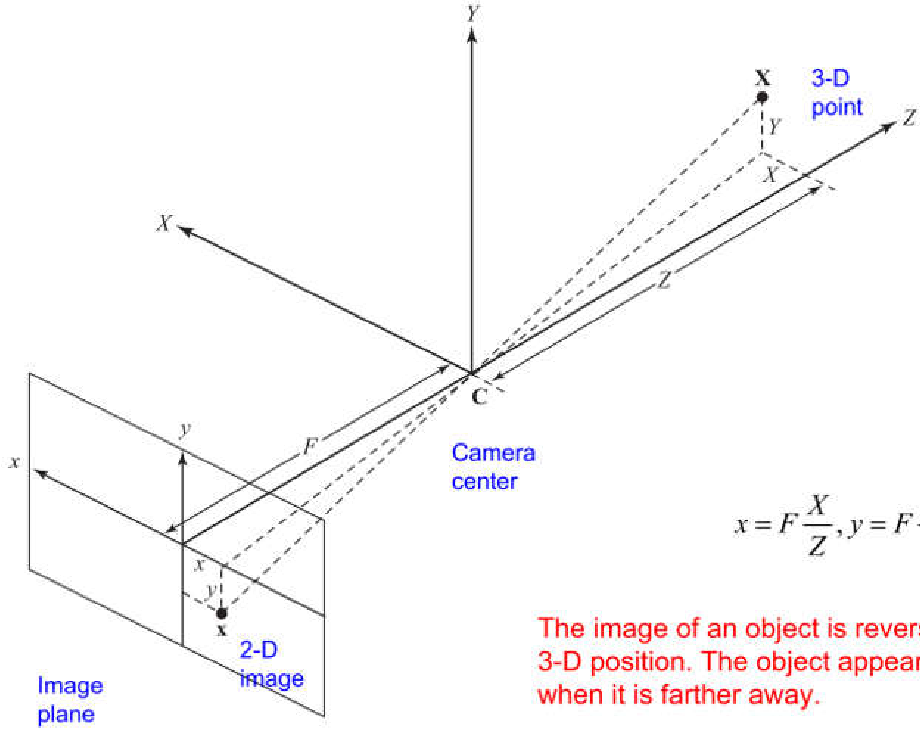
Describe briefly the types of redundancy used in video compression. How can we exploit each of them for video compression?

a. Perceptual redundancy → we can discard (or encode with fewer bits) intensities or color components (e.g. chromaticity) based on the properties of the human visual system.

b. Spatial redundancy → neighboring pixels are more likely to have similar colors. We can predict their values based on those of their neighbors.

c. Time redundancy → the content of successive video frames changes slowly. We can predict the next frame based on the previous (to some extend).

6. draw the perspective projection model.



$$x = F\frac{X}{Z}, y = F\frac{Y}{Z}$$

The image of an object is reversed from its 3-D position. The object appears smaller when it is farther away.