DIP LECTURE (Problems)

Consider the two image subsets, S_1 and S_2, shown in the following figure. For $V = \{1\}$, determine whether these two subsets are (a) 4-adjacent, (b) 8-adjacent, or (c) m-adjacent.

S_1 S_2

0	0	0	0	0	0	0	1	1	0
1	0	0	1	0	0	1	0	0	1
1	0	0	1	0	1	1	0	0	0
0	0	1	1	1	0	0	0	0	0
0	0	1	1	1	0	0	1	1	1

SOLUTION: (a) Condition: The two pixel must belongs to subset V, In this particular case, The S_1 and S_2 has two pixels following The condition.

S_1 S_2

0	0	0	0	0	0	0	1	1	0
1	0	0	1	0	0	1	0	0	1
1	0	0	1	0	1 (q)	1	0	0	0
0	0	1	1	1 (p)	0	0	0	0	0
0	0	1	1	1	0	0	1	1	1

$N_4(p)$ $N_8(p)$ $N_D(p)$

(a) Are p and q 4-adjacent?

We have to check two conditions:

i) Both have The value from V.

ii) q should like in $N_4(P)$. This condition fails

Hence P and q aren't 4-adjacent.

(b) 8-adjacents: (i) q should lie in $N_8(P)$.

(ii) P and q have the value from V.

* q lie in $N_8(P)$, therefore p and q are 8-adjacent.

(c) m-adjacent: (i) q should be in $N_D(P)$.

(ii) $N_4(P) \cap N_4(Q) = \phi$

* Yes, q lie in $N_D(P)$
* Yes $N_4(P) \cap N_4(Q) = \phi$ So,

p and q are m-adjacent.

Consider the image segment shown.

★**(a)** Let $V = \{0, 1\}$ and compute the lengths of the shortest 4-, 8-, and m-path between p and q. If a particular path does not exist between these two points, explain why.?

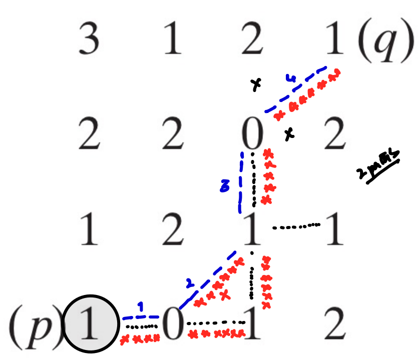
(b) Repeat for $V = \{1, 2\}$.

	3	1	2	1 (q)
	2	2	0	2
	1	2	1	1
(p)	1	0	1	2

(a) For $V = \{0, 1\}$

(i) 4-path: p and q can't established 4-path using 4-adjancey having the values of V.

(ii) 8path: The length of 8-path is "4"



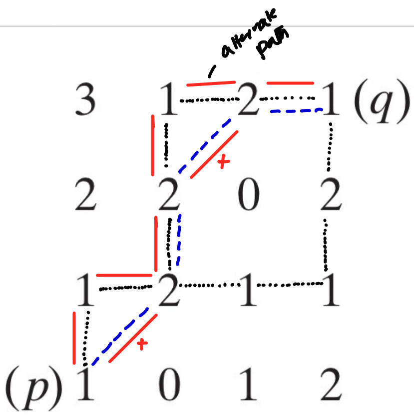
(iii) m-path: The length of m-path is "5"

Now for $V = \{1, 2\}$

(i) 4-path: Length = 6 (Not Unique)

(ii) 8-path: Length = 4

(iii) m-path: Length = 6



⊙ Let P and Q be the pixel at coordinate (10,12) & (15,20) respectively, find out which distance measure gives the min distance between the pixels.

Sol: Suppose $p(x,y) = (10,12)$ and $Q(s,t) = (15,20)$

(a) Euclidean distance:

$$D_e(P,Q) = [(x-s)^2 + (y-t)^2]^{1/2}$$
$$= [(10-15)^2 + (12-20)^2]^{1/2}$$
$$= [5^2 + 8^2]^{1/2} = (25+64)^{1/2} \simeq 9.$$

(b) D_4 distance: $D_4(P,Q) = |x-s| + |Y-t|$
$$= |10-15| + |12-20|$$
$$= 5 + 8 = 13$$

(c) D_8 distance: $D_8(P,Q) = \text{Max}[|x-s|, |y-t|]$
$$= \text{Max}[|10-15|, |12-20|]$$
$$= \text{Max}[|-5|, |-8|]$$
$$= \text{Max}[5, 8]$$
$$= 8$$

Hence, $D_8(P,Q)$ is the minimum distance between P & Q.

Q: Find 8-path & m-path for the following 2-D section with V = {0,1} & V = {1,2} between the P & Q.

	5	4	3	1	1 (q)
	5	4	0	2	0
	3	2	0	2	4
	2	1	1	3	5
(P)	1	3	5	1	3

Sol: For V = {0,1}

(a) 8-path: Length = 5

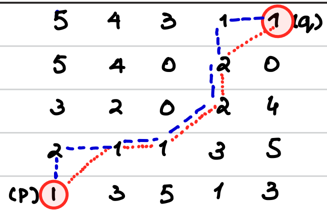
(b) m-path: Length = 6

	5	4	3	1	1 (q)
	5	4	0	2	0
	3	2	0	2	4
	2	1	1	3	5
(P)	1	3	5	1	3

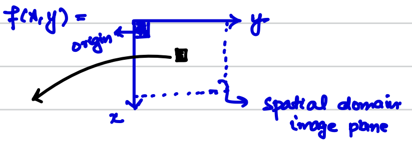
- For $V = \{1, 2\}$

(i) 8-path : Length = 5

(ii) m-path : Length = 7



Spatial Domain And Frequency Domain:

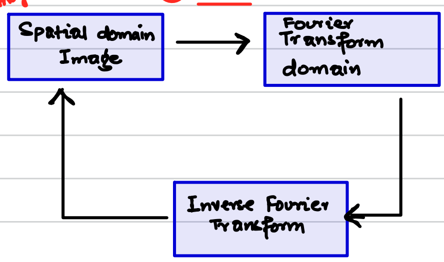


We can directly manipulate a single pixel in spatial domain However, it is not possible in frequency domain.

However, in frequency domain, we do not deal with the image plane directly. Here, we need to transform the image from spatial to frequency domain and take the inverse transform.

$$g(x, y) = T[f(x, y)]$$

output image ← $g(x,y)$; operator: T; input image: $f(x,y)$



- Very easy to process in spatial domain rather than frequency domain.
- Spatial domain, the computational effeciency is very high, less resources are required.
- In frequency domain, the computational efficiency is low & high resources are required.

SPATIAL DOMAIN

· Two transformation

- intensity Transformation
- Spatial Filtering

- Intensity Transformation:-

We directly manipulate on each & every single pixel and we transform this pixel and the output of this transformation is a new intensity value for this pixel.

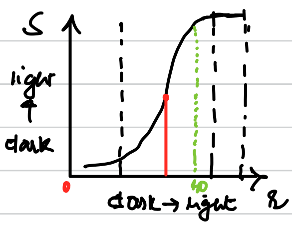
$$S = T(r)$$

T → Transform operator.

r → Intensity value of the pixel before transformation

S → o/p Intensity of the pixel after transformation

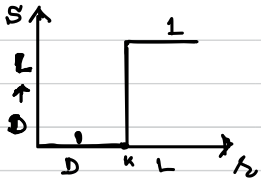
- Intensity transformation is used in:
  - Image thresholding
  - Contrast stretching.



- contrast stretching:
  - Enhance the image
  - Improve the quality of the image

$r_0 > k$: image is more brighter.

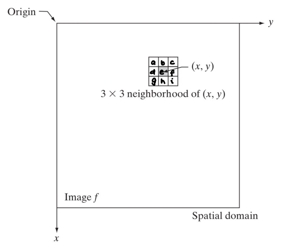
(b) **Image thresholding:**



In Binary image, the black is assigned to the pixel having intensity value < K and white to the intensity value > K.

- **SPATIAL FILTERING:**

$$\underset{O/P}{g(x,y)} = \underset{\text{Transform operator.}}{T}[\underset{I/P}{f(x,y)}]$$



- Intensity transformation, we directly deal with the single pixel present in the image, however, in the spatial filtering, the neighborhood of the pixel are considered.

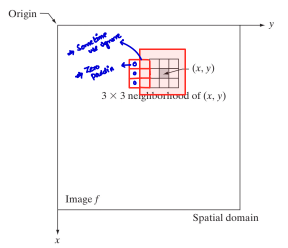
- In spatial filtering, the output image g(x,y) is obtained by performing the operation on this entire neighborhood of a target pixel e.g if the "T" is an average filter, then this operator computes the average of the neighborhood.

$$\boxed{T = \frac{1}{9}\sum_i \sum_j x_{ij}}$$

note
pixel "e" will be assigned as an avg.

This 3×3 neighborhood is called "Spatial filter", "kernel", "template", "mask", "window"

* There are four intensity transformation:
(1) Point transformation
(2) Linear (Negative or identity) transformation.
(3) Log (Log & inverse Log) transformation.
(4) Power-law or gamma correction (n^{th} root & n^{th} power).



- **POINT TRANSFORMATION:** $S = T(r)$
  - S: intensity level of the O/P image.
  - T: Transform operator
  - r: intensity level of the input image

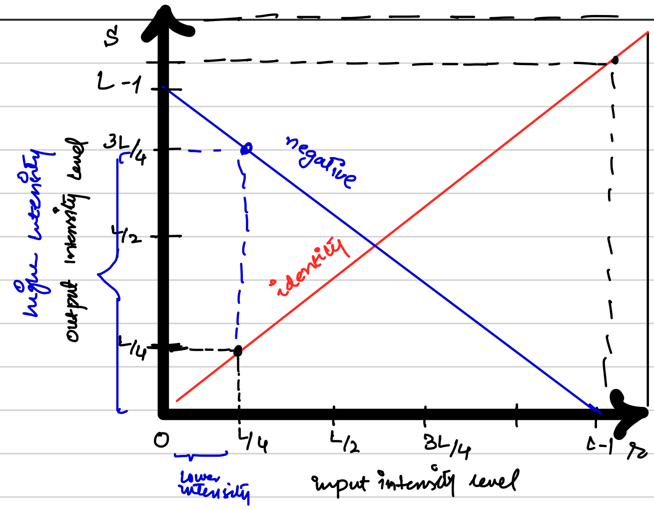
8 bit image

Size of lookup table.

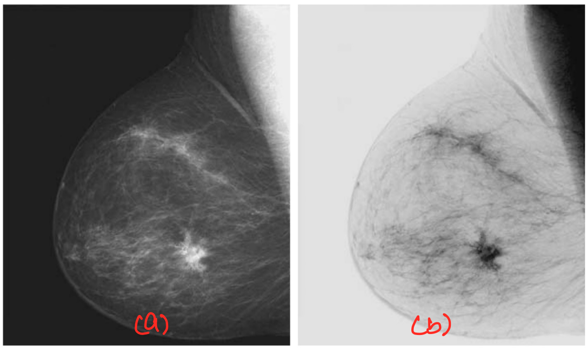
Linear Transformation : $S = (L-1-r)$
- S: intensity level of O/P
- r: intensity level of I/P

L: intensity level
0 – black
1 – white

$L = [0 - L-1]$



if $r = 0, s = L-1$
$r > L-1, s = 0$



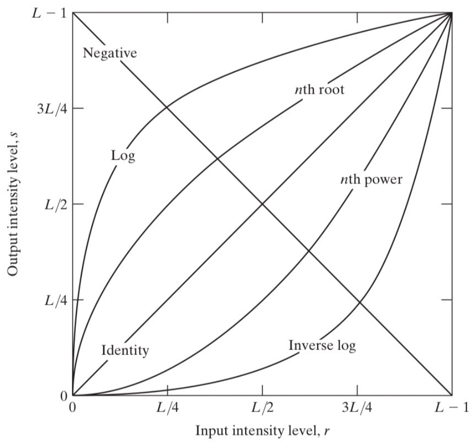
a b

FIGURE 3.4
(a) Original digital mammogram.
(b) Negative image obtained using the negative transformation in Eq. (3.2-1).
(Courtesy of G.E. Medical Systems.)

(c) Log Transformations:-

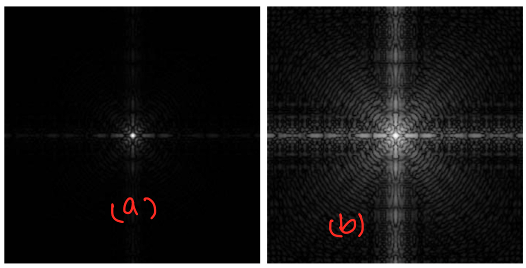
$$S = c \log(1+r) \quad \therefore c = \text{constant}$$

They are usually used to expand the darker intensity level or compressed the brighter Intensity Level. Map narrow range of low intensity values in the input to the wider ranges of output level. The opposite is true for higher values of input levels.



a b

FIGURE 3.5
(a) Fourier spectrum.
(b) Result of applying the log transformation in Eq. (3.2-2) with $c = 1$.



Power-Law or gamma correction:

$$S = c \cdot r^{\gamma} \quad \therefore c \text{ and } r \text{ is the constant.}$$

$$S = c(r + \varepsilon)^{\gamma}$$

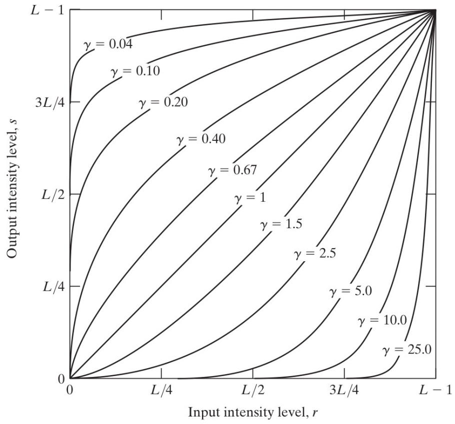
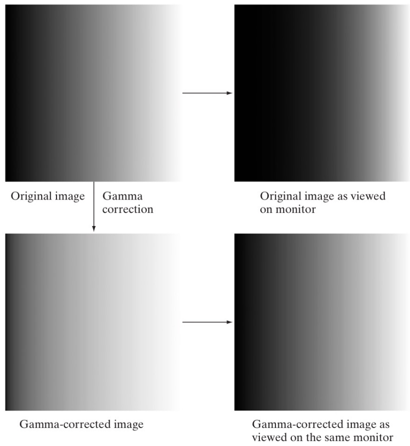
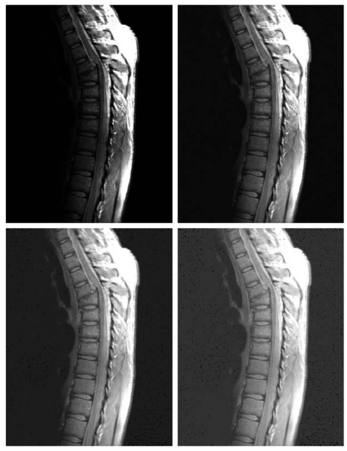


FIGURE 3.6 Plots of the equation $s = cr^{\gamma}$ for various values of γ ($c = 1$ in all cases). All curves were scaled to fit in the range shown.

a b
c d

FIGURE 3.7 (a) Intensity ramp image. (b) Image as viewed on a simulated monitor with a gamma of 2.5. (c) Gamma-corrected image. (d) Corrected image as viewed on the same monitor. Compare (d) and (a).





a b
c d

FIGURE 3.8 (a) Magnetic resonance image (MRI) of a fractured human spine. (b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 0.6, 0.4,$ and 0.3, respectively. (Original image courtesy of Dr. David R. Pickens, Department of Radiology and Radiological Sciences, Vanderbilt University Medical Center.)

a b
c d

FIGURE 3.9 (a) Aerial image. (b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 3.0, 4.0,$ and 5.0, respectively. (Original image for this example courtesy of NASA.)