Lecture 2

Basic relationships between pixels

Some Basic Relationships between Pixels

1. Neighbors of a Pixel
2. Adjacency, Connectivity, Regions, and Boundaries
3. Distance Measures

Neighbors of a Pixel

4-neighbors of p *$N_4(p)$*:

(x + 1, y), (x - 1, y), (x, y + 1), (x, y - 1)

The four *diagonal* neighbors of p have coordinates

$$(x + 1, y + 1), (x + 1, y - 1), (x - 1, y + 1), (x - 1, y - 1)$$

and are denoted by $N_D(p)$. These points, together with the 4-neighbors, are called the 8-*neighbors* of p, denoted by $N_8(p)$. As before, some of the points in $N_D(p)$ and $N_8(p)$ fall outside the image if (x, y) is on the border of the image.

Relationships between Pixels

(a) 4-*adjacency*. Two pixels p and q with values from V are 4-adjacent if q is in the set $N_4(p)$.

(b) 8-*adjacency*. Two pixels p and q with values from V are 8-adjacent if q is in the set $N_8(p)$.

m-adjacency (mixed adjacency). Two pixels p and q with values from V are m-adjacent if

(i) q is in $N_4(p)$, *or*

(ii) q is in $N_D(p)$ *and* the set $N_4(p) \cap N_4(q)$ has no pixels whose values are from V.

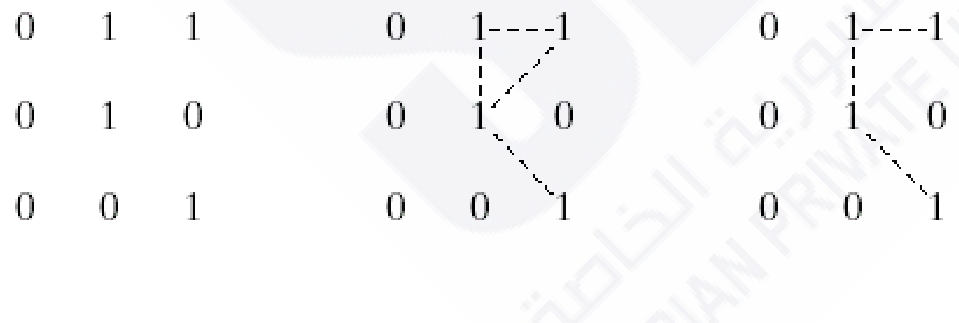

FIGURE 2.26 (a) Arrangement of pixels; (b) pixels that are 8-adjacent (shown dashed) to the center pixel; (c) m-adjacency.

- A (digital) **path** from pixel **p** to pixel **q** is a sequence of adjacent pixels (4,8 or m adjacency). n : is its length.

- Two pixels p and q are said to be **connected** in S (subset of pixels) if there exists a path between them consisting entirely of pixels in S.

- Let R be a subset of pixels in an image. We call R **a region** of the image if R is a connected set.

- Two regions, are said to be **adjacent** if their union forms a connected set. Regions that are not adjacent are said to be **disjoint.**

- The *boundary (also called the border or contour) of a region R is the set of* points that are adjacent to points in the complement of *R*. the ***inner border** of* the region to distinguish it from its ***outer border**, which is the corresponding* border in the background

Background and foreground

Suppose that an image contains K disjoint regions, $R_k, k = 1, 2, \ldots, K$, none of which touches the image border.† Let R_u denote the union of all the K regions, and let $(R_u)^c$ denote its complement (recall that the *complement* of a set S is the set of points that are not in S). We call all the points in R_u the *foreground*, and all the points in $(R_u)^c$ the *background* of the image.

Distance Measures

D is a *distance function or metric if* :

1. $D(p, q) \geq 0$ $(D(p, q) = 0$ if $p = q)$,
2. $D(p, q) = D(q, p)$,
3. $D(p, z) \leq D(p, q) + D(q, z)$.

Distance Measures

1. The *Euclidean distance* between p and q is defined as

$$D_e(p, q) = \left[(x - s)^2 + (y - t)^2\right]^{\frac{1}{2}}.$$

2 The D_4 *distance* (also called *city-block distance*) between p and q is defined as

$$D_4(p, q) = |x - s| + |y - t|. \qquad (2.5\text{-}2)$$

4	3	2	3	4
3	2	1	2	3
2	1	0	1	2
3	2	1	2	3
4	3	2	3	4

The D_8 *distance* (also called *chessboard distance*) between p and q is defined as

$$D_8(p, q) = \max(|x - s|, |y - t|). \tag{2.5-3}$$

2	2	2	2	2
2	1	1	1	2
2	1	0	1	2
2	1	1	1	2
2	2	2	2	2

5. *Consider the image segment shown below:*
Let $V = \{0,1\}$ *,compute the lengths of the shortest 4-, 8-, and m-path between p and q and draw the path.*

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

4. *Find the distance between two points a, b using the following distance measures (write the equations):* *(3)*

				b	
a					

a. City-bloc distance:

b. Chess board distance:

*Show all the pixels having equal distance values from points **a** and **b** in the following image. Use the formula of city bloc distance for distance calculations.* (3

$$D_4(p, q) = |x - s| + |y - t|$$

a					
				b	

END OF PRESENTATION