Solutions to Optional Homework (Lecture 1)

Problem 2.5

(a) The vertical (or horizontal) dimension in which the image has to fit is 5 cm or 50 mm. So, we have to fit 2048 lines in 50 mm or approximately 41 lines/mm. Line pairs is half of that, or approximate 20 line pairs per mm.

(b) (2048 pixels)/(2 inches) = 1024 pixels/inch = 1024 dpi in both directions.

Problem 2.9

(a) The total amount of data (including the start and stop bits) in an 8-bit, 1024×1024 image is $(1024)^2 \times (8+2)$ bits. The total time required to transmit 500 such images over a 3 M baud modem is:

$$\text{Trans time} = 500 \times (1024)^2 \times (10) / (3 \times 10^6) = 1,748 \, \text{sec}.$$

(b) Similarly,

$$\text{Trans time} = 500 \times (1024)^2 \times (10) / (30 \times 10^9) = 1.748 \, \text{sec}.$$

Problem 2.14

Let p and q be as shown in Fig. P2.14. Then,

(a) S_1 and S_2 are not 4-connected because q is not in the set $N_4(p)$.

(b) S_1 and S_2 are 8-connected because q is in the set $N_8(p)$.

(c) S_1 and S_2 are m-connected because (i) q is in $N_D(p)$, and (ii) the set $N_4(p) \cap N_4(q)$ is empty.

	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	q 1	1	0	0	0
0	0	1	1	p 1	0	0	0	0	0
0	0	1	1	1	0	0	1	1	1

Figure P2.14

Problem 2.18

(a) When $V = \{0,1\}$ a 4-path does not exist between p and q because it is impossible to get from p to q by traveling along points that are both 4-adjacent and also have values from V. Figure P2.18(a) shows this condition; it is not possible to get to q. The shortest 8-path is shown in Fig. P2.18(b); its length is 4. The length of the shortest m-path (shown dashed) is 5. Both of these shortest paths are unique in this case.

(b) One possibility for the shortest 4-path when $V = \{1,2\}$ is shown in Fig. P2.18(c); its length is 6. It is easily verified that another 4-path of the same length exists between p and q. One possibility for the shortest 8-path (it is not unique) is shown in Fig. P2.18(d); its length is 4. The length of a shortest m-path (shown dashed) is 6. This path is not unique.

Figure P2.18

Problem 2.19

(a) A shortest 4-path between a point p with coordinates (x, y) and a point q with coordinates (s,t) is shown in Fig. P2.19, where the assumption is that all points along the path are from V. The lengths of the segments of the path are $|x-s|$ and $|y-t|$, respectively. The total path length is $|x-s|+|y-t|$, which we recognize as the definition of the D_4 distance, as given in Eq. (2-20). (Recall that this distance is independent of any paths that may exist between the points.) The D_4 distance obviously is equal to the length of the shortest 4-path when the length of the path is $|x-s|+|y-t|$. This occurs whenever we can get from p to q by following a path whose elements (1) are from V, and (2) are arranged in such a way that we can traverse the path from p to q by making turns in at most two directions (e.g., right and up).

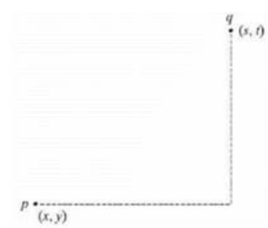

Figure P2.19

(b) The path may or may not be unique, depending on V and the values of the points along the way.