ECE 172a	Machine Vision	Pamela Cosman	2/27/12

QUIZ 2 SOLUTIONS

1. **Binary Morphological Operators:**

   Don't confuse the number of foreground pixels with the number of connected components. It is true that with dilation of the foreground, the number of foreground pixels can only increase, until the time that the entire image is composed of foreground pixels. Similarly, with erosion of the foreground, the number of foreground pixels can only decrease, until the time that there are none left. But this is not what you were asked about. The question asked about numbers of connected components, that is, a group of foreground pixels which are all connected to each other. So:

   - First: number of connected foreground components versus the number of dilations. When you dilate, the number of connected foreground components can only stay the same or decrease. If a dilation causes two previously unconnected components to touch each other, then the number of connected components will decrease by 1. Otherwise, the number will stay the same. So the function is monotonically non-increasing. (accept monotonically decreasing)
   - Second plot: number of connected foreground components versus the number of (8-neighbor) erosions. This plot can be non-monotonic. An erosion can cause a foreground component to disappear entirely, in which case the number would decrease by 1. An erosion can also cause a bridge between two lumps to disappear, so that the connected component turns into two separate components. The number then increases by 1. Depending on the configuration of connected components, any given erosion step might cause multiple disappearances, or multiple splits, so the number of connected components might go up or down by more than 1 at any step.

2. **Vector Distance Measures:**

   The region in the 2D plane consisting of all points having Euclidean distance less than 2 from the origin is the disk of radius 2, shown below left. The region consisting of all points having a city-block distance less than 2 from the origin is shown below middle, a diamond shape which extends from -2 to +2. The region consisting of all points having a chessboard distance less than 2 from the origin is shown below on the right, a square extending from -2 to +2.

   Grading: 2 points for EDT, 3 points for each of the others.

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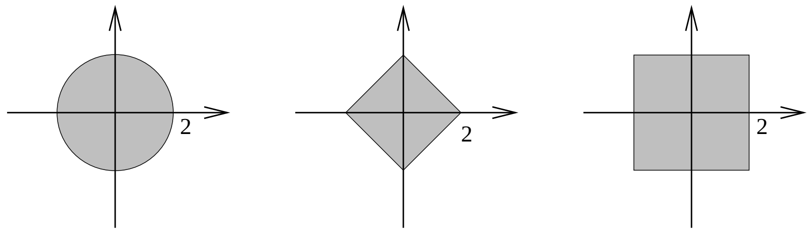

3. **Color:**

   (a) **TRUE**

   (b) **TRUE**

   (c) **FALSE** because the xy space is not perceptually uniform

   (d) **FALSE**

   (e) **TRUE**

   (f) **FALSE**

   (g) **TRUE**

   (h) **FALSE**

4. **Segmentation in a binary image:**

   The simple way to accomplish the stated goal is to do an 8-neighbor erosion followed by an 8-neighbor dilation. Then simply extract the connected components. Since we are guaranteed that the lines are only one or two pixels thick, the 8-neighbor erosion will get rid of them. The dilation will then grow the squares back to their original size, and they can be extracted as connected components.

   The distance transformation will turn the squares into pyramids rising out of the flat plain. The lines will get turned into very low-lying ridges, with height only 1. This image could be thresholded at 2, so that everything with value 2 or higher becomes a logical 1, and everything with value 1 or 0 (including all the low-lying ridges) gets set to zero. The outer edges of the pyramids would get set to zero also, so we would still need to do an 8-neighbor dilation step to get them back to their proper size. And then we would need to do an extraction of connected components step.

   Note that, after the DT, the watershed algorithm is *not* what is required here. Because the squares are not touching each other, after the distance transformation, a simple global bilevel thresholding will do the trick.

   Grading: 4 points for any reasonable method *not* using DTs and 4 points for the method using DTs. Remove 1 point for the DT approach if the watershed algorithm is specified, because it is more complicated than needed.

5. **Hough transforms:**

   D, A, B, C (2 points each)