Assignment, Week 7 - Mathematical Morphology
Signal and Image Processing 2014

1. Try to explain erosion and dilation in terms of set theory.

2. Sketch the outcome of the following operations upon the test image below (available in Matlab format on Absalon), using a 3x3 diamond (actually a cross with 5 elements) structuring element.

    1. "Opening"
    2. "Closing"

    (For your report, you may find it easiest to show the results using tables, with one cell per pixel. Either colour the cells, or use different symbols for a pixel being on and off.)

Table 1

			1	1	1	1	1			1							
	1	1	1	1	1	1	1		1	1	1						
	1	1	1	1	1	1	1	1	1	1	1	1					
		1	1	1	1	1	1	1	1		1	1	1				
		1	1	1	1	1	1	1			1	1					
			1	1	1	1	1	1	1	1	1				1		
		1					1			1		1	1	1			
		1			1			1		1			1				
	1				1			1	1			1					
1				1	1	1		1		1							
1				1													
	1	1	1	1				1									
1							1						1				
1													1				
													1				
						1	1	1	1								

For each, show the resultant images, and explain what is happening (select a few different locations and describe why they change). What are the differences between the two operations?

If we only wanted a single resultant blob, how big should the structuring element be? (Assume you keep the diamond shape of the structuring element).

3. Apply the following operations to the "blobs" example image.

    1. Hit-and-Miss
    2. TopHat
    3. BottomHat

    Experiment with different sizes and shapes of structuring elements.

    What are the differences between these three operations? What features do they pick-up? For

each operation, show a couple of images demonstrating the effects you found. Remember to specify which structuring elements you applied.

4. Apply background normalisation to the Matlab "rice" image using different sizes of the "disk" structuring element. Comment on the size required to isolate the background (with reference to the features present in the image).

5. Load the binary image "test_digits.bmp" available on Absalon. Try to detect the presence of digit 5 using basic hit-miss morphology operation and the image "five.bmp" also on Absalon.

   How well does it work? Why? How can you relax the method to deal with this ?

   Using all the sample images of digits in the Absalon folder, write some code that detects the different digits present in an image such as "test_digits.bmp" and overlays a marker for their centre location.

   Would this also work if the digits were for instance scaled differently or rotated ?

6. Put together a chain of operations in order to automatically extract the in-focus areas of the image "flowers.jpg" (available on Absalon). To achieve this, you will need to generate a mask image which can then be used to show only those pixels that are inside the mask.

   To do this you may find some (not necessarily all) of the following steps useful:

   1. Convert the flowers image to greyscale
   2. Blur the image. (Use a gaussian filter. Parameters to vary: filter size, sigma), then calculate the difference image.
   3. Perform edge detection using the morphological gradient. (Parameters to vary: structuring element).
   4. Dilation followed by erosion.
   5. Filling by "thickening"
   6. Extraction of the skeleton.
   7. Extraction of the "distance to centre" metric
   8. Remove small/isolated branches. This can be used to prune any spurious portions that have survived the previous steps.

      Finally, apply your mask to the image. Use the alpha channel to mask out the areas outside of the mask.

      Show the result of each step in your pipeline to generate the mask. Explain your parameter choice for each step.