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CSE585/EE555: Digital Image Processing II
Spring 2014
Project #1 — Mathematical Morphology: Hit-or-Miss Transform

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assigned:	20 January 2013
due:	Friday, midnight, 31 January 2014 in ANGEL project drop box
reading assignment:	Sections 6.1-6.7 of P&V (PitasCh6.pdf) and the Maragos and Schafer paper (Maragos-Schafer.pdf) — these are under the "Readings" folder on ANGEL.

1. MATLAB Introduction — *This portion of the project has NO required work.* To help you get acquainted with manipulating images and performing simple operations in MATLAB:

   (a) Read 'MATLABprimer.pdf' and 'G-W-Matlab-Ch2.pdf' under "Project Material" on ANGEL. Also, see 'MatLabIntro.pdf,' which I discussed in class, under this folder.

   (b) Experiment with the four sample MATLAB files (main.m, zero.m, localmean.m, localmean3x3.m) I placed in "Project Material." Note the way we process 2D image arrays and consider border effects. As a rule, you will <u>zero out</u> the outer portions of an image that can't be fully processed.

   Also, as a rule, *you are NOT allowed to use built-in MATLAB functions for mathematical morphology and other operations directly related to the main goals of the project, unless I allow it.* Thus, you must write your own erosion, dilation, and set-theory operations below (simple!).

2. Hit-or-Miss Transform — Consider the image "RandomDisks-P10.jpg," which appears in "Project Material." This binary-valued image considers WHITE to be background and BLACK to be foreground (to save on ink if you print things!). It contains fives sets of differently sized solid black disks that are randomly scattered in the image. Each set of disks is characterized by a specific radius. The image is also corrupted by a 10% level of salt-and-pepper noise. This noise causes the disks to be corrupted by small cavities or very slightly corrupted outer borders. (*Note that the input image is "almost" binary — you will need to threshold it appropriately to convert to a truly binary-valued image for the task below.*)

   Your task is to design an appropriate hit-or-miss transform

   $$X \circledast (A, B) = (X \ominus A^s) - (X \oplus B^s)$$

   as discussed in pages L4-8 — L4-9 of the class notes and P&V eq. (6.2.43), where X is the input image and A and B are appropriately selected structuring elements. You are to design a transform that detects the disks with the <u>three middle-size radii</u>; i.e., your transform must reject the largest- and smallest-sized sets of disks. Before applying your transform, however, you should first filter the noise with a small close/open filter to fill holes in regions. Note: you can use any means necessary to pick the structuring element sizes (e.g., interactively inspecting the input image with `imshow`).

3. Some points to do and discuss in your report:

   (a) Discuss exactly how you reduced the salt-and-pepper noise.

   (b) Discuss how you selected structuring elements, A and B, for the hit-or-miss transform.

   (c) Show pictures for <u>all</u> steps in your processing; the final result should be an image showing just the detected disks.

   (d) Suppose you do not apply the small close/open as suggested. Will your hit-or-miss transform work? Demonstrate this and discuss your results.

   (e) Write a detailed report describing your results and implementations. Give a well-commented listing of your MATLAB code, abiding by the code specifications of the class project protocol.

   (f) Carefully discuss your results. Make sufficiently big images — no more than 4 per page! Have complete figure captions.