

**CSE585/EE555: Digital Image Processing II**  
**Spring 2019**

**Project #1 — Mathematical Morphology: Hit-or-Miss Transform**

**assigned:** 8 January 2019

**due:** Friday, 25 January 2019 in CANVAS 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 CANVAS.

1. MATLAB Introduction (no required work here) — I assume you are already acquainted with processing images in MATLAB. To refresh your memory (all items below appear under “Project Material” on CANVAS):

(a) Read ‘MATLABprimer.pdf,’ ‘G-W-Matlab-Ch2.pdf,’ and ‘MatLabIntro.pdf.’

(b) Experiment with my three sample MATLAB files: main.m, mean3x3.m, and zero.m.

Note the way we process 2D image arrays and consider border effects. As a rule, you will zero out the outer portions of an image that can’t be fully processed.

In general, *you are NOT allowed to use built-in MATLAB functions for mathematical morphology and other operations directly related to the main project goals, unless I allow it.* Thus, you must write your own erosion, dilation, and set-theory operations below.

2. Hit-or-Miss Transform — Consider the image “RandomDisks-P10.jpg” (see “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 **five sets** of differently-sized solid black disks 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 image is “almost” binary — you will need to threshold it appropriately to convert it into a true 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 on 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 *smallest* and *largest* disks; i.e., your transform must reject the sets of disks characterized by the three middle-sized radii. Before applying your transform, however, you must 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. 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.

Some points you must discuss and do for 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) Suppose you do not apply the small close/open as suggested. Will your hit-or-miss transform work? Demonstrate this and discuss your results.
- (d) Show pictures for all steps in your processing. The final result should be an image showing just the detected disks.
- (e) Provide sufficiently big images in the report, but no more than 4 per page! Have complete figure captions.