

CSE585/EE555: Digital Image Processing II
Spring 2020

Project #3 — Nonlinear Filtering and Anisotropic Diffusion

assigned: 4 March 2020
due: Friday, 27 March 2020
reading assignment: P&V order-statistics paper, pp. 1893-1897, 1901-1908, and 1913-1916 (“PitasVenetsanopoulos.pdf”)
Perona and Malik anisotropic diffusion paper (“Perona.pdf”)

1. *Nonlinear Filtering:*

- (a) Implement the following filters:
 - i. 5×5 mean
 - ii. 5×5 median
 - iii. 5×5 alpha-trimmed mean ($\alpha = 0.25$)
 - iv. 5×5 sigma filter ($\sigma = 20$);
 - v. 5×5 symmetric nearest-neighbor mean.

Feel free to use MATLAB’s median filter `medfilt2` for part (i).

Also, you are welcome to use MATLAB’s order-statistic function `ordfilt2` to construct your alpha-trimmed mean in part (ii). It will be up to you, however, to figure out how to use this function (read MATLAB’s help on how to use it).

- (b) Consider the “disk” image in our database. For this image, give filter results for: (1) 1 iteration; (2) 5 iterations. For each result after 5 iterations, also give:
 - (a) the gray-scale histogram;
 - (b) mean and standard deviation of the interior of the large disk region (you can manually define the sub-region you consider for these calculations).
- (c) Give observations on your results, similar to what I did in my discussion of the filter results in L12.

2. *Anisotropic Diffusion for Image Filtering:* Implement the anisotropic diffusion algorithm. For your experiments below, pick $\lambda = 0.25$. It is up to you to select an appropriate value of K . Produce the following results:

- (a) For the “cwheelnoise” image, give the following anisotropic-diffusion results after 0 (original), 5, 20, and 100 iterations (do for both forms of $g(\cdot)$, per the discussion after equation (13) in Perona and Malik):
 - i. The image
 - ii. Gray-scale histogram
 - iii. Plot of the line $y = 128$ through the image.
 - iv. Segmented version of the image, whereby you try to segment out the gray “spokes” component of the wheel by manual thresholding.
- (b) Run anisotropic diffusion on the “cameraman” image, using both forms of $g(\cdot)$. Give images for 0 (original), 5, 20, and 100 iterations. No need for histograms, line plots, or segmentations here.
- (c) Discuss the following questions on your results of parts (a-b):
 - i. How does the result change as you iterate? How does K affect the results?
 - ii. How does $g(\cdot)$ affect the results (filtered and segmented)?
 - iii. How does anisotropic diffusion run on “cwheelnoise” versus “cameraman”?