CSE585/EE555: Digital Image Processing II
Spring 2023
Project #3 — Nonlinear Filtering and Anisotropic Diffusion

assigned:	28 February 2023
due:	Sunday, 26 March 2023
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.

   The sample Matlab files I posted on Canvas at the beginning of the semester, of course, give the code for a 3×3 mean filter — it is trivial to modify this for a 5×5 filter for part (i). Feel free to use MATLAB's median filter `medfilt2` for part (ii). You may also use MATLAB's order-statistic function `ordfilt2` to construct your alpha-trimmed mean in part (iii).

   (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"?