

Problem Set 1: Nonlinear Diffusion

Note that there is a test image on the class web page. Please include in your write-up images that show the result of your smoothing using this image. Note that you will need to scale the intensities in the image to lie in the range 0 to 1 in order for the parameters given below to be reasonable.

1. Gaussian Smoothing

Implement a function to smooth an image using convolution with a Gaussian filter. Show the results of this filter on the test image, using $\sigma = 1.5$. You do not have to write your own convolution code. For example, if you are using Matlab you can use built in functions like `imfilter`.

2. Perona-Malik

Implement the Perona-Malik diffusion method, as described by Equations (23) and (21) in Weickert's paper. Show the results of applying this diffusion to the test image, using $\lambda = .01$ and $\sigma = 1$. Weickert does not indicate a diffusivity. Use a diffusivity of .1, so that $u_{new} = u + .1u_t$. Apply this diffusion process for 300 iterations.

3. Non-linear diffusion

Implement the diffusion method in Weickert's paper, in which the diffusion tensor D is formed with eigenvectors given in Equations (27) and (28), with $\lambda_1 = g(\|\nabla u_\sigma\|^2)$ and $\lambda_2 = 1$. Using this D , Equation (3) is then applied. Apply this to the test image using the same parameters as for Perona-Malik.

4. Experimentation

Find or create one or two test images that you think highlight the differences between these three diffusion processes. Show the results of applying all three to your test images, perhaps varying the parameters to produce a range of results. Explain in one or two paragraphs what you see as the main differences in these results, and why they occur.