BIL 717 – Programming Assignment 1: Nonlinear Diffusion

Due date: Wednesday, 2015-03-25, 11:59 PM

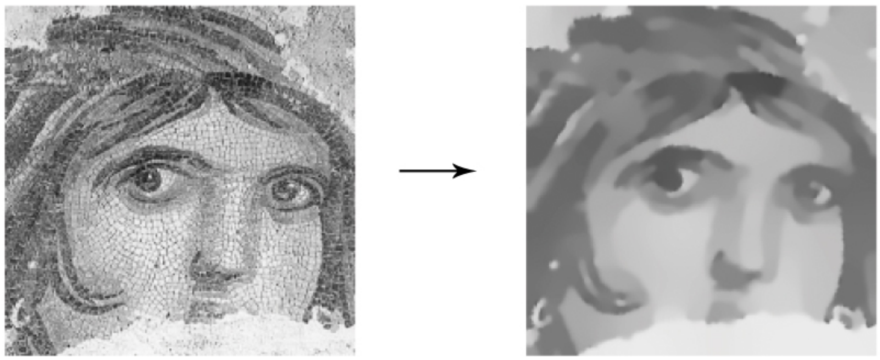

Figure 1: A sample filtering result obtained by the Perona-Malik model.

Overview

The purpose of this problem set is to familiarize you with nonlinear diffusion filtering. The main theory behind nonlinear diffusion filtering is to use nonlinear PDEs to create a scale space representation that consists of gradually simplified images where some image features such as edges are preserved or even enhanced. The assignment requires you to implement a Perona-Malik type nonlinear diffusion model and apply it to some sample images (Figure 1).

Problem 1.1

To smooth an image, implement a Perona-Malik (PM) type nonlinear diffusion model. Your program should take a grayscale image as input and produce a smoothed version of it as output. It should have the following structure:

1. Read the input image.
2. Set the parameters of the model.
   - contrast threshold: λ
   - scale parameter: σ
   - diffusion time: T
3. Perform smoothing.

You are provided a linear diffusion code. You can use this code as a skeleton and make the necessary changes to implement the PM model.

Problem 1.2

Use your own implementation of the Perona-Malik model to address the following issues:

- Relation between linear diffusion and Gaussian filtering (see Matlab functions `imfilter` and `fspecial`).
- Comparison of the results of linear and PM type nonlinear diffusion.
- Effects of the parameters on the smoothing results (both for linear and PM diffusion)
- Changes in the mean intensity value, the variance of the intensities and total gradient magnitude throughout iterations.

Problem 1.3

Extend your Perona-Malik (PM) implementation so that your program can smooth colored images as well.

For that, you can consider the following PDE defined for individual color channels:

$$\frac{\partial u^i}{\partial t} = \nabla \cdot \left(g \left(\sum_{k=1}^{3} |\nabla u_\sigma^k|) \right) \nabla u^i \right) \tag{1}$$

where i denotes the color channel (R, G or B channels), $u_\sigma^i = G_\sigma * u^i$ represents a Gaussian-smoothed version of the ith color channel, and g is the diffusivity function.

What to Hand In

You are required to submit all your code along with a report in PDF format (should be prepared using LaTeX). The codes you will submit should be well commented. Your report should be self-contained and should contain a brief overview of the problem, the details of your implemented solution and your comments about the experimental analysis on the aforementioned issues. Finally, prepare a ZIP file named `name-surname-pa1.zip` containing

- `report.pdf` (PDF file containing your report)
- `code/` (directory containing all your codes)

The ZIP file will be submitted via email to `erkut@cs.hacettepe.edu.tr`.

Late policy

You may use up to three *extension* days (in total) over the course of the semester for the three programming assignments. Any additional unapproved late submission will be weighted by 0.5.

Academic Integrity

All work on assignments must be done individually unless stated otherwise. You are encouraged to discuss with your classmates about the given assignments, but these discussions should be carried out in an abstract way. That is, discussions related to a particular solution to a specific problem (either in actual code or in the pseudocode) will not be tolerated. In short, turning in someone elses work, in whole or in part, as your own will be considered as a violation of academic integrity. Please note that the former condition also holds for the material found on the web as everything on the web has been written by someone else.