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Homework Assignment 4

H 4.1 (Isotropic flow-driven optical flow) 12 Points

Consider the following energy functional for optical flow computation

$$E(u,v) = \int_\Omega (f_x u + f_y v + f_t)^2 + \alpha \Psi\left(|\nabla u|^2 + |\nabla v|^2\right)\, dxdy \tag{1}$$

(a) Compute the Euler-Lagrange equations.

(b) Compute an analytical expression for the arising derivative $\Psi'(s^2)$ for

$$\Psi(s^2) = \lambda^2 \log\left(1 + \frac{s^2}{\lambda^2}\right)$$

(c) What is the relation to the isotropic nonlinear diffusion studied in Lecture 13?

(d) What is the effect of the function Ψ considering flow edges?

(e) How would the Euler-Lagrange equations change, if Ψ was applied to the data term instead?

(f) What could be the impact of this modification?

P 4.2 (Coherence-Enhancing Diffusion Filtering)

Please download the required file `cv24_ex04.zip` from ILIAS and unpack the data.

(a) Supplement the file `diff_tensor.c` with the missing code. You may use the included routines for principle axis transformation and backtransformation. Compile the programme with

`gcc -O3 -o ced ced32.o diff_tensor.c -lm` (on 32-bit machines),
`gcc -O3 -o ced ced64.o diff_tensor.c -lm` (on 64-bit machines).

(b) Use the programme `ced` for enhancing the fingerprint image `finger.pgm` with the paramters $C = 1,\ \sigma = 0.5,\ \rho = 4,\ \alpha = 0.001,\ \tau = 0.2,$ 40 iterations. You will observe that the extremum principle is violated by the standard discretisation that is used in this algorithm.

(c) Use `ced` for creating your own Christmas postcards. Its easy: just take `xmas.pgm` and filter it with the same parameters as for the fingerprint.

(d) Use `ced` to visualize all stripes of `fabric.pgm` at different scales. Use the standard parameters and increase the number of iterations.

Submission:

Please note that up to four people can work and submit their solutions together. The theoretical problem(s) have to be submitted digitally (uploaded in ILIAS) before the deadline.

Deadline for Submission: see ILIAS.

Classroom Assignment 4

C 4.1 (Mumford-Shah Cartoon Model)

Let $\Omega_i, \Omega_j \subset \Omega$ denote two segments with mean u_i resp. u_j. Furthermore, let $\partial(\Omega_i, \Omega_j)$ denote the common boundary between Ω_i and Ω_j.

Show that for the Mumford-Shah cartoon model, merging these two regions results in the following change of energy:

$$E\left(K \setminus \partial\left(\Omega_i, \Omega_j\right)\right) - E\left(K\right) \;=\; \frac{|\Omega_i| \cdot |\Omega_j|}{|\Omega_i| + |\Omega_j|} \cdot \left(u_i - u_j\right)^2 - \lambda\, l\left(\partial\left(\Omega_i, \Omega_j\right)\right) \;.$$