Corso di Dottorato-INDAM

VARIATIONAL MODELS AND FAST NUMERICAL SCHEMES IN IMAGE PROCESSING AND COMPUTER VISION

TAI XUE-CHENG

Professor, **Dept. of Mathematics, University of Bergen, 5008 Bergen, Norway.**
Home page: http://www.mi.uib.no/ ~tai/
Email: Tai@mi.uib.no

Course description. This course will introduce students to a number of problems in image processing and computer vision, and describe how they can be tackled by modern techniques based on calculus of variations and partial differential equations. We will focus especially (but not exclusively) on image reconstruction (denoising, deblurring, inpainting, as well as some inverse problems) and image segmentation. These procedures are fundamental in many applications, such as medical imaging and target recognition. Numerical solution of the models, which involve minimizing appropriate energies (often by solving associated partial differential equations) will be a major concern of the course: A variety of numerical techniques for this purpose, including level set and diffuse interface methods for evolving curves and surfaces, will be introduced and covered in detail. In addition, important theoretical questions about the various models and how they have been answered will be presented. We will try to cover some of the newest developments for these problems which have not been covered in any other standard text book.

Tentative outline.
(1) Mathematical preliminaries.
- Some elementary partial differential equations.
- Basic about minimization and calculus of variations
- Functions of bounded variation.

(2) Image restoration, inpainting and deblurring.
- Linear diffusion.
- Anisotropic diffusion: Motion of isocontours by mean curvature.
- The total variation model of Rudin, Osher, and Fatemi.
- Mumfor-Shah model
- Euler's Elastica model
- Higher oder methods of PDE nonlinear filters.
- Other geometrical models for image filters.

(3) Fast numerical schemes
- Gradient decent method.
- Operator splitting and AOS schemes

CIRAM -Centro Interdipartimentale di Ricerca per le Applicazioni della Matematica
Via Saragozza 8 - 40123 Bologna (Italy) - Tel. 051 2093982 - Fax 051 2093908
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- Dual approaches.
- Split-Bregman.
- Augmented Lagrangian approach.
- Other fast minimization approaches for image processing.

(4) Image segmentation and geometrical PDEs
- Active contours model of Kass, Witkin, and Terzopoulos: Segmentation via snakes (curve evolution).
- Geodesic active contours; implementation using level-sets.
- Mumford-Shah and Chan-Vese models using level-sets.
- Global active contours method of Cohen & Kimmel.
- Piecewise Constant Level set method.
- Graph cut approach for interface problems and image segmentation.
- Ambrosio and Tortorellis approximation: Di_use interface formulation.
- Combining diffusive and sharp interface approaches.
- Discussion of a few other vision problems.

Periodo delle lezioni 20 maggio-18 luglio 2011

Gli interessati sono invitati a partecipare e ad inviare una adesione preliminare via mail o telefono entro il 20 marzo onde poter concordare in modo ottimale la sede di svolgimento (Dip. Matematica-CIRAM) e gli orari delle 24 ore di lezione.

Prof. Fiorella SGALLARI,

Dip. Matematica, Piazza Porta San Donato 5 - 40126 Bologna
C.I.R.A.M. Via Saragozza 8 - 40123 Bologna

E-mail: SGALLARI@DM.UNIBO.IT
Tel. 051 2093982