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Fall 2007

MA651: Variational Models in Image Processing and Computer Vision

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.

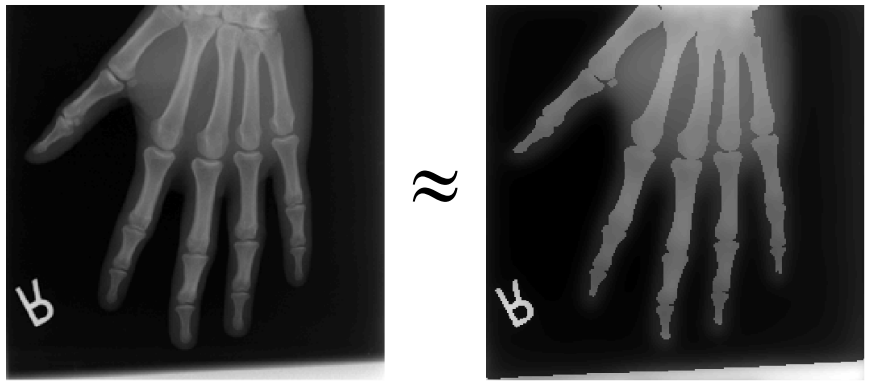
We will focus especially (but not exclusively) on image reconstruction (denoising, deblurring, inpainting, as well as some inverse problems) and image segmentation. These procedures are fundamental in many applications, such as medical imaging and target recognition. Numerical solution of the models, which involves 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.

Prerequisites: Some coursework in (or willingness to learn) partial differential equations and numerical methods. Ability to program in (or willingness to learn) a language such as Fortran, C, or Matlab.

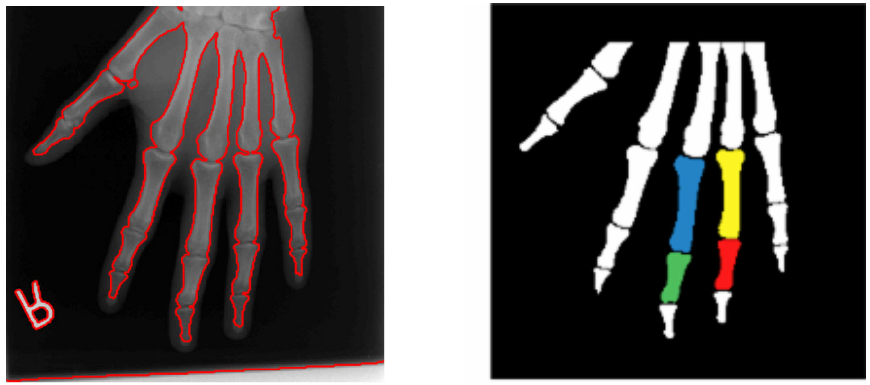
Grading: There will be short problem sets and simple programming tasks.

Textbook:

Aubert, G; Kornprobst, P. *Mathematical Problems in Image Processing. Partial Differential Equations and Calculus of Variations.* Applied Mathematical Sciences #147. Springer Verlag. New York, 2006.



Piecewise smooth approximation (right) to a given image (left) computed by minimizing a variant of the Mumford-Shah segmentation energy, an important model that will be studied in detail during the course. Distinct regions (bones, flesh, background) are identified as a byproduct in obtaining the image on the right.



After segmentation, region of interest (bones, in this case) can be extracted as indicated by the red contour, and individual bones identified as shown in the image on the right by non-rigid template matching, another variational problem that will be discussed.

Visit http://www.math.lsa.umich.edu/~esedoglu/Teaching/651.html for the syllabus.