Segmentation of Inhomogeneous Noisy Images via a Bayesian Model Coupled with Anisotropic Mesh Adaptation

Matteo Giacomini[1,2,*] and Simona Perotto[3]

[1] Laboratori de Càlcul Numèric (LaCàN), E.T.S. de Ingeniería de Caminos, Canales y Puertos, Universitat Politècnica de Catalunya, Barcelona, Spain

[2] Centre Internacional de Mètodes Numèrics en Enginyeria (CIMNE), Barcelona, Spain
matteo.giacomini@upc.edu

[3] MOX, Dipartimento di Matematica, Politecnico di Milano, Piazza L. da Vinci 32, I-20133 Milano, Italy

ABSTRACT

Automatic image segmentation is a key process in many applications of science and engineering, from medical imaging to autonomous vehicle driving and smart agriculture monitoring. In these contexts, the presence of spatial inhomogeneities and noise challenges the robustness of segmentation strategies [1].

In this talk, a finite element-based segmentation algorithm handling images with different spatial patterns is presented. The methodology relies on a split Bregman algorithm for the minimisation of a region-based Bayesian energy functional and on an anisotropic recovery-based error estimate to drive mesh adaptation [2]. On the one hand, a Bayesian model is considered to exploit the intrinsic spatial information in inhomogeneous images [3]. To address the ill-posedness of the associated optimisation problem, a convexification technique [4] is coupled with a split Bregman algorithm for the minimisation of the regularised functional [5]. On the other hand, an anisotropic mesh adaptation procedure guarantees a smooth description of the interface between background and foreground of the image, without jagged details [2,6]. The proper alignment, sizing and shaping of the anisotropically adapted mesh elements guarantee that the increased precision is achieved with a reduced number of degrees of freedom [2,6].

Numerical experiments will be presented to showcase the performance of the resulting split-adapt Bregman algorithm on synthetic and real images featuring inhomogeneous spatial patterns. The method outperforms the standard split Bregman approach, providing accurate and robust results even in the presence of Gaussian, salt and pepper and speckle noise, as well as for a challenging medical image obtained from the ultrasound of a gallbladder.

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