Variational Methods and Convex Optimization for Computer Vision

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Abstract

Variational methods are among the most classical and established methods to solve a multitude of problems arising in computer vision and image processing. Over the last years, they have evolved substantially, giving rise to some of the most powerful methods for optic flow estimation, image segmentation and 3D reconstruction, both in terms of accuracy and in terms of computational speed. In this tutorial, I will introduce the basic concepts of variational methods. I will show how problems like image segmentation, stereo and 3D reconstruction can be formulated as variational problems. Subsequently, I will focus on recent developments of convex optimization, convex relaxation and functional lifting which allow to compute globally optimal or near-optimal solutions to respective energy minimization problems. Experimental results demonstrate that these spatially continuous approaches provide numerous advantages over spatially discrete (graph cut) formulations, in particular they are easily parallelized (lower runtime), they require less memory (higher resolution) and they do not suffer from metrication errors (better accuracy).

Keywords: Variational methods, 3D Recontruction, Optic flow estimation, Image segmentation