
Generalizing Mumford-Shah Model for Multiphase Piecewise Smooth Image Segmentation

Abstract:

This paper concerns multiphase piecewise smooth image segmentation with intensity inhomogeneities. Traditional methods based on the Mumford-Shah (MS) model require solving complicated diffusion equations evolving in irregular subdomains, leading to significant difficulties in efficient and accurate segmentation, especially in multiphase scenarios. In this paper, we propose a general framework to modify the MS model by using smoothing operators that can avoid the complicated implementation and inaccurate segmentation of traditional approaches. A detailed analysis connecting the smoothing operators and the diffusion equations is given to justify the modification. In addition, we present an efficient algorithm based on the direct augmented Lagrangian method, which requires fewer parameters than the commonly used augmented Lagrangian method. Typically, the smoothing operator in the general model is chosen to be Gaussian kernel, the bilateral kernel, and the directional diffusion kernel, respectively. Ample numerical results are provided to demonstrate the efficiency and accuracy of the modified model and the proposed minimization algorithm through various comparisons with existing approaches.