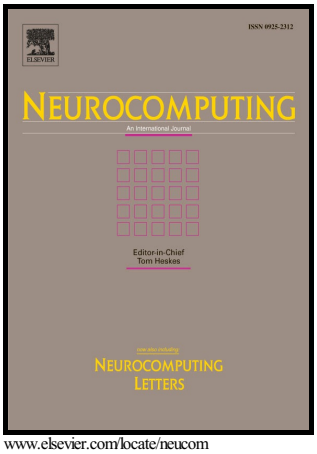

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A Novel Dual Minimization Based Level Set Method for Image Segmentation

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Abstract: In this paper, we propose a novel dual minimization (DM) method based on level set to segment images with intensity inhomogeneity. Considering the variance of intensity inhomogeneity, we introduce an energy term based on multi-layer structure and further incorporate it into so-called optimal evolution layer which is used to construct final energy functional. Specially, by optimizing each layer of energy term based on multi-layer structure, we obtain multiple intensity centers in local neighborhoods with different sizes of inside and outside of contour. Then, the multi-layer intensity differences are constructed by utilizing multiple intensity centers to describe each pixel point. Next, we use the proposed dual minimization method to incorporate and minimize the energy term based on multi-layer structure. On one hand, we obtain the optimal evolution layer by minimizing the multi-layer energy term. On the other hand, we obtain the final segmentation results by minimizing the final energy functional based on optimal evolution layer. The multi-layer structure extracts more intensity information and the dual minimization method adaptively determines the desirable local region size for each pixel so as to solve the problem of variance of intensity inhomogeneity. The partition of local regions in optimal evolution layer induces the accurate segmentation results. Experimental results and quantitative experimental comparisons demonstrate that the proposed method is more robust and accurate in segmenting images with intensity inhomogeneity than the classical LIC and LBF models.

Keyword: image segmentation; level set; intensity inhomogeneity; dual minimization; multi-layer structure

1. Introduction

Level set methods have been extensively applied to image segmentation [1-5]. The fundamental idea of level set method is to represent a contour as the zero level set of a higher dimensional function and formulate the motion of the contour as the evolution of the level set function. By minimizing the level set function, the evolving contour can be forced to approximate the object boundary in image.

Existing level set models for image segmentation can be categorized into two major classes: edge-based models [6-10] and region-based models [1, 11-18]. Edge-based level set models consider boundary as a discontinuation in gray values. However, it is not easy to detect weak boundary in images. Besides, this type of method is sensitive to the placement of initial contour. To address the problem, Chan and Vese [1] proposed a region-based level set model, i.e. CV model, which incorporates the Mumford-Shah [11-12] functional into a level set framework to give a piecewise

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