A contour detection method based on some knowledge of the visual system mechanisms

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Abstract

We propose a contour detection method based on the mechanisms from biological visual perception. The temporal analysis of image is the basis of the model. The temporal notion means that the static image is transformed into a data flow. Each element of the flow is treated independently from the others. Our aim is image segmentation through contour detection. The model is composed of a succession of five stages: noise reduction, asynchronous processing, isotropic filtering and adaptive smoothing, dynamic thresholding, and temporal integration. To evaluate the proposed approach, objective and subjective analyses are performed on synthetic and actual images.

INTRODUCTION

The usefulness of contour detection in a great number of applications has been well established and demonstrated. Indeed, this operation is of great help for further image analysis and scene understanding. There are many kinds of edge detectors [18-19]. Most of them are based on derivative operators that give a high response at the contour points and a low response in homogeneous areas. The oldest and simplest edge detector is undoubtedly the digital gradient operator. However, its usefulness in image processing is limited, since it is not an isotropic operator. Given the bidimensionality of the image signal, one has to ensure rotation-invariance in the design of a derivative operator. The gradient magnitude fulfills this requirement but the gradient vector does not. This limitation has led to the development of many directional gradient filters [13]. In contrast, the laplacian filter is an orientation-invariant derivative operator. However, because of the second-order derivative, this operator is more sensitive to noise than the gradient operator. One can reduce the effects of noise by smoothing the image before applying the laplacian. Marr and Hildreth adopted this strategy for designing the well-known LOG (Laplacian of gaussian) filter as a contour detection operator [14]. Other edge detectors, such as the Sobel one, are based on the same principle. However, now, no universal contour detection method has emerged. Furthermore, as compared to the great number of investigations in this field, a little effort has been spent on the design of a quantitative evaluation of the contour detection, except the pioneer work by Abdou and Pratt [22], the one by Canny [15], and other few similar works [23]. In Canny's approach, three performance criteria for good detection are defined. However, there is an inevitable trade-off