SEQUENTIAL ESTIMATION OF BOUNDARIES IN TEXTURE IMAGES

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ABSTRACT

In this paper we describe a method for estimating boundaries between perceptually distinct regions in an image. The method is a two step procedure which first identifies image regions which exhibit uniformity. Boundaries between uniform regions are approximated by a complete cubic spline function and the linear recursive filter is used to estimate the values of the function at the knots. Boundaries are assumed to be smooth; however, abrupt changes in boundary location may infrequently occur. In these exceptional cases flexibility of boundary approximation is achieved by adding additional knots at the positions where abrupt changes occur.

KEYWORDS: segmentation, splines, texture, linear recursive filter.

1. INTRODUCTION

Determination of boundaries delimiting objects and their parts in an image is recognized to be a crutial link between an image and its interpretation. It is well recognized that boundary detection in images wherein meaningful regions exhibit textural properties is a difficult task. Regions in such images can be identified by region based segmentation operators, e.g. [10,11]. However, determination of boundaries between texture regions requires further processing. Recently, attempts have been made to develop estimation theory-based boundary detectors [1,4].

This paper describes the design, implementation and performance of an estimation theory-based segmentation operator for noisy images which contain regions of uniform intensity as well as texture regions. The operator performs segmentation at the signal level and it assumes no a priori knowledge on images considered. Its essence is incorporation of region based segmentation with curve fitting to find boundaries between perceptually distinct regions in an image. First, dominant regions which exhibit uniformity and which are called cue regions are identified. Then, boundaries lying between cue regions are estimated globally.Boundaries are approximated by a complete cubic spline function. The flexibility of boundary approximation is achieved by adding additional knots at positions where boundary location changes abruptly.

The function of this segmentation operator corresponds to early vision in humans and it is viewed as a part of a multi-level modular segmentation scheme. At the first level of segmentation hierarchy this operator is employed to perform rough segmentation of an image. The obtained result is then used as an input to subsequent levels of segmentation which take advantage of knowledge on the scene domain and are task dependent. Their function is to perform refined segmentation, label cue regions and identify smaller objects that are of interest.

The method underlying identification of cue regions is described in Section 2. Boundary approximation and estimation schemes are the subject of Section 3. Results and future work are discussed in Section 4.

2. IDENTIFICATION OF CUE REGIONS

The first task of the segmentation operator is to identify cue regions and intermediate zones where boundaries between cue regions lie. Consequently, the problem of boundary estimation between regions of unknown properties reduces to the problem of boundary estimation in the ambiguity zone between two regions of known properties.

Since most of textures appearing in nature are viewed as "uniform" only as a whole while locally they exhibit various statistical and structural irregularities images are subjected to pre-processing prior to region identification. The purpose of this procedure is to eliminate minor textural detail and map texture regions into regions which exhibit higher degree of ergodicity Figure 1(b). This task is accomplished by using Gaussian filter applied locally over a pixel neighborhood and as a result local image variances decrease as a function of σ. The filter is implemented by using method of hierarchical discrete correlation [3] which performs filtering in stages and approximates Gaussian by weighted sums over small neighborhoods.

The identification of uniform regions involves generation of a T image in which each pixel (x,y) is