UNSUPERVISED SEGMENTATION OF TEXTURED IMAGES

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Abstract:

This paper describes a procedure for segmenting an image consisting of several regions with different texture into regions of similar texture. The technique does not require training prototypes but operates in an "unsupervised" mode. In addition, no knowledge about the number of regions in the underlying image is needed. Segmentation is achieved by finding "textural edges", i.e. boundaries of homogeneously textured regions. Textural edges are defined to be at positions where abrupt changes in textural features of small neighboring regions occur. To detect them, the image is scanned by a small size sliding window. Six features are extracted from the encompassed region by each window. These features are the estimated parameters of two two-dimensional, non-causal random field models which capture region characteristics in [horizontal, vertical] and [diagonal, off-diagonal] directional pairs. Sobel edge enhancement operator is used to accentuate the changes in individual features over local blocks of three windows wide by three windows high. A new image is then created in which a pixel value corresponds to a measure of "textural change" constructed from the normalized outputs of the Sobel operator and integrating the effects of all the features. This "textural change image" is thresholded to get a binary edge/no edge image. The location of the edge pixels are mapped onto the original image in the spatial domain. Finally, an edge thinning algorithm is applied to obtain one-pixel wide edges. A novel approach for automatic selection of the size of the scanning window is presented. Two window sizes are used instead of one and the common resulting edges are picked. The goodness of the method is demonstrated through experimental studies involving images containing two and three different natural textures.

Keywords:

Segmentation, texture, random field models, textural edge detection.

I. Introduction

One of the most difficult problems in image segmentation is to divide an image into distinct regions, each of which are more or less homogeneously textured, and to establish the boundaries among them. In general, the problem is an unsupervised pattern classification task in the sense that no a priori information about the number of regions and the types of textures in the underlying image is available. This is a missing feature in the majority of previously developed texture segmentation algorithms. They usually make unrealistic assumptions regarding the availability of some a priori knowledge which makes the problem easier to solve.

Addressing the problem in the stated framework presents three major issues to be resolved. They are: (1) selection of *m good* features to represent texture, (2) selection of an appropriate size for the scanning window, (3) devising a way to combine the contributions of individual features to create a measure of "total change".

There has been quite a number of different approaches toward development of textural features over the years [1],[2]. The segmentation algorithm which is presented here can employ any set of *m* features provided that they satisfy the following three requirements. (1) Within-class invariance: this means that features extracted from several images all having a similar texture should have numerically close values. (2) Between-class separation: implies that features extracted from images with different textures be quite different. (3) Low sensitivity to small sample size: means that satisfying requirements (1) and (2) should not be contingent upon availability of large size texture fields. The features extracted from small size regions should satisfy the above requirements as well. The reason for this requirement will become clear later when the algorithm is outlined.

Any set of features with strong class discrimination power will do well. In this study, our selected features are derived from a class of spatial interaction random field models called "Simultaneous Autoregressive (SAR)" model [3]. The estimates of the parameters of the SAR models fitted to the image are taken as textural features. Specifically, six parameters estimated from two different SAR models which capture region characteristics in [horizontal, vertical] and [diagonal, off-diagonal] directional pairs are used in this study. The effectiveness of such features in supervised texture classification problems as shown in [4] provided the motivation for their use in here.

A second and very important problem is how to select an appropriate size for the scanning window over