Dynamic Region Growing

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Abstract

A novel segmentation algorithm based on the region growing paradigm is presented. Unlike previous segmentation methods, this novel scheme requires neither hand-tuning of parameters nor knowledge about the scene. Instead, the parameter which controls the segmentation is dynamically *derived from the data for each region, based on a local quality measure of the region's contour. The algorithm assigns a* stability *value to each extracted region that reflects the robustness of that region. Results are shown for some gray level aerial images.*

1 Introduction

We are developing a segmentation algorithm as a first step in an image indexing and retrieval system. Some important design criteria for such a segmentation algorithm are as follows:

- The algorithm must deliver homogeneous *regions* from which various region based features (color, shape, texture, etc.) can be computed. Edges that don't form closed contours, as for example produced by the Canny edge detector [2], don't lead directly and naturally to regions (contour *gap* problem). Edge detectors that by their design produce closed contours, as for example the zerocrossings of the Laplacian of Gaussian, usually don't deliver the desired regions, especially in noisy images.

- Hand-tuning of parameters, e.g. of thresholds, is not acceptable. The system should work fully automatically.

- A measure to quantify the stability of each region must be provided.

- Because of the wide variety of images in a typical image database, no assumptions can be made about the image in terms of lighting conditions, objects to be expected, scale, number or shape of regions etc. That is, we cannot assume any domain knowledge or the existence of object or scene models.

The latter point signifies a departure from the approach most image processing systems take these days. Certainly, better results can be expected if we can integrate knowledge about the expected objects, the lighting conditions, the scene geometry, etc., but in the application we have in mind, we are much more likely to encounter images where we lack prior knowledge but still want to perform some useful actions. Therefore, it is important that the algorithm can measure the quality of the segmentation not in terms of model selection and parameter fitting but in terms of the image data itself. We propose a metric that measures the strength of a contour relative to its neighboring pixels which are not part of the contour. Since the algorithm dynamically adjusts the merging threshold for each region in order to maximize the contour strength, we call it *Dynamic Region Growing* (DRG). DRG addresses not only the automatic setting of thresholds but also the unwanted region chaining problem that has plagued many region growing algorithms [5].

Some classic region growing techniques have been described and classified in [5]. Their greatest drawback has been their dependence on a good choice of the parameters involved. A recent review [10] includes references to segmentation methods based on fuzzy logic, neural networks, and color. A seeded region growing method has been proposed in [1]. The authors claim that their algorithm does not require parameter tuning; however, it critically relies on the seed points being given as input. Active contour models ("snakes") [7] fit contours with energy-minimizing splines. These are attracted to nearby edges, but they have to be placed somewhere near the desired contour by external forces, which makes them useful in an interactive environment rather than in a fully automatic system. [15] aims at a unification of region growing with active contour models and Bayesian techniques that allow the integration of global constraints. Problems of global approaches with respect to an application in image indexing and retrieval include the