INTEGRATING METHODOLOGIES IN IMAGE ANALYSIS*

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ABSTRACT

We discuss ways by which different methodologies for image analysis may be combined for better results. We focus on the combination of region growing and edge detection to achieve better segmentation.

Introduction

After thirty years of research, the literature of image analysis (or computer vision) contains numerous methodologies for dealing with each of the problems encountered. For example, shape analysis is addressed by Fourier descriptors, polygonal approximations of contours, skeletonization, etc. Each method has its proponents and occasionally one reads debates about their relative merits. We claim that a successful attack to image analysis problems requires the simultaneous application of more than one methodology. While there is a significant literature on integrating input from different sensors, very little has been written on integrating methodologies although is by no means new [Ya76, Gr80]. However we have found only three recent references [BML86, ABM87, FH87]. The reasons for that attitude may have to do more with an academic desire for methodological purity than the adequacy of a single methodology to completely solve a problem.

Mixing of methodologies is common in practical systems, for example in OCR (reading machines). It is well known that some pairs of characters are discriminated best by their contour features (for example D and O without serifs) while others are discriminated best by skeletal features (for example E and F with serifs). See [KPB87] for a discussion of a complete character recognition system using a mixture of methodologies. We will present here some results showing combinations of region growing and edge detection. For details of the work the reader is referred to [PL88] and [LP88]. The fundamental justification for integrating methodologies is the fact that human observers use a multiplicity of clues in analyzing an image. While one might show that under ideal conditions a single methodology is sufficient (for example, skeletonization provides complete information about shape) this is not true in the presence of noise and distortions.

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Improving on the Results of Region Growing with Edge Detection

Segmentation by region growing contains artifacts around regions that do not satisfy exactly the model implied by the uniformity predicate. For example, a method will produce false boundaries because the uniformity criterion may not be satisfied over a given area even if there is no clear line where a transition occurs. For example, if the light intensity varies linearly within a region *R* and we insist that the intensity be approximately constant within a region, then there will be artificial boundaries within R. Furthermore, it is likely that such boundaries will reflect the data structures and traversal strategies used during region growing. For example, if we traverse an image along scanlines, then artificial boundaries will tend to be parallel to scan lines. The method detailed in [PL88] uses two steps after segmentation. In the first boundaries are eliminated and in the second boundaries are modified. The boundary-elimination criterion uses a merit function of the form

$$f_1(contrast) + \beta \cdot f_2(segmentation\ artifacts) \quad (1)$$

Edge modification considers edges according to a criterion

$$f_3(contrast) + \alpha \cdot f_4(smoothness) \quad (2)$$

In the sequel we use the regions produced by a split-and-merge algorithm [HP76]. Since this method uses a quad tree for the initial traversal of