CONTOUR LINE REGION SEGMENTATION

(Extended Abstract)

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ABSTRACT

In images such as of contour maps, fingerprints, and electric fields, regions of contour lines can be distinguished, and these regions are often used for image understanding. In this work, such images are collectively termed contour line images. The objectives are to determine the properties by which contour line regions are characterized, and to develop an approach using these properties to automatically determine regions. An algorithm is proposed to group lines into regions. This is based in part on the parallel-adjacency criterion which is defined here. The algorithm has been applied to several contour line images, and the resultant regions are shown.

KEYWORDS: contour line regions, image segmentation, pattern recognition

1. Introduction

It is a simple matter for a person to locate a knot in wood grain, or to recognize a pattern in marble. Patterns on contour maps can be recognized as locations of rivers or steep grades. Other constant-value plots such as flux line fields in electromagnetics and isobar maps in meteorology are interpreted by the *pattern* of lines (rather than by individual lines) to understand global information in the image. Differences in the shape of contour patterns in fingerprint images can be used, even by non-experts, to distinguish different prints. All these examples involve images of contour lines in which regions of line patterns are discerned by human viewers, and from which interpretation or recognition is performed. Although human recognition of these patterns seems trivial, it is no trivial task for a computer. In this paper, we examine properties which characterize regions in contour line images, and propose an approach for performing automatic determination of these regions.

We wish to deal with contour line images, irrespective of what the contour lines represent. The expression *contour line image* will refer to an image made up of lines (where lines can be curved) which run approximately parallel to adjacent lines, at least over short distances. The spacing between adjacent lines is often small, and the lines may be densely packed. Therefore, groups of lines appear as regions rather than boundaries. Examine Figure 1, and determine the number of contour line regions in each diagram based on the "similarity of pattern" within each region. Our experience shows that there is a general consensus in the number of regions perceived for each. It is this response that we desire to emulate by machine. (Our informal examination of the human perception of these regions is inadequate to claim that this is a universal response, however this does not lessen the interest in proposing a method for emulating what we have found to be a common response.) The common responses given for the number of regions in each diagram of Figure 1 are shown in Figure 2.

2. Method

Our objectives are to determine the properties which characterize contour line regions, and to describe an approach which utilizes these properties in order to segment regions. It is necessary to clarify some terminology before describing the properties and approach. A *contour line*, or *line*, is a straight or curved sequence of contiguous points between two endpoints. A *segment* is a straight line fit to a portion of a line. We will refer to *regions* of lines, and *groups* of segments.

First, we combine descriptions of some of the properties of contour line images into the expression **parallel-adjacency**. The parallel-adjacency criterion specifies that if a pair of segments are:

1. adjacent (i.e. not separated by other lines),
2. close in distance,
3. approximately parallel, and
4. overlap by a specified amount,