

Chapter 2

Theoretical Concepts and Technical Aspects on Image Segmentation

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ABSTRACT

Image segmentation is the process of partitioning a digital image into multiple segments (super pixels). Segmentation is typically used to locate objects and boundaries in images. The result of segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property. Adjacent regions are significantly different with respect to the same characteristics. A predicate for measuring the evidence for a boundary between two regions using a graph-based representation of the image is defined. An important characteristic of the method is its ability to preserve detail in low-variability image regions and ignoring detail in high variability regions. This chapter discuss basic aspects of segmentation and an application and presents a detailed assessment on different methods in image segmentation and discusses a case study on it.

INTRODUCTION

Image segmentation is a very significant area in computer vision. Image segmentation, partitions an image into multiple regions based on certain similarity constraints. This acts as the pre-processing stage in several image analysis problems like image compression, image recognition etc. Segmentation is the vital part for the successful extraction of image features and classification. Image segmentation can be defined as the partition of an image into several regions or categories. These regions can be similar in any features like color, texture, intensity etc. Every pixel in an image is assigned to any one of the categorised region. Quality of segmentation is described as pixels in the same region are similar in some

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characteristics whereas pixels in different regions differ in the characteristics. The segmentation process includes restoration, enhancement, and representation of the image data in the required form.

Image segmentation techniques can be broadly classified based on certain characteristics. Basic classifications of image segmentation techniques include local and global image segmentation techniques. The segmentation method that is concerned with segmenting specific parts or region of image is known as local image segmentation. The segmentation method that is concerned with segmenting the whole image, consisting of very large number of pixels is known as global image segmentation.

The next category of image segmentation method is based on the properties of the images to be segmented. It is categorised as discontinuity detection based approach and similarity detection based approach. In discontinuity detection based approach, the segmentation is based on discontinuities in the images like edge based segmentation and similarity detection based approach is based on similarity of regions like Threshold based, Region growing, Region Splitting and Merging etc. The segmentation technique which is based on the information of the structure of required portion of the image is known as structural segmentation. Most of the segmentation methods are stochastic type, where the segmentation is completely depended upon the discrete pixel values of the image.

An undirected graph, set of vertices and a set of edges, are considered. Vertex represents the pixels in an image and edges denote the connection between the adjacent pixels. There exists a source and sink node which holds the foreground and background respectively. In graph cut method, each edge is assigned with a non-negative weight which coins the term cost [20]. A graph cut is actually the partitioning of the edge set into several component sets. Graph cut method can be either min cut or max cut. Min cut can be defined as cut through minimum cost and max cut can be defined as the cut through maximum cost. That is after the cut performed, the vertices are divided into two sets, source and sink, which holds the foreground and background pixels respectively.

Implementing graph cut method assigns value 1 to the pixels in the foreground and 0 to the pixels in the background. This is achieved through minimum graph cut method by minimizing the energy function.

BACKGROUND

Graph-based image segmentation techniques generally represent the problem in terms of a graph, $G = (V, E)$ where each node $v_i \in V$ corresponds to a pixel in the image, and the edges in E connect certain pairs of neighboring pixels. A weight is associated with each edge based on some property of the pixels that it connects, such as their image intensities. Depending on the method, there may or may not be an edge connecting each pair of vertices. The earliest graph based methods use fixed thresholds and local measures in computing segmentation.

Different cluster-structures can be detected using algorithms on minimum spanning tree. The dataset used by Zahn include Fisher Iris data in four dimensional space. The work of Zahn (1971) presents a segmentation method based on the minimum spanning tree (MST) of the graph. This method has been applied both to point clustering and to image segmentation. For image segmentation the edge weights in the graph are based on the differences between pixel intensities, whereas for point clustering the weights are based on distances between points. The segmentation criterion in Zahn's method is to break MST edges with large weights, which is inadequate. Differences between pixels within the high variability region can be larger than those between the ramp and the constant region. Thus, depending on

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