Image Segmentation based on a Geometric Representation

Noboru Sugiyama (310052)

School of Information Science,
Japan Advanced Institute of Science and Technology

February 10, 2005

Keywords: image segmentation, coutour representation, computer vision.

In recent decades, computer vision has flourished in the industrial world. It is useful to develop machines that can process visual information such as assembling machines and face detection. The techniques already have achieved high level to work quickly and accurately. However, a lot of problems are left to be resolved in the field of coputer vision since some techniques work only in limited cases.

The purpose of computer vision is to analyze a scene in the real world to achieve a final goal of recognizing the scene. Since there are many processes on the system, we decompose them into a series of subproblems. The first step is preprocessing, such as noise reduction, to facilitate following steps. The second step is image segmentation which consists of dividing an image into meaningful regions. The third step is feature extraction where we pick up characteristic features of an image. The final step is recognition which is concerned with classifying the object.

To make a computer vision system as flexible as human vision, it is necessary to design a system that can recognize object in a simple way. Recently, template matching is often used to isolate features. This is a method to compare the input image with a lot of images prepared in advance. If the input image is related to the prepared images, the method is a strong ap-

proach to recognize objects. But we need to set up on a case-by-case basis, and this method is not appropriate for the purpose of flexibility.

In order to remove this defect, we should extract features from an input image and eliminate redundancy. In this paper, we present a method of image segmentation based on a simple geometric representation which describes features of images. We also propose a method for eliminating redundancy from the representation.

A number of methods for image segmentation have been proposed so far, such as thresholding, region growing, edge tracing, split-and-merge and so on. One of the features of these methods is to directly use color data to specify regions. On the other hand, human vision depends not only on colors but also on shapes. We think the shapes will be a great help in considering the problem of constructing flexible computer vision.

In this paper, we determine regions using a geometric representation without color information extracted out of images. The properties of a geometric representation help to divide an image into regions.

We focus our attention on the contour representation which is one of geometric representations. Especially, we use a set of contour lines for this purpose. Regarding brightness levels at pixels as heights, an image can be viewed as a terrain map. A contour line is a boundary of points of equal heights on the terrain.

The excellent properties of the contour representation are as follows: if we draw contour lines between pixels, they must form cycles without self intersections. They are great advantages for region segmentation. On the other side, there are so many contour lines in an image, which makes it difficult to choose nice contour lines from the contour representation.

We implemented experiments using various approaches in order to find contour lines having this feature. As a result, it turned out that it is effective to eliminate small areas and to use thresholds at which brightness histogram changes abruptly. We can reduce contour lines without degrading most features by these rules. Since it is difficult to divide an image into rough regions only using contour lines, we require another method for the purpose of the task. We combined the image segmentation based on the contour representation and image growing method with color shade.

On the basis of experimental results, it finds that the contour representa-

tion has high potentiality for constructing flexible computer vision systems, because this form is suitable to preserve geometric information. However, we have to wait for an output from a final recognition process to find out whether the extracted contour lines are truly helpful.

We explain properties of the contour representation, and present a method for selecting good contour lines. Finally we describe some influences of post-processes.