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A Study on Segmentation an Object of Arbitrary Edge Form

Satoshi Asou

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

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Digital image composition has recently received great attention for special effects in image industry. Particularly, region segmentation is one of the basic problems in image composition. Because it is a very important problem, many algorithms have been proposed in the past. "Snakes" and "Intelligent Scissors" are typical conventional methods. The former was first proposed by Kass et al, at the international conference on compute vision in 1987. At first, it tries to bring a boundary close to the true boundary based on the "power" which acts on a boundary expressed by a spline curve in the region, which is specified in an appropriate way (including manual input). The latter is proposed by Mortensen and Barrett. It is completely different from the existing method which puts more importance on continuity of an edge. In this method, a minimum cost (magnitude of image gradient, Laplacian zero-crossing, gradient direction are taken into consideration) path from one edge to all other edges, is found not only tracking an edge but also using dynamic programming.

It is the purpose of this study to develop a method which can correctly segment an object of arbitrary edge form without manual input by a mouse. But if there were no restrictions for this purpose, it would be very difficult to segment an object in an image without any knowledge in advance. Therefore, in this study it is assumed that brightness level inside an object is almost equal and distinction from a background is clear. Moreover, we do not consider the case where two or more objects are included in an image. Moreover, it is difficult to attain the goal by the above-mentioned existing methods. Then, in this study we seek an optimal segmentation in the sense that segments an image so that the intercluster distance in brightness level becomes maximum, apart from heuristic methods. However, at the first stage it is difficult to correctly segment an object of fine complicated edge form. Then, at the first stage we try to segment an object globally (global region segmentation), and an initial bondary is extracted. The segmentaion based on the standard discrimination analysis is one of the methods which can achieve our goal without any manual input by a mouse. In this method it is assumed that an object region is formed in 4-connectivity and we do not consider the case where two or more objects are included in an image. Moreover, the case where a boundary of an object region is not monotone on real image is considered, but even in such a case we assume that an object region is surrounded by a monotone curve in horizontal direction or vertical direction in order to obtain the polynomial-time algorithm, and segment an object globally. In global region segmentation, the following should be solved. First we consider the case where no reasonable object region is extracted on a real image due to our assumption that the boundary of an object region is must be a monotone curve in horizontal direction or vertical direction. The other case we have to consider is that an object delicately connected with a main connected region cannot be extracted well due to our assumption that an object region is formed in 4-connectivity. For example, when a region is not merged with others having the same brightness level, even if one is judged to be an object region it is difficult to judge both object regions simultaneously. In order to correctly segment an object of fine complicated edge form, it is necessary to solve such problems. Then we evaluate segmentation locally along a boundary extracted in global region segmentation. Specifically, we perform binarization using Otsu's automatic threshold selection method in a local region along a boundary without taking connectivity into consideration (local region segmentation). In addition, in local region segmentation local region size depends on magnitude of image gradient. Generally speaking, a region extracted along an edge of an object has large magnitude of gradient, while a region separated from an edge has small magnitude of gardient. In a region which has small magnitude of gradient, region size to be evaluated must be large to include an edge of an object. Therefore, the larger the magnitude of gradient is the smaller region size to be evaluated is, while the smaller the magnitude of gradiente is the larger region size to be evaluated is. As a result a pixel which is regarded as an object region but is not connected with a main connected region often exists. If so, it must be the case that a region to be connected with a main region is interrupted by shadow of an object or that there are noises around the region. In the latter case we have to remove those noises. We consider the distance from a pixel to the main connected region to be relatively small in the former case, and large in the latter case. Therefore, as fine adjustment of the last stage, noises are removed based on the distance from a pixel to the main connected region.

In this paper we propose a method in which global region segmentation is combined with local region segmentation. We have implemented the proposed method. The results imply the following: First, we find that to some extent we can segment an object if we implement the proposed method to the sample image satisfying our assumption. However, if it does not, it is difficult to correctly segment an object. Secondly, in the proposed method we can segment an image including many fine complicated edge correctly, while in the existing method it is difficult to segment such an image. Thirdly, in the proposed method we can speed the algorithm for segment an object with manual input by a mouse in the existing method such as "Snakes" and "Intelligent Scissors".