Höhenkarten-basierte Bildsegmentierung
Image Segmentation Based on Height Maps

Projektleiterin
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Abstract
In this paper we introduce a new method for image segmentation. It is based on a height map generated from the input image. The height map characterizes the image content in such a way that the application of the watershed concept provides a proper segmentation of the image. The height map enables the watershed method to provide better segmentation results on difficult images, e.g., images of natural objects, than without the intermediate height map generation. Markers used for the watershed concept are generated automatically from the input data holding the advantage of a more autonomous segmentation. In addition, we introduce a new edge detector which has some advantages over the Canny edge detector. We demonstrate our methods by means of a number of segmentation examples.

1 Introduction
In this paper we introduce a new method for image segmentation. It is based on a height map which is generated from the gray values of the input image. Among the different methods for image segmentation morphological watersheds have some advantages. They yield more stable results in comparison to other segmentation concepts such as detection of discontinuities, thresholding, or region processing. But they also have a drawback. Watersheds work on height level images. The association with height maps refers directly to the input image. If an image is interpretable as topographic image, such as images of cells under a microscope, watersheds perform well. To apply watershed segmentation to arbitrary images such as photographs of natural objects we propose to generate a height map which characterizes the content of the image in an appropriate way. A simple interpretation of an arbitrary image, e.g., of a tree, as height map would make no sense. We introduce the derivation of an appropriate height map from an edge filtered version of the input image. For that purpose we propose a new edge detector related to the Canny edge detector, but endowed with some advantages. This enables us to apply the watershed concept for the segmentation of arbitrary images and to exploit its friendly properties also for difficult images such as those depicting natural objects. The segmentation based on height maps is derived in section 2, section 3 describes some results, and in section 4 we conclude the paper with a summary.

2 Image Segmentation Based on Height Maps
In figure 1 an overview of the proposed image segmentation method is given. We start with the original image to be segmented. An edge detector is applied to the gray values of this image resulting in an edge image. From this binary edge image we generate a topographic image, the gray values of which can be interpreted as different height levels (figure 2). Given this height map a skeleton image is derived, which is again a binary image. The height map is the source image for the watershed algorithm, which is applied utilizing the skeleton image as markers. This results in the final segmentation of the original image (figure 3). The details of our approach are described in [CAIP 2007].

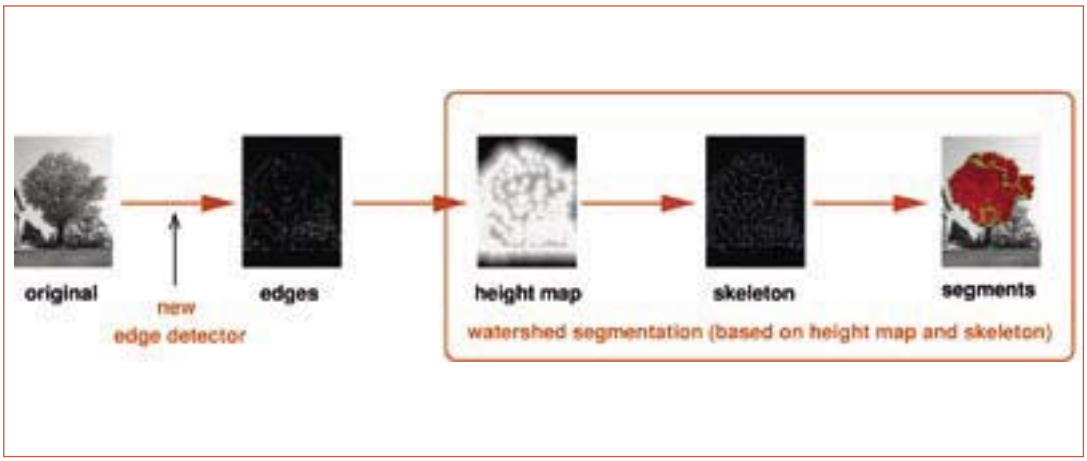

Figure 1. Image segmentation based on height maps, overwiew. The contributions of this project are highlighted in red.

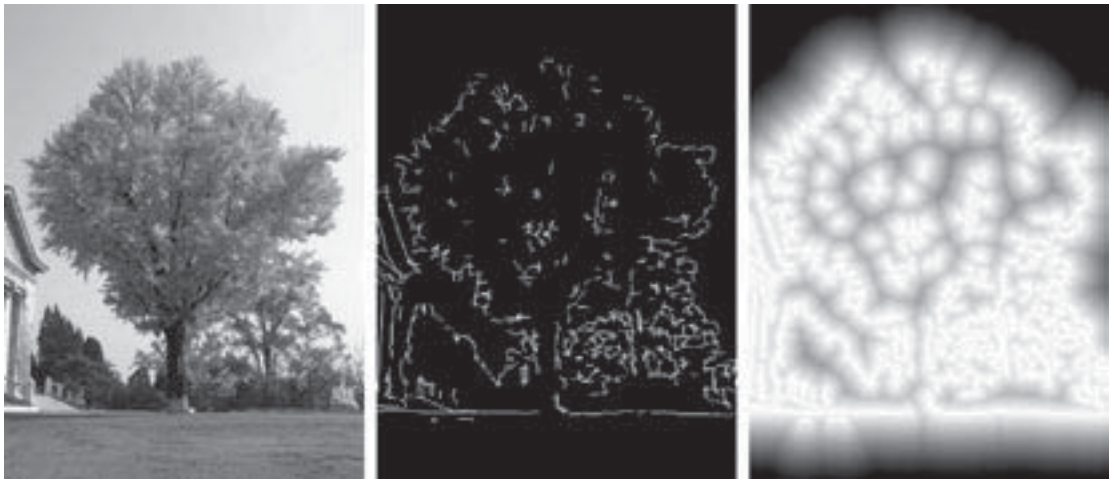

Figure 2. Edge image and height map. Left: original gray value image. Middle: binary edge image. Right: gray value height map. Note the gap in the top of the tree outline in the edge image. The height map compensates perfectly for this deficiency.

Figure 3. Skeleton images and final segmentation. Left: skeleton image of the same original image as depicted in figure 2, generated with a 3 x 3 Laplace filter. Middle: skeleton image generated with an 11 x 11 Laplace filter. Right: parts of the segmentation after applying the watershed algorithm with the left skeleton image as marker.

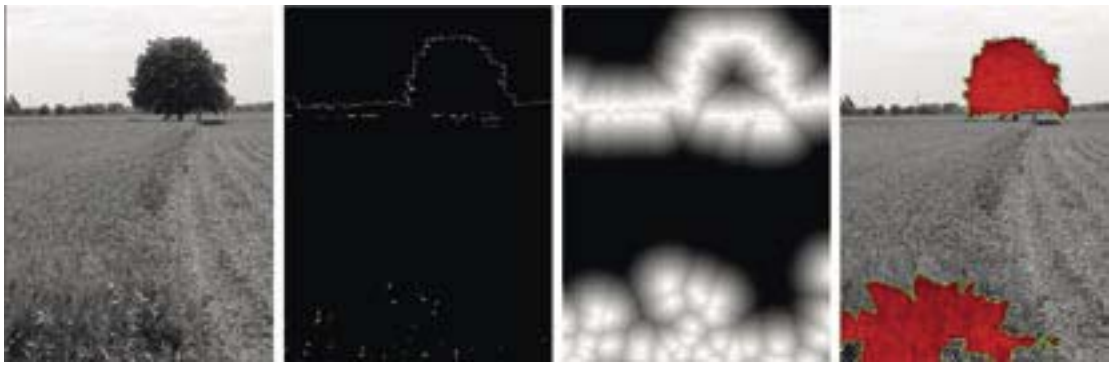

Figure 4. Example of image segmentation based on height maps. First: original image. Second: edge image. Third: height map. Fourth: parts of the resulting segmentation.

3 Results

For the evaluation of the proposed segmentation method we chose images depicting natural objects such as trees as these are typically difficult to segment. A first example is depicted in figure 2. The height map compensates for gaps in the outline of the tree in the edge image. The resulting segmentation of the tree is fairly well accomplished and the foreground tree is separated from the tree in the background although these image areas are quite similar in terms of texture (figure 3). Regrettably, the final fusion of similar segments turned out to be the weak point of the whole segmentation process as it was difficult to choose the values of the thresholds for average, variance, and entropy in such a way that neither an oversegmentation nor an undersegmentation occured, and this still for a series of different examples. But in the second example displayed in figure 4 our approach provided one segment for the tree and another for the dominant tuft in the foreground which corresponds quite well to our human perception. The separation between the tuft and the surrounding image areas can be regarded as difficult, because they are quite similar in structure. In addition, here again a gap in the contour of the tree poses no challenge for the further processing.

References

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- Jochen Kerdels, Dynamisches Lernen von Nachbarschaften zwischen Merkmalsgruppen zum Zwecke der Objekterkennun, diploma thesis, Technical University Dortmund, 2006.