Watershed segmentation: switching back and forth between markers and hierarchies

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Watershed from markers

In the watershed from markers approach [2], the segmentation problem is reduced to the problem of finding a proper set of markers for the objects and for the background of the image to be segmented. The watershed lines are computed so as to partition the image into regions, each marker corresponding exactly to one region.

For this reason, the watershed from markers is a suitable approach for interaction: handling the set of markers interactively, the user can manage the segmentation process, obtaining the image segmented in the desired level of detail.
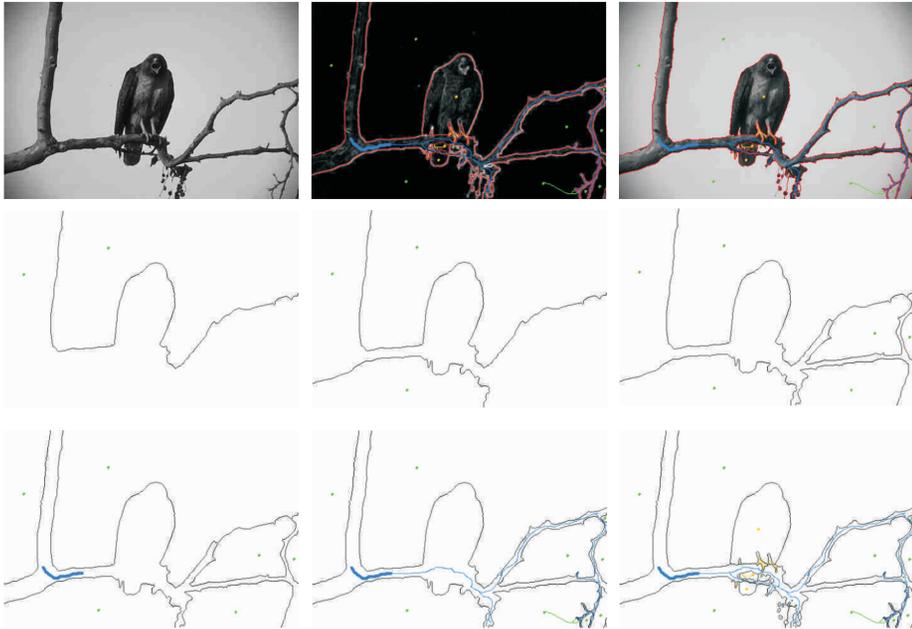
The images above were obtained using our interactive tool for image segmentation [1], available from http://www.ime.usp.br/~klava/tfs/. The tool is based on the watershed from markers, and the user interaction focuses on the manual edition of the set of markers used by the algorithm.
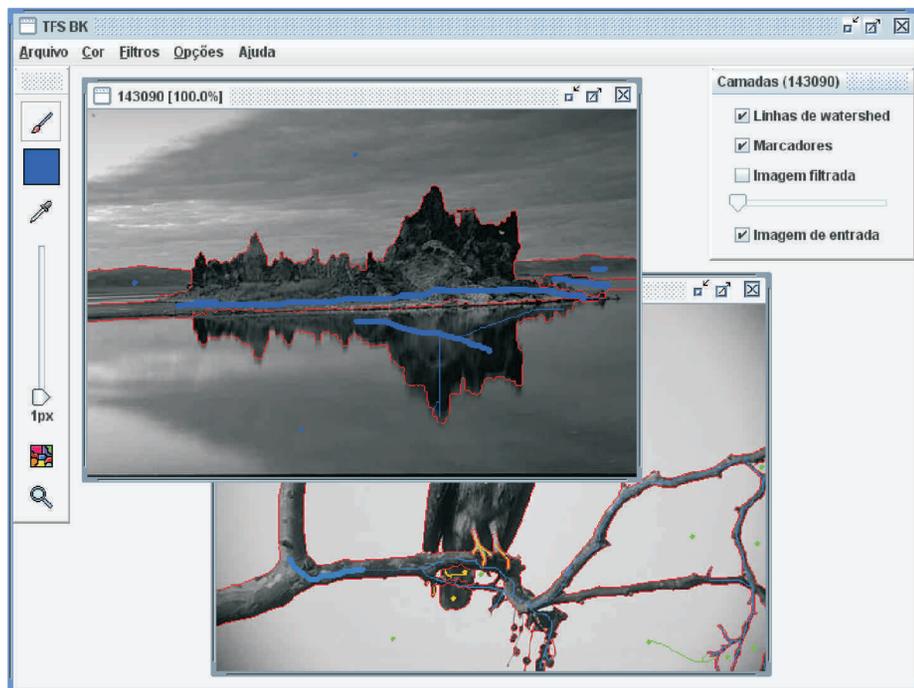
Although being a suitable approach for user interaction, watershed from markers for complex segmentation requires a lot of interaction (marker redesign), as can be seen in the examples below:
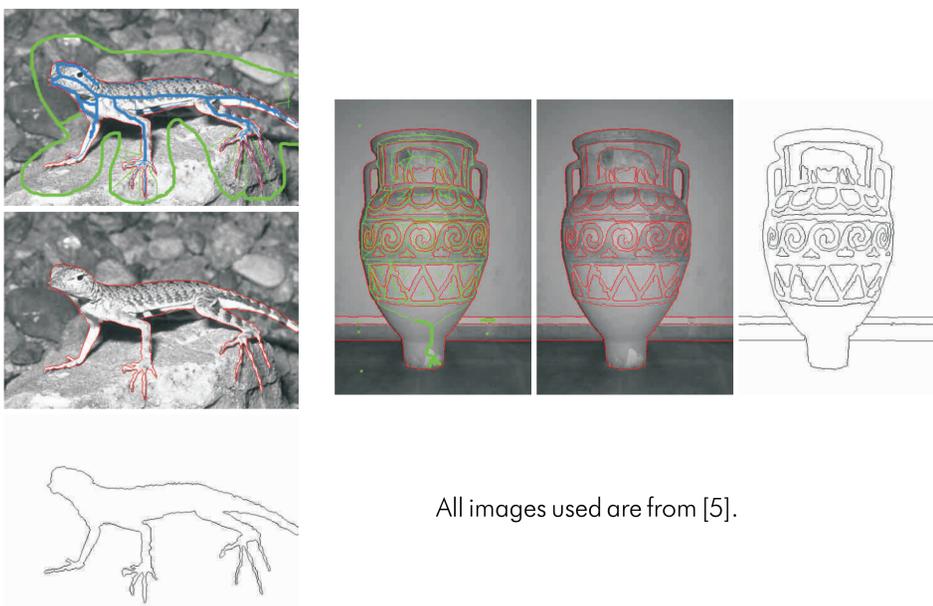

All images used are from [5].

Hierarchical watershed

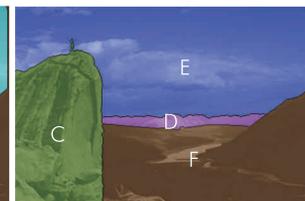The hierarchical watershed generates a set of images segmented in different levels of resolution [4], from which one can choose the level of segmentation of each region of interest. This choice is made through various cuts on the hierarchical structure, that generally has a large vertex set, once it is proportional to the number of local minima of the image. To achieve this goal, a suitable approach is to manipulate the hierarchical structure through three operations, as proposed in [3]:
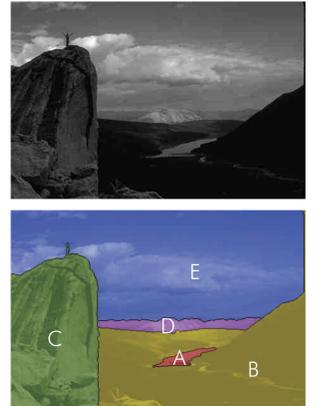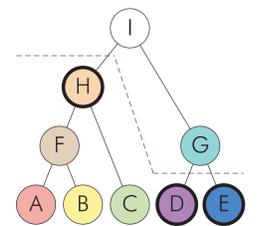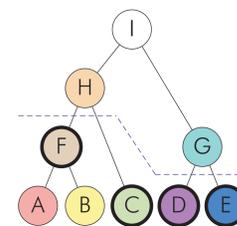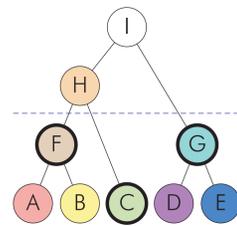

choice of the number of regions (through a slider)　　split a region　　merge regions
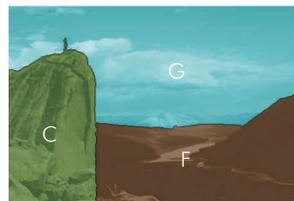
Notice that these operations can be done in user real time, once the hierarchical structure have to be constructed only once.

Combining watershed from markers and hierarchical watershed

Currently, we are investigating the relation between markers and the hierarchical watershed as a method to reduce the interaction effort to achieve a satisfactory segmentation result. More specifically, we would like to:

* **given a hierarchical structure, with cuts at several levels, generate a set of markers that, used in the watershed from markers algorithm, results in the same partition of the image;**

* **given a set of markers and the corresponding partition of the image, do appropriate cuts at the structure of the hierarchical watershed in order to obtain the same segmentation result.**

With functionalities like these, the user can be benefited by alternating between the two approaches. For example, a manner to obtain quick results by alternating between the two watershed approaches would be: the user selects a level at the hierarchical structure, using a slider control to find a partition that most approximates to the desired result; then, switching to the markers approach, the user handles the automatically generated markers set, refining just the necessary details. In this way, the user doesn't need to create manually the markers for each object of the image, just correcting the regions that weren't segmented as desired by the hierarchical watershed.

References

[1] BRUNO KLAVA, *Ferramenta interativa para segmentação de imagens digitais*, December 2006.

[2] S. BEUCHER and F. MEYER, *Mathematical morphology in image processing*. The morphological approach to segmentation: the watershed transformation (E. Dougherty, ed.), M. Dekker, 1993.

[3] B. MARCOTEGUI, F. MEYER and F. ZANOGUERA, *A toolbox for interactive segmentation based on nested partitions*, International Conference on Image Processing 1 (1999), 21-25.

[4] S. BEUCHER, *Mathematical Morphology and its Applications to Image Processing*. Watershed, hierarchical segmentation and waterfall algorithm (J. Serra and P. Soille, eds.), Eds. Kluwer Acad. Publ., Dordrecht,1994.

[5] Computer Vision Group of Berkeley University of California, *The Berkeley Segmentation Dataset and Benchmark*, available from <http://www.eecs.berkeley.edu/Research/Projects/CS/vision/grouping/segbench/>.