A HYBRID ALGORITHM FOR THE SEGMENTATION OF 2D/3D IMAGES

Stelios ORPHANOUDAKIS, George TZIRITAS, Kostas HARIS
Institute of Computer Science, FORTH and
Department of Computer Science, University of Crete
P.O. Box 1385, 71110 Heraklion, Crete, Greece

The hybrid segmentation algorithm described in this communication assumes a piece-wise image model and is based on the integration of edge and region based techniques. First, adaptive smoothing is applied to the input image followed by gradient estimation, the detection of watersheds in the gradient magnitude image, and hierarchical region merging to get around the problem of oversegmentation which is characteristic of the watershed algorithm.

Edge-preserving adaptive smoothing of the input image is achieved by the statistical local classification method described in [1]. Then, the Canny gradient operator [2] is applied to the smoothed image and a preliminary segmentation is obtained by detecting the watersheds of the gradient magnitude image [3]. Oversegmentation, a known drawback of the watershed algorithm, is limited by the first stage of noise reduction and by thresholding the gradient magnitude in order to retain regions with a relatively high contrast. However, there still remain neighboring regions which can be merged to obtain a more accurate segmentation. For this purpose, a hierarchical region merging process has been implemented which merges the most similar pair of neighboring regions at each iteration. A brief description of this process follows.

Having obtained a good initial segmentation of the input image into K segments, a cost function F is defined over the space of the K-partition. Assuming that the optimal $(K-1)$-partition with respect to F is produced from the optimal K-partition by merging a pair of neighboring regions, good suboptimal solutions to a difficult combinatorial optimization problem are found by a stepwise optimization approach [4]. Partitions are represented by the Region Adjacency Graph (RAG) [5]. The *Most Similar Neighbor Graph (MSNG)* is introduced to allow consideration of the fact that it is not necessary to store all edges of the RAG so that the memory and computational requirements of the algorithm may be reduced.

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The hybrid segmentation algorithm described above has been applied to 2D MR images with very good results as shown in Figure 1. The total execution time for a 256x256x8bit image is approximately 10sec on a SUN4. The algorithm has been extended in a straightforward manner for the segmentation of 3D images and can be easily adapted for use in an interactive medical image processing environment by allowing the user to control the stopping point of the iterative hierarchical merging process.

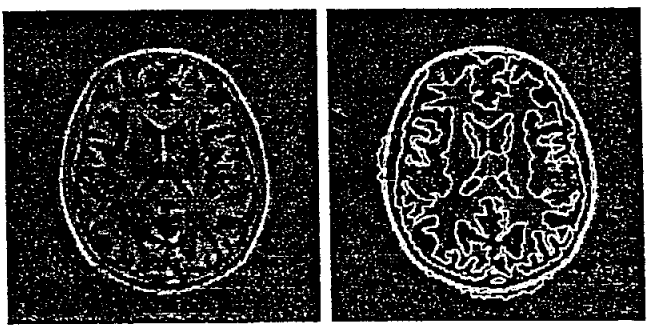

Figure 1: Original MR image (left) and segmented image overlaid on original (right)

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