Multiresolution CT Head Image Analysis using Simulated Annealing

Sven Lončarić and Zoran Majcenić

Faculty of Electrical and Computer Engineering, University of Zagreb
Unska 3, 10000 Zagreb, Croatia

Segmentation of computed tomography (CT) head images is an important step in quantitative analysis of human spontaneous intracerebral brain hemorrhage (ICH). A multiresolution probabilistic approach for segmentation of CT head images containing ICH primary and edema regions is presented in this work. In this method, the segmentation problem is viewed as a pixel labeling problem. In this particular application the labels are: background, skull, brain tissue, and ICH. The proposed method is based on the Maximum A-Posteriori (MAP) estimation of the unknown pixel labels (i.e. the segmented image). The MAP method maximizes the a-posterior probability of segmented image given the observed (input) image. Markov random field (MRF) model has been used for the posterior distribution. The MAP estimation of the segmented image has been determined using the SA algorithm. The SA algorithm is used to minimize the energy function associated with MRF posterior distribution function.

The problem in the practical realization of the algorithm is that even for a moderately sized image, e.g. 256×256 the number of variables (i.e. pixels to be labeled) in the optimization space is $65,536$. This number is even larger in case of higher resolution images. This is the reason for the large computational complexity of the algorithm leading to a long execution times. To overcome this difficulty and speed up the algorithm we have developed a multiresolution image analysis approach as follows. In the first step of the algorithm, the SA segmentation is performed on 64×64 image hence reducing the number of variables in the optimization space and decreasing the algorithm complexity. In the subsequent step at double resolution, a subset of pixels from previous resolution is used as initial approximation for the segmentation at next higher-resolution level. The pixel subset consists of pixels that most likely have been correctly segmented at the previous resolution. In such a manner, the computational complexity of the algorithm is reduced up to five times. Experimental results have demonstrated that the proposed multiresolution segmentation procedure performs accurate segmentation at the reduced computation cost.

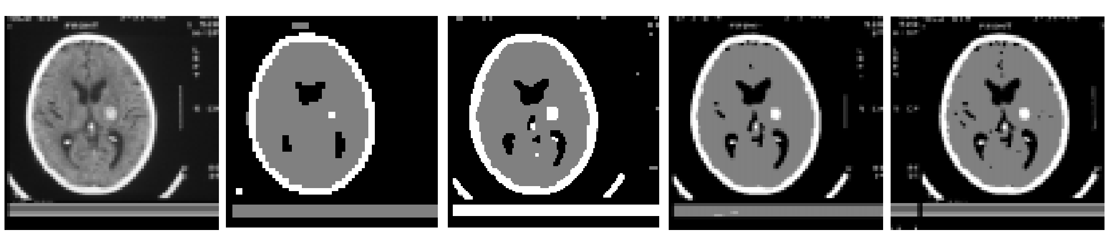

Figure 1: Original image and segmentation results at resolutions of 64, 128, 256, and 512 pixels.