Information Theoretic Criteria for Bayesian Image Segmentation

The need for an accurate model of patient anatomy for 3-D RTP motivates the development of automated contouring methods. Our approach, based on the integrated maximum *a posteriori* (MAP) analysis of region texture, flexible modeling of gradient-edge coincidences, and prior shape (Chakraborty, *et al*., IEEE TMI, 15:859, 1996), adapted for 3-D RTP (Hibbard, AAPM Abstract WE-D4-10, 1998), assumes stationary Gaussian distributions for voxel textures and contour shape parameters. Voxel and shape data may both deviate from the Gaussian model, so robust MAP inference of organ and tumor boundaries without relying on explicit statistical models would be advantageous. Cover and Thomas (1991) demonstrated that MAP inference via the likelihood ratio test has an equivalent expression in terms of relative entropies of the observed data distributions. This makes possible hypothesis testing on observed data without dependence on any underlying statistical model. An optimal contour that best matches a true object boundary is one for which voxel intensity distributions inside and outside the contour correspond to a maximum in their relative entropy; a single object interior is certainly likely to have a different distribution than the object exterior (the rest of the patient) to which it is being compared. Likewise, shape parameter distributions are most like prior distributions when their relative entropies are minimum. The use of these entropy measures in an automated contouring tool will be demonstrated for defined-content, synthetic images and for actual CT images.

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