Direct Segmentation of Tomographic Data By Level-Set Surface Models

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Under ideal circumstances the problem of tomographic reconstruction is well-posed, and measured data are sufficient to obtain accurate estimates of volume densities. In such cases segmentation and surface estimation from the reconstructed volume are justified. In other situations the reconstructed volumes are not suitable for subsequent segmentation or visualization. This can happen in the case of incomplete sinograms, noise in the measurement process, or misregistration of the views.

This paper presents a direct approach to the segmentation and visualization of incomplete and noisy tomographic data. The strategy is to impose a fairly simple model on the data, and treat segmentation as a problem of estimating the interface between two substances of somewhat homogeneous density. The segmentation is achieved by simultaneously deforming a surface model and updating density parameters in order to achieve a best fit between the projected model and the input sinograms. The deformation is implemented with level-set surface models, calculated at the resolution of the input data. The formulation is novel, and several computational innovations make the approach feasible with state-of-the-art computers. The usefulness of the approach is demonstrated by reconstructing the shape of spiny dendrites from electron microscope tomographic data.