Abstract

This thesis deals with surface extraction from noisy volumetric images, which is a common problem in medical image analysis. Due to noise, the use of *a-priori* information about surface topology and shape is necessary for automatic surface extraction methods. Deformable surface models can incorporate such geometric knowledge into extraction process which is restated as an energy minimization problem. A drawback of deformable models is that the formulated minimization problem is difficult to solve because of numerous local minima and a large number of variables. This difficulty may lead to sensitivity to the initialization, complicating the unsupervised use of deformable models. The main contributions of this thesis are algorithms for solving the minimization problem globally. We propose two classes of algorithms for the task, *Dual surface minimization* (DSM) and a hybrid of real-coded genetic algorithms and a greedy algorithm (GAGR). By global optimization of the energy of the deformable models, we are capable of reducing the initialization sensitivity of deformable surface models, and hence enabling automation of surface extraction. Moreover, these methods for global optimization do not lead to unforseeable sensitivity to values of the model parameters, another problem common with deformable models. As our second contribution, we extend a shape modeling approach for two-dimensional contours to surfaces and analytically derive a shape model for the sphere (surface). We also consider surface extraction from positron emission tomography (PET) images as an application of the deformable model based on the DSM algorithm. This task is problematic because of high noise levels in PET as compared to the contrast of the images. Our automatic method based on the proposed deformable model reliably yielded extraction results of good accuracy as compared to the imaging resolution. The success in this application demonstrates the good properties of global optimization - based deformable models for automatic surface extraction.