DISSERTATION ABSTRACT
Integrated Surface Model Optimization from Images and Prior Shape Knowledge

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Abstract

The dissertation describes an integrated Bayesian solution to the surface model optimization problem, which is a model-based computer vision problem. In the integrated framework, the observed images and the prior shape knowledge are combined to make the most consistent inference about unknown surface models using the maximum *à posteriori* rule.

Typical model-based computer vision techniques divide the overall problem into two separate low- and high-level subproblems. In the low level, edge detection or image segmentation is performed. In the high level, geometric models are fit to the features detected from the low level. This paradigm has proven insufficient when the image quality is too poor to reliably detect accurate features.

Unlike previous approaches, the integrated approach unifies the two levels through a pixel class prediction mechanism. A putative surface model is generated from a catalog of representative surface models. For each pixel, its appearance probability profile from different classes is first computed, based on the observed images. Then the class predication probability profile is also computed, based only on the putative surface model. An optimal surface model has the best overall match between these two profiles for all the pixels.

The pixel appearance probability model and the pixel class prediction probability models are estimated jointly by the expectation maximization algorithm. For the pixel appearance probability model, the statistically effective and computationally efficient non-parametric optimal quantization representation is employed. For the pixel class prediction probability model, the intensity, exponential, or hyperbolic decaying parametric models are suggested.

3-D echocardiography is an important application of the integrated approach. Quantitative experimental results on left ventricle surface model optimization show the advantage of the integrated approach, and verify the theoretical arguments for the integrated approach.