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Major Research Interest: **Image processing, medical imaging, inverse problems, numerical analysis, fast iterative methods, convex minimizations, parallel computing**

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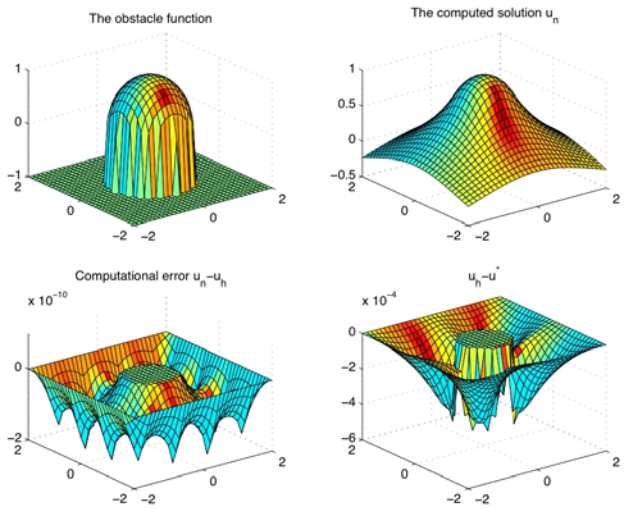
Image Processing

Modern technology is producing an enormous amount of data. We need to analyze and extract information from these data. For image processing, restoration, segmentation and registration are some of the fundamental tasks. In order to deal with images of different natures, special methods need to be used and mathematical modeling is of crucial importance. In the last decades, several new models have been proposed by my research group for noise removal, segmentation using level set methods. We have also applied these new models for MRI medical image processing and other medical and industrial image construction. These new techniques could have fundamental impact on many problems related to interface constructions. The image above shows extracted information from a 3D MRI brain image. The image below shows a restored image from an image with text.

Numerical Analysis

For image processing and applications of many other modern technologies, numerical simulation is the foundation. Especially, numerical schemes for the solutions of partial differential equations are very important. It is known that different approximation and numerical schemes shall be used for different kind of equations. Better schemes could give numerical solutions that are many times faster and accurate. This requires proper designing, analyzing and implement of the schemes. One of my research concerns is to design and analyze stable, fast numerical schemes for different equations. We have been working with finite element and finite difference methods for special singular perturbed problems and nonlinear non-traditional equations. Multigrid and domain decomposition methods have been studied for fast simulations and parallel computations.



The figure above shows the accuracy and numerical results of a fast multigrid algorithm for solving mechanical problems that must satisfy some constraints with the solution.

Selected Publications

X..-C. Tai and J. Xu: Global convergence of subspace correction methods for convex optimization problems, Math. Comp. 71, 105-124 (2001).

K. Mardal, X.-C. Tai and R. Winther: A robust finite element method for Darcy-stokes flow, SIAM J. Numer. Anal. 40, 1605--1631 (2002).

X.-C. Tai: Rate of convergence for some constraint decomposition methods for nonlinear variational inequalities, Numer. Math. 93, 755-786 (2003).

T. F. Chan and X.-C. Tai: Level Set And Total Variation Regularization For Elliptic Inverse Problems With Discontinuous Coefficients, Journal of Computational Physics, 193, 40-66 (2003).

M. Lysaker. S. Osher and X.-C. Tai: Noise Removal Using Smoothed Normals and Surface Fitting, IEEE Transaction on Image Processing, 13, 1345-1457 (2004).

J. Lie, M. Lysaker and X.-C. Tai: A Binary Level Set Model and Some Applications to Mumford-Shah Image Segmentation, IEEE Transection on image processing, 15, 1171-1181 (2006).