

Yen-Hsi Richard Tsai

Office

Department of Mathematics
University of Texas at Austin
Austin, TX 78712
Phone: (512) 471-7133
Fax: (512) 471-9038

Residence

1705 Ravey St.
Austin, TX 78704
phone: (609) 933-1114
URL: <http://www.ma.utexas.edu/users/ytsai>
Email: ytsai@math.utexas.edu

EDUCATION AND APPOINTMENTS

- 2007- Associate Professor
Mathematics Department and Institute for Computational Engineering and Sciences (ICES),
University of Texas at Austin. (Tenure approved Dec 2006, effective Sept 2007)
- 2004-2007 Assistant Professor
Mathematics Department and Institute for Computational Engineering and Sciences (ICES),
University of Texas at Austin.
- 2002-2004 Veblen Research Instructor
Joint employment of Princeton University and Institute for Advanced Study.
- 2002 Ph.D. Mathematics, University of California Los Angeles, June 2002.
Thesis advisor: Professor Stanley Osher.
- 1999 M.A. Mathematics, University of California Los Angeles.
- 1995 B.S. Mathematics, National Taiwan University, Taiwan.

HONORS AND AWARDS

- Frank Gerth III Research Fellowship, 2007-present.
- Alfred P. Sloan Fellowship, 2006-2008.
- Visiting Fellowship of the Isaac Newton Institute for Mathematical Sciences, 2007.
- Veblen Research Instructorship, Institute for Advanced Study and Princeton University, 2002-2004.
- The FEMLAB Prize, April 2002.

RESEARCH INTERESTS

- Multiscale problems, modeling, and the related numerical methods.
- Inverse source problems and optimization involving visibility
- High frequency wave propagation
- Level set methods and their applications

RECENT FUNDINGS

- 2009-2012 PI, NSF Algorithms for Threat Detection (ATD) \$382,484
Dynamic Visibility and Inverse Source Problems in Unknown Environments with Complicated Topology.
DMS-0914465.
- 2009-2012 PI, NSF Computational Mathematics. \$236,401
Inverse Problems Methods in Chemical Threat Detection.
DMS-0914840
- 2007-2010 co-PI NSF Computational Mathematics. \$555,467
Multiscale Computations of Stiff Oscillatory Ordinary Differential Equations.
DMS-0714612.
- 2009-2010 PI, DoD. \$125,000
Model Classes, Approximation, and Metrics for Dynamic Processing of Urban Terrain Data.
MURI sub-contract from Univ. of S. Carolina grant No. W911NF-07-1-0185.
- 2007-2009 PI, DoD. \$302,083
Model Classes, Approximation, and Metrics for Dynamic Processing of Urban Terrain Data.
MURI sub-contract from Univ. of S. Carolina grant No. W911NF-07-1-0185.
- 2007-2009 co-PI, Chevron, \$225,179
High Fidelity Gaussian Beams for Seismic Imaging.

POST-DOC MENTORING

- 2009- Jay Chu, Bing Instructor at UT Austin.
- 2007- Nick Tanushev, RTG Lecturer at UT Austin.
- 2006-2009 Gil Ariel, Bing Instructor at UT Austin (currently an assistant professor in Isreal)
- 2005-2007 Richard Sharp, ICES Post-Doc Fellow (currently a post-doc at CMU)

STUDENT ADVISING

- 2009- Hector Chang, PhD student at UT Austin.
- 2009- Seong Jun Kim, PhD student at UT Austin.
- 2006-2008 Yanina Landa, PhD student at UCLA.
- 2006-2007 Michael McCoy (VIGRE undergraduate research mentor. Now at Caltech ACM PhD program.)

PUBLICATIONS IN REFEREED JOURNALS

- Gaussian beam decomposition of high frequency wave fields
N. Tanushev, B. Engquist, and R. Tsai.
To appear in *J. Comput. Phys.*
- Diffusion generated motion using signed distance functions
S. Ruuth, S. Esedoglu, and R. Tsai.
To appear in *J. Comput. Phys.*
- A reversible multiscale integration method
G. Ariel, B. Engquist, and R. Tsai.
To appear in *Comm. Math. Sci.*
- Numerical multiscale methods for coupled oscillators
G. Ariel, B. Engquist, and R. Tsai.
Multiscale Model and Simul, Vol. 7, No. 3, pp1387-1404, 2009.
- A multiscale method for highly oscillatory ordinary differential equations with resonance
G. Ariel, B. Engquist, and R. Tsai.
Math. Comp., 78(266):929–956, 2009.
- Visibility of point clouds and exploratory path planning in unknown environments
Y. Landa and R. Tsai.
Communications in Mathematical Sciences., 6(4), 2008.
- Threshold dynamics for high order geometric motions
S. Esedoglu, S. Ruuth, and R. Tsai.
Interfaces and Free Boundaries, 10(3), 2008.
- Redistancing by flow of time dependent eikonal equation
L.-T. Cheng and Y.-H. Tsai.
Journal of Computational Physics, 227(8):4002–4017, 2008.
- Properties of a level set algorithm for the visibility problems
C.-Y. Kao and R. Tsai.
Journal of Scientific Computing, 35(2-3), 2008.
- Threshold Dynamics for the piecewise constant Mumford-Shah Functional
S. Esedoglu and Y.-H. Tsai.
Journal of Computational Physics, 211(1):367-384, 2006.
- Multi-valued solution and level set methods in computational high frequency wave propagation
H. Liu, S. Osher and R. Tsai.
Commun. Comput. Phys., 1, pp. 765-804, 2006.
- Visibility Optimizations using Variational Approaches
L.-T. Cheng and R. Tsai.
Communications of Mathematical Sciences, Vol 3(3), 2005.

- Computing Multi-Valued Physical Observables for the High Frequency Limit of Symmetric Hyperbolic Systems
 S. Jin, H. Liu, S. Osher, and R. Tsai.
Journal of Computational Physics, Vol 210(2), December, 2005.
- Total Variation and Level Set based Methods in Image Science
 Y.-H. Tsai and S. Osher.
Acta Numerica 2005.
- Discretization of the Dirac δ functions in Level Set Methods
 B. Engquist, A.-K. Tornberg, and R. Tsai.
Journal of Computational Physics, Vol 207(1), July, 2005.
- Computing Multivalued Physical Observables for Semiclassical Limit of the Schrodinger Equation
 S. Jin, H. Liu, S. Osher, and R. Tsai.
Journal of Computational Physics, Vol 205(1), May 2005.
- Heterogeneous Multiscale Methods for Stiff ODEs
 B. Engquist and Y.-H. Tsai.
Mathematics of Computations, 74 (2005), 1707-1742.
- Fast Sweeping Algorithms for Hamilton-Jacobi Equations
 C.-Y. Kao, S. Osher, and Y.-H. Tsai.
SIAM, Journal of Numerical Analysis, Vol 42, No 6, 2005.
- Visibility and its Dynamics in a PDE Based Implicit Framework
 Y.-H. R. Tsai, L.-T. Cheng, S. Osher, P. Burchard, and G. Sapiro.
Journal of Computational Physics, Vol 199(1), 2004.
- Level Set Methods and Their Applications in Image Science
 Y.-H. Tsai and S. Osher.
Communications in Mathematical Sciences, Vol 1(4), 2004.
- Reflection in a Phase Space Based Level Set Framework
 L.-T. Cheng, M. Kang, S. Osher, H. Shim, and Y.-H. Tsai.
Computer Modeling in Engineering and Sciences 2003.
- Estimation of 3D Surface Shape and Smooth Radiance from 2D Images: A Level Set Approach
 H. Jin, A. J. Yezzi, Y.-H. Tsai, L.-T. Cheng, and S. Soatto.
Journal of Scientific Computing Vol 19, No. 1-3, 2003.
- Fast Sweeping Methods for a Class of Hamilton-Jacobi Equations
 Y.-H. R. Tsai, L.-T. Cheng, S. Osher, and H.-K. Zhao.
SIAM Journal of Numerical Analysis, Vol 41, Num 2, 2003.
- A Level Sets Approach for Computing Discontinuous Solutions of Hamilton-Jacobi Equations
 Y.-H. R. Tsai, Y. Giga and S. Osher.
Mathematics of Computations, Vol 72, 2003.
- Geometric Optics in a Phase Space Based Level Set and Eulerian Framework
 S. Osher, L.-T. Cheng, M. Kang, H. Shim, and Y.-H. Tsai.
Journal of Computational Physics, Vol 179(2), 2002.

- Rapid and Accurate Computation of the Distance Function Using Grids
Y.-H. R. Tsai.
Journal of Computational Physics Vol 178(1), 2002.

PUBLICATIONS IN REFEREED PROCEEDINGS

- Multiscale computations for highly oscillatory problems
G. Ariel, B. Engquist, H.-O. Kreiss, and R. Tsai.
In B. Engquist, P. Lötstedt, and O. Runborg, editors, LNCSE. Springer, 2008.
- Discovering point sources in unknown environments
M. Burger, Y. Landa, N. Tanushev, and R. Tsai.
In WAFR 2008: The Eighth International Workshop on the Algorithmic Foundations of Robotics, 2008.
- Threshold and redistancing dynamics for geometric motions
S. Esedoglu, S. Ruuth, and R. Tsai.
In Recent Progress on Reaction-Diffusion Ssystems and Viscosity Solutions. World Scientific. 2008
- Robotic path planning and visibility with limited sensor data
Y. Landa, D. Galkowski, Y. Huang, A. Joshi, C. Lee, K. Leung, G. Malla, J. Treanor, V. Voroninski, A. Bertozzi, and Y.-H. Tsai.
American Control Conference, 2007. ACC '07, pages 5425–5430, July 2007.
- Visibility of Point Clouds and Mapping of Unkown Environments
Y. Landa, R. Tsai, and L.-T. Cheng.
Springer Lecture Notes in Computational Science and Engineering, pp 1014-1025, 2006.
- Threshold Dynamics for Willmore Flow and Related High Order Energies in Image Processing
Selim Esedoglu, Steven Ruuth, and Yen-Hsi Tsai.
IEEE International Conference on Image Processing 2005.
- Multiple time scale numerical methods for the inverted pendulum problem
R. Sharp, Y.-H. Tsai, and B. Engquist.
Springer Lecture Notes in Computational Science and Engineering, Proc. Multiscale Methods in Science and Engineering held at Uppsala University, 2004.
- Level Set Methods in Image Science
Y.-H. Tsai and S. Osher.
Proceedings of ICIP (International Conference on Image Processing), 2003.
- Numerical Methods for Computing Discontinuous Solutions of a Class of Hamilton-Jacobi Equations Using a Level Set Method.
Y.-H.. R. Tsai, Y. Giga and S. Osher, November, 2000.
Free Boundary Problems.

TECHNICAL REPORTS

- Supra-convergence of Time Dependent Linear PDEs on Irregular Grids
R. Tsai, L.-T. Cheng, and H.-O. Kreiss, UCLA CAM Report 02-65.
- A Numerical Study of Anisotropic Crystal Growth with Bunching under Very Singular Vertical Diffusion
Y.-H. Tsai and Y. Giga. Proceedings of the 3rd Annual Conference in PDEs, Taiwan.
- The Bivariate Contouring Problem
B. Craciun, N. Heitmann, B. Ingalls, Q. T. Le Gia, M.-J. Ou, and Y.-H. R. Tsai. IMA February 2001 Preprint Series.

UNDER REVIEW

- Autonomous Source Discovery and Navigation in Complicated Environments
Y. Landa, H. Shen, R. Takei, and Y.-H. R. Tsai. 2009.
- A practical algorithm for vehicle path planning with curvature constraints: a Hamilton-Jacobi approach
R. Takei, R. Tsai, Y. Landa, H. Shen. 2009.
- Multiscale methods for stiff and constrained mechanical systems
J.M. Sanz-Serna, G. Ariel, and R. Tsai. 2009.

PAPERS IN PREPARATION

- Greedy L1-constrained solutions for a class of inverse heat source problems
Y. Li, S. Osher, and R. Tsai.
- Inverse source problems for Helmholtz equations in complicated domains
Y. Landa, N. Tanushev, and R. Tsai.
- Gaussian beam decomposition of high frequency seismic data
N. Tanushev, R. Tsai, S. Fomel, and B. Engquist.

PROFESSIONAL SERVICES

Board membership

- Associate editor, SIAM Multiscale Modeling and Simulations
- Scientific Advisory Board of Banff International Research Station (BIRS)

Selected Conference Organization

Upcoming:

- IMA Annual Program for 2010-2011.
Simulating Our Complex World: Modeling, Computation and Analysis.
- A minisymposium in SIAM Imaging conference, 2010
- BIRS, Banff Canada, Dec, 2009
Numerical Analysis of Multiscale Computation.

Recent:

- IPAM Optimal Transport, Workshop II: Numerics and Dynamics for Optimal Transport. April, 2008.
<http://www.ipam.ucla.edu/programs/otws2/>
- ICIAM 2007: Recent development of the level set methods
- ICIAM 2007: Multiscale modeling and computation
- BIRS, Banff Canada: Numerical Analysis of Multiscale Computations, Feb 2007
http://www.birs.ca/birspages.php?task=displayevent&event_id=07w5069
- International Workshop on Scientific Computing, National Center of Theoretical Sciences, Taiwan, June 2006.

PhD thesis committee

- **Univ. of Texas at Austin:** Khoa Tran (ICES), Wenhao Wang (ICES), Jacob Glenn-Levin (Math), Ray Yang (Math), Peijia Liu (Math), Chandrasekhar Vikram (ECE).
- **L'Université Bordeaux I, France: Examineur** for Paul VIGNEAUX, 2007.
- **KTH (Royal Institute of Technology), Sweden: Opponent** of Andreas ATLE's doctorate degree thesis, 2006.

Referee activities

Journals AMS journals, Journal of Computational Physics, SIAM journals, IEEE Journals, Communications in Mathematical Sciences, Inverse Problems, Journal of Scientific Computing, Journal of Computer Vision and Image Understanding.

Funding agencies National Science Foundation (NSF), Department of Defence (DoD), Austrian Science Fund (FWF), Norwegian Science Fund.

Other Services at UT Austin

- Establishment of the new preliminary examination in numerical analysis for the applied math program in the math department.
http://www.math.utexas.edu/dev/math/Graduate/Prelims/Exam_Syllabi/Numerical_Analysis.html
- Chair of the NA prelim exams.
- VIGRE research mentor for undergraduate students.
- Math Department Graduate Study Committee, Instructor Hiring Committee, and Budget Committee.
- ICES Center for Numerical Analysis Seminar Chair, 2004-present.
- International Science Opportunities, College of Natural Sciences, University of Texas at Austin.
- Faculty Organizer: University of Texas Maymester Study Abroad Program, 2006.

SELECTED INVITED TALKS AND CONFERENCE PARTICIPATION

- Workshop on Kinetic and Mean-field models in the Socio-Economic Sciences, ICMS, **Edinburgh, UK**, July 27, 2009
- The 2nd International Workshop on Viscosity Solutions and Diffusion-Reaction Equations, Jul 13-18, 2009, Providence University, **Taiwan**.
- International Workshop on Applied Math, National Taiwan University, Jun 29-Jul 11, 2009. **Taiwan**.
- SCICADE, **Beijing**, May, 2009
- DTRA/NSF Workshop on Algorithms for Threat Detection, Aug 17, 2009
- Workshop on Multiscale Modeling and Computations, Princeton University, May 15-16, 2009.
- Multiscale Workshop at ICMS Edinburgh, UK, March 30-April 3, 2009
- NSF Workshop on Algorithms for Threat Detection, Nov 3-6, 2008
- Multiscale Modeling and Simulations, Michigan State University, Oct 10-11, 2008.
- BIRS Workshop: Recent Developments in Numerical Methods for Nonlinear Hyperbolic Partial Differential Equations and their Applications, Aug 31-Sep 5, 2008.
- Level Set Methods for High Frequency Wave Propagations, **Tokyo University, Japan**, July, 2006
- Workshop: Level Set Methods for Direct and Inverse Problems, Johannes Kepler Universität, Linz, **Austria**, Sep 14-16, 2005
- **Los Alamos National Laboratory** and **IPAM** Intelligent Extraction of Information from Graphs and High Dimensional Data, July 11-29, 2005
- Workshop: High Frequency Wave Propagation, The Center for Scientific Computation and Mathematical Modeling (**CSCAMM**), Maryland, Sep. 18-23, 2005
- GUMBY: Guaranteed Many Body Behavior Surveillance, hosted by **DARPA and IPAM**, Oct 2004
- Variational Problems Related to Visibility, **IMA** "Hot Topics" Workshop: Adaptive Sensing and Multimode Data Inversion. June 2004.

TEACHING

Special programs

- 2008 Tutorial. RTG Summer School on Multiscale Modeling and Analysis, Austin, Texas.
<http://math.utexas.edu/rtg/school/index.html>
- 2007 Tutorial. Summer school on Multiscale Modeling and Simulation in Science, Bosön, Sweden.
- 2006 Tutorial. Summer program on multiscale methods at National Taiwan University.
- 2004 Tutorial. Summer program on image processing at National Taiwan University.
- 2002 Faculty mentor for IPAM RIPS (a summer workshop for a selected group of undergraduates).
(1) *ENO discretization of Boltzmann Transport Equations*;
(2) *Silicon Oxidation Process in Semiconductor Manufacturing*.

Regular semester

- 2009 Undergraduate Real Analysis.
- 2008 Graduate Prelim Course: Numerical Analysis.
- 2007 Graduate Prelim Course: Numerical Analysis and Multivariable Calculus,
- Previously Undergraduate PDE, Real Analysis, Applied Linear Algebra, Differential Calculus (ODE),
Freshman Calculus

MEMBERSHIPS

- Alfred P. Sloan Fellow, 2006-2008.
- Institute for Advanced Study, 2002 - 2004.
- American Mathematics Society, 1997 - present.
- Society of Industrial and Applied Mathematics, 1997 - present.