

ANIL N. HIRANI

CURRICULUM VITAE

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Research Interests: *Algorithms* (numerical and combinatorial) in *geometry, topology*, and *scientific applications*, applications of geometry and topology, *numerical analysis*. Specific areas: discrete exterior calculus, finite element exterior calculus, applied and computational topology, discrete differential geometry, computational geometry.

1 Education

CALIFORNIA INSTITUTE OF TECHNOLOGY: Ph.D. in Computer Science with minors in Mathematics and Control and Dynamical Systems, June 2003; *Advisor*: Professor Jerrold E. Marsden.

STANFORD UNIVERSITY: M. S. in Computer Science, January 1988.

BIRLA INSTITUTE OF TECHNOLOGY SCIENCE (PILANI, INDIA): M. Sc. (Tech.) in Computer Science (B.S. equivalent undergraduate degree), May 1985.

2 Employment

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN AUGUST 2005 – CURRENT

- Assistant Professor in the Department of Computer Science, University of Illinois at Urbana-Champaign.
- Affiliate faculty, Program in Applied Mathematics.
- Affiliate faculty, Computational Science and Engineering Program.

NASA'S JET PROPULSION LABORATORY JULY 2004 – JULY 2005

- Senior Engineer in the Guidance, Navigation and Control Section, of JPL, Pasadena, CA.
- Used invariant manifold theory and approximation methods for design of low-cost trajectories to the icy moons of Jupiter in the JIMO (Jupiter Icy Moon Orbiter) mission.
- This was a planned mission that used an ion engine and had to use the dynamical phase space structure around Jupiter and its moons.

CALIFORNIA INSTITUTE OF TECHNOLOGY JULY 2003 – JUNE 2004

- CIMMS (Center for Integrative Multiscale Modeling and Simulation) Postdoctoral Fellow in Control and Dynamical Systems, Caltech, Pasadena, CA.

SONY CORPORATION

1994 – 1996

- Researcher in Sony Research Center, Shinagawa, Tokyo, Japan.
- Invented and implemented algorithm for scratch removal from digital images, using an iterative method of projections onto convex sets, combining frequency and spatial domain information.
- When I left Sony, an engineering team was implementing my algorithms for Sony Pictures professional post-production software.
- Awarded 2 patents, one of which won Sony's internal Best Patent Award for that year.
- Research resulted in an ACM SIGGRAPH publication in 1996 which has been cited about 100 times.

SUN MICROSYSTEMS

1988 – 1994

- Software Engineer in Graphics Products Division, Mt. View, CA.
- Designed and implemented parts of XGL (Sun's 3D graphics library); an automated test generator system for XGL; and 3D graphics and multimedia demo programs, one of which was shown at the Sun booth in ACM SIGGRAPH Exhibition 1989.

3 Awards and Distinctions

- NSF CAREER Award, 2007; for *Algebraic Topology and Exterior Calculus in Numerical Analysis*; NATIONAL SCIENCE FOUNDATION.
- Invited for extended visits to invitation-only events, twice to MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH (2004 and 2012), to FIELDS INSTITUTE (2011), and to SCHLOSS DAGSTUHL (2012).
- ARCS Scholar (Achievement Rewards for College Scientists), 2003, ARCS FOUNDATION.
- Best Patent Award (shared with co-inventor T. Totsuka, for U.S. Patent 5974194, Projection based methods for scratch and wire removal from digital images), 1999, SONY CORPORATION.
- Pixar Computer Graphics Graduate Fellowship, 1996, PIXAR CORPORATION.

4 Grants

1. NSF Grant, PI: Anil N. Hirani, co-PI: A. Demlow, *Adaptive Finite Element and Discrete Exterior Calculus*, NATIONAL SCIENCE FOUNDATION, Division of Mathematical Science (DMS) (pending).
2. NSF Grant, PI: Anil N. Hirani, co-PIs: T. Dey, B. Krishnamoorthy, *Optimality in Homology - Algorithms and Applications*, NATIONAL SCIENCE FOUNDATION, Division of Computing and Communication Foundations (CCF), 2011 – 2015, \$900K, my share \$302,583.
3. NSF CAREER Award, PI: Anil N. Hirani, *Algebraic Topology and Exterior Calculus in Numerical Analysis*, NATIONAL SCIENCE FOUNDATION, Division of Mathematical Sciences (DMS), 2007–2012, \$400,000.
4. CSE Fellowships for three students, \$25,300 each, Computational Science and Engineering Program, UIUC, 2006–2007, 2007–2008, and 2010–2011.

5 Publications

In the hyperlinked version of this document, clicking on “pdf” brings up the PDF file of the paper. Similarly the DOI, URL, and arXiv e-print numbers are also hyperlinked.

5.1 JOURNAL PAPERS

1. BELL, N., AND HIRANI, A. N. PyDEC: Algorithms and software for Discretization of Exterior Calculus. *ACM Transactions on Mathematical Software* (2012), (To appear). [arXiv:1103.3076](#)
2. DEY, T. K., HIRANI, A. N., AND KRISHNAMOORTHY, B. Optimal homologous cycles, total unimodularity, and linear programming. *SIAM Journal on Computing* 40, 4 (2011), 1026–1044. [doi:10.1137/100800245](#) [pdf].
3. VANDERZEE, E., HIRANI, A. N., GUOY, D., AND RAMOS, E. A. Well-centered triangulation. *SIAM Journal on Scientific Computing* 31, 6 (2010), 4497–4523. [doi:10.1137/090748214](#) [pdf].
4. VANDERZEE, E., HIRANI, A. N., ZHARNITSKY, V., AND GUOY, D. A dihedral acute triangulation of the cube. *Computational Geometry: Theory and Applications* 43, 5 (July 2010), 445–452. [doi:10.1016/j.comgeo.2009.09.001](#) [pdf].
5. COLOMBI, A., HIRANI, A. N., AND VILLAC, B. F. Structure preserving approximations of conservative forces for application to small body dynamics. *Journal of Guidance, Control and Dynamics* 32, 6 (November–December 2009), 1847–1858. A publication of the American Institute of Aeronautics and Astronautics. [doi:10.2514/1.42067](#) [pdf].
6. COLOMBI, A., HIRANI, A. N., AND VILLAC, B. F. Adaptive gravitational force representation for fast trajectory propagation near small bodies. *Journal of Guidance, Control and Dynamics* 31, 4 (July–August 2008), 1041–1051. A publication of the American Institute of Aeronautics and Astronautics. [doi:10.2514/1.32559](#) [pdf].
7. WARREN, J., SCHAEFER, S., HIRANI, A. N., AND DESBRUN, M. Barycentric coordinates for convex sets. *Advances in Computational Mathematics* 27, 3 (October 2007), 319–338. [doi:10.1007/s10444-005-9008-6](#) [pdf].
8. TONG, Y., LOMBAYDA, S., HIRANI, A. N., AND DESBRUN, M. Discrete multiscale vector field decomposition. *ACM Transactions on Graphics (Special issue of SIGGRAPH 2003 Proceedings)* 22, 3 (July 2003), 445–452. [doi:10.1145/882262.882290](#) [pdf].
9. HIRANI, A. N., AND SUBRAHMANIAN, V. S. Algebraic foundations of logic programming, I: the distributive lattice of logic programs. *Fundamenta Informaticae* 13 (1990), 317–332.

Journal papers in review

1. VANDERZEE, E., HIRANI, A. N., GUOY, D., ZHARNITSKY, V., AND RAMOS, E. Geometric and combinatorial properties of well-centered triangulations in three and higher dimensions. *Computational Geometry: Theory and Applications* (2009), (Submitted). [arXiv:0912.3097](#)
2. HIRANI, A. N., NAKSHATRALA, K. B., AND CHAUDHRY, J. H. Numerical method for Darcy flow derived using Discrete Exterior Calculus. *Applied Numerical Mathematics* (2011), (Submitted). [arXiv:0810.3434](#)

3. HIRANI, A. N., KALYANARAMAN, K., WANG, H., AND WATTS, S. Cohomologous harmonic cochains, 2011. [arXiv:1012.2835](https://arxiv.org/abs/1012.2835)
4. JOSSEY, J., AND HIRANI, A. N. Equivalence theorems in numerical analysis : Integration, differentiation and interpolation. *Applied Numerical Mathematics* (2011), (Submitted). [arXiv:0709.4046](https://arxiv.org/abs/0709.4046)

Journal papers in preparation

1. DUNFIELD, N. M., AND HIRANI, A. N. The least spanning area of a knot and the optimal bounding chain problem, 2011. Continuation of the work that appears in ACM Symposium on Computational Geometry.
2. DEMLOW, A., AND HIRANI, A. N. A posteriori error estimates for finite element exterior calculus: The de Rham complex, 2012. [arXiv:1203.0803](https://arxiv.org/abs/1203.0803).

5.2 CONFERENCE PAPERS

1. DUNFIELD, N. M., AND HIRANI, A. N. The least spanning area of a knot and the optimal bounding chain problem. In *Proceedings of the 27th annual ACM symposium on Computational geometry* (New York, NY, USA, 2011), SoCG '11, ACM, pp. 135–144. URL <http://doi.acm.org/10.1145/1998196.1998218>, doi:10.1145/1998196.1998218 [pdf]
2. DEY, T. K., HIRANI, A. N., AND KRISHNAMOORTHY, B. Optimal homologous cycles, total unimodularity, and linear programming. In *STOC '10: Proceedings of the 42nd ACM Symposium on Theory of Computing* (New York, NY, USA, June 6–8 2010), ACM, pp. 221–230. doi:10.1145/1806689.1806721 [pdf].
3. VANDERZEE, E., HIRANI, A. N., AND GUOY, D. Triangulation of simple 3D shapes with well-centered tetrahedra. In *Proceedings of the 17th International Meshing Roundtable*, R. V. Garimella, Ed. Springer Berlin Heidelberg, Pittsburgh, Pennsylvania, October 12–15 2008, pp. 19–35. doi:10.1007/978-3-540-87921-3_2. [pdf]
4. COLOMBI, A., HIRANI, A. N., AND VILLAC, B. F. Structure preserving approximations of conservative forces for application to small body dynamics, Paper AIAA-2008-7205. In *AAS/AIAA Astrodynamics Specialist Conference, Honolulu, Hawaii* (August 18–21 2008), American Astronautical Society and American Institute of Aeronautics and Astronautics. URL http://www.cs.illinois.edu/hirani/papers/CoHiVi2008a_ASC.pdf. [This paper led to the journal publication number 4 above] [pdf]
5. VANDERZEE, E., HIRANI, A. N., GUOY, D., AND RAMOS, E. Well-centered planar triangulation – an iterative approach. In *Proceedings of the 16th International Meshing Roundtable* (Seattle, Washington, October 14–17 2007), M. L. Brewer and D. Marcum, Eds., Springer, pp. 121–138. doi:10.1007/978-3-540-75103-8_7. [pdf]
6. COLOMBI, A., HIRANI, A. N., AND VILLAC, B. F. Efficient gravity field computation for trajectory propagation near small bodies, Paper AAS 07-223. In *17th AAS/AIAA Space Flight Mechanics Meeting, Sedona, Arizona* (AAS Publications Office, P.O. Box 28130, San Diego, CA 92198, January 28 – February 1 2007), American Astronautical Society and American Institute of Aeronautics and Astronautics. URL http://www.cs.illinois.edu/hirani/papers/CoHiVi2007_SFM.pdf. [This paper led to the journal publication number 5 above] [pdf]

7. LAM, T., HIRANI, A. N., AND KANGAS, J. Characteristics of transfers to and captures at Europa, Paper AAS 06-188. In *16th AAS/AIAA Space Flight Mechanics Meeting, Tampa, Florida* (January 2006), American Astronautical Society and American Institute of Aeronautics and Astronautics. URL http://www.cs.illinois.edu/hirani/papers/LaHiKa2006_SFM.pdf. [Results from this paper were used in a planned NASA mission to the icy moons of Jupiter] [pdf]
8. HIRANI, A. N., AND RUSSELL, R. P. Approximations of distant retrograde orbits for mission design, Paper AAS 06-116. In *16th AAS/AIAA Space Flight Mechanics Meeting, Tampa, Florida* (January 2006), American Astronautical Society and American Institute of Aeronautics and Astronautics. URL <http://hdl.handle.net/2014/38896>. [Results from this paper were used in a planned NASA mission to the icy moons of Jupiter and there were plans to include the algorithms of this paper in software used at JPL for mission design] [pdf]
9. HIRANI, A. N., AND LO, M. W. Surface structure of an invariant manifold of a halo orbit, Paper AAS 05-379. In *AAS/AIAA Astrodynamics Specialist Conference, Lake Tahoe, California* (August 2005), American Astronautical Society and American Institute of Aeronautics and Astronautics. URL <http://hdl.handle.net/2014/39480>. [Results from this paper were used in a planned NASA mission to the icy moons of Jupiter] [pdf]
10. DESBRUN, M., HIRANI, A. N., AND MARSDEN, J. E. Discrete exterior calculus for variational problems in computer vision and graphics. In *Proceedings of the 42nd IEEE Conference on Decision and Control (CDC03), Hawaii* (December 9–12 2003), vol. 5, pp. 4902–4907. doi:10.1109/CDC.2003.1272393. [Invited paper] [pdf]
11. GRINSPUN, E., HIRANI, A. N., DESBRUN, M., AND SCHRÖDER, P. Discrete shells. In *Proceedings of the 2003 ACM SIGGRAPH/Eurographics symposium on Computer animation* (Aire-la-Ville, Switzerland, Switzerland, 2003), SCA '03, Eurographics Association, pp. 62–67. URL <http://portal.acm.org/citation.cfm?id=846276.846284>. [pdf]
12. HIRANI, A. N., MARSDEN, J. E., AND ARVO, J. Averaged template matching equations. In *Energy Minimization Methods in Computer Vision and Pattern Recognition* (2001), M. A. T. Figueiredo, J. Zerubia, and A. K. Jain, Eds., vol. 2134 of *Lecture Notes in Computer Science (LNCS)*, Springer–Verlag, pp. 528–543. doi:10.1007/3-540-44745-8_35. [pdf]
13. HIRANI, A., AND TOTSUKA, T. Dual domain interactive image restoration: basic algorithm. In *Image Processing, 1996. Proceedings., International Conference on* (Sept. 1996), vol. 1, pp. 797–800. doi:10.1109/ICIP.1996.559619. [pdf]
14. HIRANI, A. N., AND TOTSUKA, T. Combining frequency and spatial domain information for fast interactive image noise removal. In *Proceedings of the 23rd annual conference on Computer graphics and interactive techniques* (New York, NY, USA, 1996), SIGGRAPH '96, ACM, pp. 269–276. doi:10.1145/237170.237264. [Patent Number 5974194 resulting from this paper won a Sony Corporation internal Best Patent Award for 1999, and the algorithms were slated for use in Sony Pictures in-house post-production software for digital movie editing] [pdf]

5.3 OTHER

Unpublished manuscripts

1. DESBRUN, M., HIRANI, A. N., LEOK, M., AND MARSDEN, J. E. Discrete exterior calculus, August 2005. [arXiv:math.DG/0508341](https://arxiv.org/abs/math/0508341)

E-prints

1. HIRANI, A. N., AND KALYANARAMAN, K. Numerical experiments for Darcy flow on a surface using mixed exterior calculus methods, March 2011. [arXiv:1103.3076](https://arxiv.org/abs/1103.3076)
2. HIRANI, A. N., KALYANARAMAN, K., AND WATTS, S. Least squares ranking on graphs, 2011. [arXiv:1011.1716](https://arxiv.org/abs/1011.1716)

Theses

1. HIRANI, A. N. *Discrete Exterior Calculus*. PhD thesis, California Institute of Technology, May 2003. URL <http://resolver.caltech.edu/CaltechETD:etd-05202003-095403>
2. HIRANI, A. N. Linearization methods for variational integrators and Euler-Lagrange equations. Master's thesis, California Institute of Technology, 2000.

Software

PyDEC : a Python software library for discretization of exterior calculus, joint work with N. Bell, 2008, released to the public domain on Google code at <http://code.google.com/p/pydec>.

6 Invited Extended Visits

1. MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH, Germany, Invitation-only *Oberwolfach Workshop on Triangulations*, April 29–May 5, 2012; organized by W. Jaco, F. Lutz, F. Santos, and J. Sullivan.
2. SCHLOSS DAGSTUHL, Germany, Invitation-only *Dagstuhl Seminar on Applications of Combinatorial Topology to Computer Science*, March 18 – March 23, 2012; organized by L. Fajstrup, D. Feichtner-Kozlov, R. Ghrist, M. Herlihy.
3. FIELDS INSTITUTE, Toronto, as Scientific Researcher for the *Workshop on Computational Topology*, November 7–11, 2011; organized by H. Edelsbrunner, R. Ghrist, and D. Kozlov. The workshop is part of the Thematic Program on Discrete Geometry and Applications.
4. MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH, Germany, Invitation-only *Oberwolfach Seminar on Discrete Differential Geometry*, May 30 – June 5, 2004; organized by A. Bobenko, J. Sullivan, P. Schröder, and G. Ziegler.

7 Invited and Contributed Talks

7.1 INVITED TALKS

1. *Discrete Exterior Calculus and its Relationship to Finite Element Exterior Calculus* (tentative title), NSF-CBMS Conference on Finite Element Exterior Calculus, to be held June 11–15, 2012 at Institute for Computational and Experimental Research in Mathematics (ICERM) at Brown University. [NSF-CBMS series focus on a single important and timely area of research with a distinguished lecturer (Prof. Doug Arnold in this case) who delivers 10 lectures. I will be one of two auxillary speakers at this lecture series.] NATIONAL SCIENCE FOUNDATION - CONFERENCE BOARD OF THE MATHEMATICAL SCIENCE

2. *Torsion in Computations*, Dagstuhl Seminar on Applications of Combinatorial Topology to Computer Science, March 22, 2012, SCHLOSS DAGSTUHL
3. *Holes, Handles, and Tunnels*, Center for Imaging Science, February 14, 2012, JOHNS HOPKINS UNIVERSITY
4. *Hodge Decomposition: Applications and Numerics*, Scientific and Statistical Computing Seminar, Departments of Computer Science, Mathematics, and Statistics, February 3, 2012, UNIVERSITY OF CHICAGO
5. *Optimization, Knots, and Differential Equations*, Workshop on Computational Topology, November 7–11, 2011, FIELDS INSTITUTE
6. *Optimal Homology Cycles and Knots*, Certified Geometry Processing Minisymposium, October 24–27, 2011, SIAM CONFERENCE ON GEOMETRIC & PHYSICAL MODELING (GD/SPM11)
7. *Numerical Methods for Harmonic Cochain Computation*, Geometric and Exterior Calculus Methods in Computational Mechanics Minisymposium, [I had to cancel this talk due to a family emergency] July 27, 2011, 11TH U.S. NATIONAL CONGRESS ON COMPUTATIONAL MECHANICS
8. *Darcy Flow Using Discrete Exterior Calculus*, High Order Mimetic Discretizations Minisymposium, July 20, 2011, 7TH INTERNATIONAL CONGRESS ON INDUSTRIAL AND APPLIED MATHEMATICS (ICIAM 2011)
9. *Numerical Methods for Hodge Decomposition*, Applied Hodge Theory Minisymposium, July 19, 2011, 7TH INTERNATIONAL CONGRESS ON INDUSTRIAL AND APPLIED MATHEMATICS (ICIAM 2011)
10. *Optimal (Co)homologous (Co)chains*, Department of Computer Science, March 2, 2011, Host: Professor Chandrajit Bajaj, UNIVERSITY OF TEXAS AT AUSTIN
11. *Latest Developments in Discretization of Exterior Calculus*, X-Computational Physics Division, February 2011, Host: Dr. Mikhail Shashkov, LOS ALAMOS NATIONAL LABORATORY
12. *Computational Topology and Linear Programming*, Departments of Computer Science and Mathematics, May 25, 2010, Host: Professor Leonidas Guibas, STANFORD UNIVERSITY
13. *Computational Topology and Linear Programming*, Graphics, Vision and Interaction Seminar, April 29, 2010, Host: Professor Steven Gortler, HARVARD UNIVERSITY
14. *Some PyDEC Applications*, Discrete Differential Geometry for Multiphase Flow Problems, April 23, 2010, INDIANA UNIVERSITY PURDUE UNIVERSITY INDIANAPOLIS
15. *Homologous Chains, Total Unimodularity, and Linear Programming*, Department of Computer Science, January 13, 2010, Host: Professor Mathieu Desbrun, CALIFORNIA INSTITUTE OF TECHNOLOGY
16. *Optimal Topology: Homologous Chains, Total Unimodularity, and Linear Programming*, Department of Computer Science Colloquium, November 11, 2009, Host: Professor L. Ridgway Scott, UNIVERSITY OF CHICAGO
17. *Implementation of Discrete Exterior Calculus*, Guest Lecture in Topics in Scientific Computing (CMSC 34900) taught by Professor L. Ridgway Scott, November 12, 2009, UNIVERSITY OF CHICAGO

18. *Implementation of Hodge Theory for Simplicial Complexes*, University of Chicago, June 2009, Organizers: Professors Mikhail Belkin, Partha Niyogi, and Stephen Smale, MACHINE LEARNING SUMMER SCHOOL / WORKSHOP
19. *Software and Algorithms for Exterior Calculus*, Department of Mathematics Colloquium, October 17, 2008, Host: Professor Gerard Awanou, NORTHERN ILLINOIS UNIVERSITY
20. *Calculus on Meshes*, Department of Computer Science and Engineering Seminar, May 21, 2008, Host: Professor Mikhail Belkin, OHIO STATE UNIVERSITY
21. *Calculus on Meshes*, Department of Mathematics Seminar, Mumbai, May 16, 2008, Host: Professor Amiya K. Pani, INDIAN INSTITUTE OF TECHNOLOGY
22. *Dynamical Systems and Space Mission Design*, Department of Aerospace Engineering AE 590 Seminar, January 30, 2006, UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
23. *Discrete Exterior Calculus and the Averaged Template Matching Equations*, Mathematics in Brain Imaging, July 15, 2004, INSTITUTE FOR PURE AND APPLIED MATHEMATICS (IPAM)
24. *Discrete Exterior Calculus*, Oberwolfach Seminar on Discrete Differential Geometry, Germany, June 2004, MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH
25. *Discrete Exterior Calculus: Applications in Mechanics and Computer Science*, Center for Nonlinear Studies Seminar, May 24, 2004, LOS ALAMOS NATIONAL LABORATORY
26. *Discrete Hodge Star*, Guest lecture in Discrete Differential Geometry class (ACM 256) taught by Professors Peter Schröder and Mathieu Desbrun, April 23, 2004, CALIFORNIA INSTITUTE OF TECHNOLOGY
27. *Discrete Exterior Calculus: Applications in Computer Science, Applied Mathematics and Mechanics*, February 12, 2004, SANDIA NATIONAL LABORATORY
28. *Template Matching, EPDIFF and Discrete Exterior Calculus*, Turbulence Workshop, Center for Nonlinear Studies, December 5 – 6, 2003, Host: Dr. Darryl Holm, LOS ALAMOS NATIONAL LABORATORY

7.2 CONTRIBUTED TALKS

1. *Optimal homologous cycles, total unimodularity, and linear programming*, Cambridge, MA, June 6–8, 2010, 42ND ACM SYMPOSIUM ON THEORY OF COMPUTING (STOC'10)
2. *Stiffness and Mass Matrices for Whitney Forms*, Newark, DE, April 24–25, 2009, FINITE ELEMENT CIRCUS
3. *Algorithms for Exterior Calculus*, Lake Tahoe, CA, January 5–9, 2009, FINITE ELEMENT METHODS IN ENGINEERING AND SCIENCE (FEMTEC 2009)
4. *Structure Preserving Approximations of Conservative Forces for Application to Small Body Dynamics*, Honolulu, HI, August 18–21, 2008, AAS/AIAA ASTRODYNAMICS SPECIALIST CONFERENCE
5. *Approximations of Distant Retrograde Orbits for Mission Design*, Tampa, FL, January 22–26, 2006, AAS/AIAA SPACEFLIGHT MECHANICS MEETING
6. *Surface Structure of an Invariant Manifold of a Halo Orbit*, Lake Tahoe, CA, August 7–11, 2005, AAS/AIAA ASTRODYNAMICS SPECIALISTS CONFERENCE,
7. *Discrete Exterior Calculus* San Diego, CA, July 9 – 11, 2003, MIMETIC DISCRETIZATIONS OF CONTINUUM MECHANICS
8. *Discrete Exterior Calculus and its Applications*, San Diego, CA, February 13, 2003, SIAM CONFERENCE ON COMPUTATIONAL SCIENCE AND ENGINEERING (CSE03)

9. *Discrete Exterior Calculus*, Snowbird, UT, May 27 – 31, 2003, SIAM CONFERENCE ON APPLICATIONS OF DYNAMICAL SYSTEMS (DS03)
10. *Analysis of 1D Template Matching Equations*, Pasadena, CA, March 25–29, 2002, 9TH INTERNATIONAL CONFERENCE ON HYPERBOLIC PROBLEMS (HYP2002)
11. *Averaged Template Matching Equations*, Sophia-Antipolis, France, September 3–5, 2001, ENERGY MINIMIZATION METHODS IN COMPUTER VISION AND PATTERN RECOGNITION
12. *Combining Frequency and Spatial Domain Information for Fast Interactive Image Noise Removal*, New Orleans, LA, August 4–9, 1996, ACM SIGGRAPH

8 Student and Postdoctoral Advising

8.1 Ph.D. STUDENTS

1. Andrew Colombi; Ph.D. in Computer Science; August 2008; Thesis: *Quick Evaluation of Small Body Gravitation*; Currently at PALANTIR TECHNOLOGIES, a startup software company in Palo Alto, California.
2. Evan VanderZee; Ph.D. in Mathematics; January 2010; Thesis: *Well-Centered Meshing*; Co-advised with Professor Vadim Zharnitsky, UIUC Mathematics; Currently at ARGONNE NATIONAL LABORATORY and Adjunct Faculty Member at TRINITY CHRISTIAN COLLEGE, Palos Heights, Illinois.
3. Seth Watts; Ph.D. in Mechanical Science and Engineering; expected in 2012; Tentative topic : *Topology preserving design of multiphase materials*; Co-advised with Professor Daniel Tortorelli, UIUC Mechanical Science and Engineering.
4. Kaushik Kalyanaraman; Ph.D. student in Computer Science; Fall 2009 – current; Tentative topic : *Adaptive methods for finite element exterior calculus on manifolds*.
5. Han Wang; Ph.D. student in Mathematics; Spring 2010 – current; Tentative topic : *Optimality in topology*.
6. Yodsawalai Chodpathumwan; Ph.D. student in Computer Science; Fall 2011 – current.

8.2 Ph.D. THESIS COMMITTEES

(These are in addition to the thesis committees of the advisees listed above)

1. Hanna VanderZee Neradt; Spring 2007; Ph.D. thesis in scientific computing area in Department of Computer Science
2. Hamid Chitsaz, Ph.D. thesis in robotics area in Department of Computer Science; Spring 2008
3. Chris Martin, Ph.D. thesis in trajectory optimization area in Department of Aerospace Engineering; Spring 2011
4. Jacob Englander, Ph.D. thesis in trajectory optimization area in Department of Aerospace Engineering; 2012 (expected)

8.3 UNDERGRADUATE STUDENTS

Advised undergraduate students for summer research and undergraduate research experience projects:

- Ryan Nong, Summer Undergraduate Research Fellow, California Institute of Technology, Summer 2003 and Summer 2004.
- Brian Senta, Research on basketball ranking, University of Illinois at Urbana-Champaign, late Fall 2010 – Spring 2011.
- Min Kim, Research on committee ranking, University of Illinois at Urbana-Champaign, Spring 2011 – current.

8.4 POSTDOCTORAL SCHOLAR

Mentored postdoctoral scholar Dr. John Jossey, Ph.D. in Mathematics from UIUC, 2006–2007.

9 Other Academic Activities

- Member of 15 qualifying exam committees, and 6 Ph.D. preliminary exam committees in scientific computing, human-computer interaction, computer graphics, robotics, and aerospace engineering.
- National Science Foundation Panelist, Division of Mathematics Sciences, Program in Computational Mathematics, March 2008.
- Workshops and minisymposium organization:
 - Workshop on Discrete Geometry for Mechanics, Center for Integrative Multiscale Modeling and Simulation, Caltech, October 3–4, 2003. Speakers included Alain Bossavit, Mathieu Desbrun, Robin Forman, Jenny Harrison, Jerrold Marsden, Peter Schröder, Yuri Suris, and Alan Weinstein.
 - Minisymposium on Applied Hodge Theory, International Congress on Industrial and Applied Mathematics (ICIAM), July 18–22, 2011. This is the preeminent congress for applied mathematicians held only every 4 years. The speakers included Prof. Pablo Parrilo (EECS Professor at MIT, winner of the 2011 Antonio Ruberti Outstanding Young Researcher Award of the IEEE Control Systems Society), Prof. Douglas Arnold (McKnight Presidential Professor of Mathematics at Minnesota, Past President of SIAM, Past Director of the Institute for Mathematics and its Applications, AAAS Fellow, SIAM Fellow), and Prof. Yinyu Ye (Professor of Management Science and Engineering at Stanford, winner of the 2009 John von Neumann Theory Prize).
 - Workshop on Discrete Differential Geometry, special workshop co-located with ACM Symposium on Computational Geometry, the preeminent computational geometry conference, June 19, 2012 (tentative). Invited by the scientific committee to organize this workshop. Co-organizer Mathieu Desbrun (Head of Department of Computing and Mathematical Sciences, Caltech).
- Regular reviewer of papers submitted to journals including *Computers and Mathematics with Applications*, *Computer Aided Geometric Design*, *Discrete and Continuous Dynamical Systems*, *Foundations of Computational Mathematics*, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *IEEE Transactions on Visualization and Computer Graphics*, *Journal of Guidance, Control and Dynamics*, *Physica D : Nonlinear Phenomena*. Reviewer of papers submitted to various computer graphics conferences including ACM SIGGRAPH, Eurographics, and ACM SIGGRAPH Asia, as well as ACM SIGGRAPH courses, and to IEEE Conference on Decision and Control.
- Served as grant proposal reviewer for:
 - Netherlands Organization for Scientific Research (NWO)
 - National Science Foundation, Division of Mathematical Sciences, Program in Topology
 - National Science Foundation, Division of Mathematical Sciences, Program in Computational Mathematics
- Designed three new special topics courses at the Department of Computer Science, University of Illinois at Urbana-Champaign:
 - *Calculus on Meshes* (CS 598 Fall 2005, CS 558 Fall 2008)
 - *Symplectic Integrators and Discrete Mechanics* (CS 598 Fall 2006)
 - *Laplacians on Networks and Meshes* (CS 558 Fall 2009)
- Organized the lectures from my special topics courses *Calculus on Meshes*, and *Laplacians on Networks and Meshes*, into a book draft *Calculus on Meshes and Graphs* (tentative title). I am in preliminary discussion with Cambridge University Press for publishing this as a book.

- Member of various committees including the Board of Directors of Caltech's Graduate Students Council and various academic committees across campus at Caltech, 1999 – 2001; Student Awards Committee, Department of Computer Science, UIUC, Fall 2008 – Current; Executive Committee's Engineering - Physics Liaison subcommittee, UIUC, Fall 2009 – Current.

10 Patents

1. U. S. Patent 5974194: Projection based method for scratch and wire removal from digital images (with T. Totsuka). Won an internal Sony award, 1999.
2. U. S. Patent 5892853: Methods, apparatus and program storage device for removing scratch or wire noise, and recording media therefore (with T. Totsuka), 1999.

11 Consulting Activities

Taught 3 hands-on workshops (total of 6 days) on computational science and engineering for spaceflight, 2010, NASA'S JET PROPULSION LABORATORY.