# Michael J. Black

*Max Planck Insitute for Intelligent Systems*

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**Research Interests**

**Computer Vision:** Optical flow estimation, human pose and shape estimation, probabilistic models of images, natural scene statistics.

**Neural Engineering:** Statistical models of neural coding, neural decoding of arm and hand movement, human brain-machine interfaces, neural prostheses.

**Education**

YALE UNIVERSITY — New Haven, CT
Ph.D., Computer Science, 1992.

STANFORD UNIVERSITY — Stanford, CA
M.S., Computer Science, 1989.

THE UNIVERSITY OF BRITISH COLUMBIA — Vancouver, BC
B.Sc., First Class, Honours Computer Science, 1985.

**Experience**

MAX PLANCK SOCIETY — Tübingen, Germany
*Director,* Max Planck Institute for Intelligent Systems, 1/11 – present.

I am a founding director at a new Max Planck Institute focused on research in intelligent systems. We study perception, action, and learning across scales from molecules and materials to machines. I lead the Perceiving Systems Department.

STANFORD UNIVERSITY — Stanford, CA
*Visiting Professor*, Electrical Engineering, 5/11 – present.

I collaborate with Prof. Krishna Shenoy's group to analyze the neural control of natural movement using wireless neural recording and markerless motion capture.

BROWN UNIVERSITY — Providence, RI
*Adjunct Professor (Research)*, Department of Computer Science, 1/11 – present,
*Professor,* Department of Computer Science, 7/04 – 12/10,
*Associate Professor,* Department of Computer Science, 7/00 – 6/04.

My vision research addresses problems of probabilistic inference using machine learning and statistical estimation techniques. My work in early vision includes learning Markov random fields, modeling image statistics, and estimating optical flow. At higher levels, my work addresses human motion detection, estimation, tracking and analysis.

My work on brain-machine interfaces focuses on probabilistic models of neural coding in motor cortex and the decoding of this activity using Bayesian inference. This work is part of an interdisciplinary effort to develop prosthetic devices for the severely disabled.

XEROX PALO ALTO RESEARCH CENTER — Palo Alto, CA
*Area Manager,* Digital Video Analysis, 8/98–7/00,
*Area Manager,* Image Understanding Area, 1/96–1/99,
*Member of Research Staff, II,* 9/93–12/95.

Research on motion estimation with an emphasis on human motion. Learning linear models of motion, generalizing motion estimation to other forms of appearance change, recovering motion discontinuities, probabilistic methods for motion estimation, recognition of facial expressions and gestures.

Management responsibilities included: performance evaluation, budgeting, internal grant writing, hiring, coordinating with senior management, contracting with Xerox business groups, presentations to Xerox and the external world, and career development.

ROYAL INSTITUTE OF TECHNOLOGY (KTH) — Stockholm, Sweden
*Visiting Scientist,* Computational Vision and Active Perception group, 9/98–1/99.

Pursued research on learning parameterized spatio-temporal models of motion events and computational techniques based on stochastic search for exploiting these models for motion-based recognition.

UNIVERSITY OF TORONTO — Toronto, Ontario
*Adjunct Professor,* Department of Computer Science, 1995–1996,
*Assistant Professor,* (not tenure-track), Department of Computer Science, 8/92–9/93.

Research included the introduction of mixture models for optical flow estimation, detection and tracking of surface discontinuities using motion information, and robust surface recovery in dynamic environments.

YALE UNIVERSITY, — New Haven, CT
*Research Assistant,* Department of Computer Science, 9/89–8/92.

Introduced robust statistical approaches for estimating optical flow. Also pursued research on incremental estimation, temporal continuity, and the early detection of motion discontinuities.

NASA AMES RESEARCH CENTER — Moffett Field, CA
*Visiting Researcher*, Aerospace Human Factors Research Division, 6/90–8/92.

Developed motion estimation algorithms in the context of an autonomous Mars landing and nap-of-the-earth helicopter flight and studied the psychophysical implications of a temporal continuity assumption.

ADVANCED DECISION SYSTEMS — Mountain View, CA
*Computer Scientist,* Image Understanding Group, 12/86–6/89.

Research on spatial reasoning for robotic vehicle route planning and terrain analysis. Vision research including perceptual grouping, object-based translational motion processing, the integration of vision and control for an autonomous vehicle, object modeling using generalized cylinders, and the development of an object-oriented vision environment.

GTE GOVERNMENT SYSTEMS Mountain View, CA
*Engineer,* Artificial Intelligence Group, 6/85–12/86.

Developed expert systems for multi-source data fusion and fault location.

**Teaching Experience**

BROWN UNIVERSITY, Spring 2004, 2006, 2008, 2009, 2010, Fall 2010
Providence, RI
*Topics in Computer Vision.* This graduate research course takes a single advanced topic in machine vision explores it in an integrated fashion through the use of a course-long project, readings of research papers, and lectures on the mathematical and computational foundations. In 2004, the course focused on 3D human motion tracking and each of the students built a state-of-the art 3D human tracking system. In 2006 and 2008 the course focused on forensic computer vision. Each course was focused around a single real crime video. The problem provided the structure around which a coherent set of topics was explored. For examples the students learned about camera calibration, single-view metrology, image denoising, deinterlacing, super-resolution, optical flow, shape from specularity and 3D tracking. The students of the 2006 class all received commendations from a Virginia police department for their efforts.

BROWN UNIVERSITY, Fall 2003, 2004, 2005, 2007, 2008, 2009 Providence, RI
*Introduction to Computer Vision.* Undergraduate computer vision course with emphasis on vision as a problem of probabilistic inference.

BROWN UNIVERSITY, Fall 2001, 2002; Spring 2005 Providence, RI
*Topics in Brain-Computer Interfaces.* Focuses on the mathematical and computational foundations of the field while introducing the basic concepts in neuroscience, interface design, recording technologies, applications, and ethical issues.

BROWN UNIVERSITY, Spring 2001, 2002, 2003 Providence, RI
*Introduction to Software Engineering.* Advanced programming techniques including object-oriented design in C++. Basic software engineering concepts are covered including modeling, requirements analysis, design, testing, reuse, the software life cycle, and project management.

BROWN UNIVERSITY, Fall 2000 Providence, RI
*Topics in Machine Vision and Learning.* Learning in high dimensional spaces, linear models, probabilistic methods, and applications in vision. Co-taught with Thomas Hofmann.

UNIVERSITY OF TORONTO, Spring 1993 Toronto, Ontario
*Applications of Artificial Intelligence.* Senior undergraduate course introducing the fundamentals of AI with emphasis on applications.

YALE UNIVERSITY New Haven, CT
1/91–12/91, Supervision of three undergraduate senior projects.

9/89–12/89, *Teaching Assistant,* Department of Computer Science.

UNIVERSITY OF BRITISH COLUMBIA, 9/84–5/85 Vancouver, BC
*Teaching Assistant,* Department of Computer Science.

**Consulting**

Willow Garage, Advisory Board, Dec 2008 – present.

Videosurf Inc., San Mateo, CA., Scientific Advisory Board, Oct. 2006 – present.

Intel Research, Computational Nano-Vision Group, Nov. 2001 – Dec. 2007.

Cyberkinetics Inc., Foxboro MA, July 2004 – Dec. 2004.

Xerox Palo Alto Research Center, July 2000 – Dec. 2001.

Walt Disney, Feature Animation, August 2000 – Dec. 2000.

**Grants and Gifts**

Office of Naval Research, Contract W911QY-10-C-0172, "Bodies from scans: Analysis of rigid and non-rigid motion," Co-PI with Erik Sudderth. $339,333 (year one). Oct. 1, 2010-Sept. 31, 2010.

NSF CRCNS program, IIS–0904875, "Collaborative Research: Neural and computational models of spatio-temporally varying natural scenes", Co-PI with Garret Stanley and Jose-Manuel Alonso. $452,681 ($173,412 to Brown), Oct. 1, 2009 – 2011.

NIH EUREKA, 1R01NS066311 – 01, "Towards an animal model of freely moving humans," Co-PI with Krishna Shenoy. $1,206,438 (total), $564,471 (Brown), 7/1/09 - 6/30/13.

Willow Garage, $50,000, December 2008.

NSF IIS–0812364, "RI-Small: Human shape and pose from images," $399,649, 9/1/2008–8/31/2011. Principal Investigator. Plus: $30,000 (2009), $16,000 (2010) REU supplements.

Rhode Island Economic Development Corporation (RIEDC), Science and Technology Advisory Committee (STAC) Award. $118,773, Jan 2008 – Dec 2008. "Forensic computer vision: High-quality evidence from low-quality video." Principal Investigator (with D. Pincince).

Office of Naval Research award N00014-07-1-0803. "Neurotechnology Center at Brown University," $1,594,680, March 1, 2007 – August 31, 2008, With J. Donoghue and A. Nurmikko (PI).

Intel Corporation, "Accurate optical flow estimation for media applications," $182,100, April 2007 – April 2010.

NSF OISE-0624015, "U.S.-Uruguay Workshop: Vision in Brains and Machines, Montevideo, Uruguay, November, 2006," $59,983, Sept. 15 2006 – August 31, 2007. Principal Investigator (with G. Randall).

NSF IIS-0636838, "Planning Workshop: Corpora for Computational Neuroscience," $21,320, June 15, 2006 – May 31, 2007 (with Kenneth D. Harris and Bruno A. Olshausen)

Office of Naval Research, Defense University Research Instrumentation Program (DURIP), "Neural interfaces to enhance human motor performance: Instrumentation for modeling

dexterous manipulation," 2006, $314,880, Principal Investigator (with J. P. Donoghue and O. C. Jenkins).

Honda Research, $25,000, March 2006.

NSF IIS-0534858, "Statistical Models of the Primate Neocortex: Implementation and Application," $479,999, 11/15/2005–10/31/2008, co-investigator with T. Dean (PI) and O. C. Jenkins.

NSF #0535075 "Learning Rich Statistical Models of the Visual World for Robust Perception," $268,597, 8/1/2005–7/29/2008, Principal Investigator. Plus $8,750 (2006) and $9,626 (2007) REU supplements.

Intel Corporation, "Learning Probabilistic Models for Image Motion Analysis," $178,699, Nov 2004 - Nov 2006, Principal Investigator.

NIH–NINDS, R01 NS 50967-01, "CRCNS: Learning the Neural Code for Prosthetic Control," 8/1/2004–7/30/2007, $1,116,350, Principal Investigator (with M. Mehta, E. Bienenstock, and J. P. Donoghue).

Veteran's Administration, #A3772C, "Rebuilding, Regenerating and Restoring Function after Traumatic Limb Loss," 8/1/04–7/31/09, $146,776 (Brown sub-contract), Named Investigator (with J. Donoghue, P.I.).

Office of Naval Research award N0014-06-0185. "Neural Interfaces to Understand Human Motor Performance," 10/25/2005–10/26/2006, $963,000. With J. Donoghue and A. Nurmikko.

Office of Naval Research award N0014-04-1-082, "Neural Interfaces to Enhance Human Motor Performance," 10/4/2004–12/30/2005, $960,000. With J. Donoghue and A. Nurmikko.

European Commission, Beyond Robotics Program, "NEUROBOTICS – The Fusion of Neuroscience and Robotics," 1/1/2004–1/1/2008, International partner in large European consortium, total grant of 5,640,048 Euro for 60 months (100,000 Euro for the Brown partnership).

Siemens Corporate Research, $25,000, Jan. 2003; $25,000, Apr. 2004.

NIH–NINDS Contract N01-NS-2-2345, "Cortical Control of Neural Prostheses," $1,900,000, Sept. 2002 – Sept. 2005. Co-investigator (with J. Donoghue (PI) and E. Bienenstock).

NIH–NINDS, grant NS25074, "Static and Dynamic Organization of Primate Cortex", $1,470,456, May 2002 – Mar. 2007. Co-investigator (with J. Donoghue (PI) and E. Bienenstock).

NSF, ITR, "The Computer Science of Biologically Embedded Systems," $446,969, Sept. 2001 through Aug. 2005. Principal Investigator (with E. Bienenstock and J. Donoghue).

ONR contract N000140110886, "Motion Capture for Statistical Learning of Human Appearance and Motion," $339,340, May 1, 2001 through May 1, 2004, (DARPA Human-ID project). Principal Investigator.

Xerox Foundation, University Affairs Committee Grant, $15,000, Nov. 2001.

Xerox Foundation, University Affairs Committee Grant, $15,000, May 2000.

Natural Sciences and Engineering Research Council of Canada, Individual Research Grant, April 1993, $20,000/year for three years.

Connaught Fund, Operating Grant, University of Toronto, April 1993, $3,000.

NASA Graduate Student Researchers Program, Training Grant, NGT–50749, 8/91–8/92, $22,000.

**Paper Awards**

2010 *Koenderink Prize* for Fundamental Contributions in Computer Vision, for the paper: Sidenbladh, H., Black, M. J., and Fleet, D. J., "Stochastic tracking of 3D human figures using 2D image motion," *European Conference on Computer Vision*, 2000.

Journal of Neural Engineering Highlights of 2008 Collection: "Neural control of computer cursor velocity by decoding motor cortical spiking activity in humans with tetraplegia," S.-P. Kim, J. D. Simeral, L. R. Hochberg, J. P. Donoghue and M. J. Black, *J. Neural Eng.* 5(4):455-476, Dec. 2008.

Best Paper Award, INI-Graphics Net, 2008, First Prize Winner of Category Research, with S. Roth for the paper "Steerable random fields."

Best Paper Award, Forth International Conference on Articulated Motion and Deformable Objects (AMDO-e 2006), with L. Sigal for the paper "Predicting 3D people from 2D pictures."

Marr Prize, Honorable Mention, Int. Conf. on Computer Vision, ICCV-2005, Beijing, China, Oct. 2005 with S. Roth for the paper "On the spatial statistics of optical flow."

Marr Prize, Honorable Mention, Int. Conf. on Computer Vision, ICCV-99, Corfu, Greece, Sept. 1999 with D. J. Fleet for the paper "Probabilistic detection and tracking of motion discontinuities."

IEEE Computer Society, Outstanding Paper Award, Conference on Computer Vision and Pattern Recognition, Maui, Hawaii, June 1991 with P. Anandan for the paper "Robust dynamic motion estimation over time."

**Other Awards & Honors**

Commendation and Chief's Award, Henrico County Division of Police, County of Henrico, Virginia, April 19, 2007.

University of Maryland, *Invention of the Year*, 1995, "Tracking and Recognizing Facial Expressions," with Y. Yacoob.

University of Toronto, Computer Science Students' Union *Teaching Award* for 1992–1993.

Nomination: ACM Doctoral Dissertation Award, 1993.

National Research Council, Research Associateship Award, 1992 (declined).

Yale University Fellowship, 89–90 academic year.

University of British Columbia, Dean's Honour List, 1985.

National Science Foundation, Graduate Fellowship, Honorable Mention, 1985.

Natural Sciences and Engineering Research Council, Summer Research Scholarship, 1984.

## Professional Service

### Editorial

Paper Awards Committe, *IEEE Conf. Comp. Vis. Pattern Recog.*, CVPR 2009.
Editorial Board, *International Journal of Computer Vision*. Jan. 2004 – Oct. 2008.
Guest Editor (with Leonid Sigal), *International Journal of Computer Vision*, Special Issue on Evaluation of Articulated Human Motion and Pose Estimation, Vol. 87, No. 1–2, 2010.
Guest Editor (with Ben Kimia), *International Journal of Computer Vision*, Special Issue on Vision at Brown, 2003.
Associate Editor, *IEEE Transactions on Pattern Analysis and Machine Intelligence,* March 1998 – Dec. 2000.

### Program Chair or Organizer

Co-organizer, EHuM-2: Evaluation of Articulated Human Motion and Pose Estimation, Workshop at CVPR 2007.
Co-organizer, EHuM: Evaluation of Articulated Human Motion and Pose Estimation, Workshop at NIPS 2006.
General Co-Chair, International Symposium on Vision by Brains and Machines, November 13–17, 2006, Montevideo, Uruguay.
Co-organizer, NSF Planning Meeting on Data Sharing in Computational Neuroscience, Arlington, VA June 2006.
Program Co-Chair, Fourth International Conference on Automatic Face and Gesture Recognition, Grenoble, France, March 2000.

### Area Chair (or equivalent)

IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2009, 2008, 2007, 2006, 2004, 2001, 2000, 1998.
European Conference on Computer Vision (ECCV), 2012, 2010, 2008, 2006, 2002.
International Conference on Computer Vision (ICCV), 2001, 1999.
Neural Information Processing Systems (NIPS), 2007.
Theme chair, 1st IEEE/EMBS Int. Conf. on Neural Engineering, 2003.
Papers Committee member, SIGGRAPH 2002.

### Program Committee Member, Conferences

International Conference on Computer Vision (ICCV), 2005, 2003, 1995.
IEEE Conference on Computer Vision and Pattern Recognition (CVPR) 2005, 2003, 1999.

European Conference on Computer Vision (ECCV), 2004, 2000.
16th International Conference on Pattern Recognition (ICPR), 2002.
International Conference on Automatic Face and Gesture Recognition, 2002, 2000, 1998, 1996.

**Program Committee Member, Workshops**

2nd Workshop on Human Motion Understanding, Modeling, Capture and Animation, 2007.
IEEE Computer Society Workshop on Motion and Video Computing, 2005.
Workshop on Analysis and Modeling of Faces and Gestures, at ICCV 2003.
3rd Int. Workshop on Statistical and Computational Theories of Vision, 2003, 1999.
Computer Vision for the Nano-Scale, workshop at CVPR, 2003.
ECCV Workshop on Vision and Modelling of Dynamic Scenes, 2002.
IEEE Int. Workshop on Cues in Communication, 2001.
IEEE Workshop on Human Motion, 2000.
IEEE Human Modeling, Analysis and Synthesis Workshop 2000.
VISALGS – Vision Algorithms: Theory and Practice, 1999.
Workshop on Non-Rigid and Articulate Motion, 1997.

**Other**

Organizer, 2nd San Francisco Bay Area Vision Meeting. *Motion: The next 10 years.* Xerox Palo Alto Research Center, Dec. 1997.
Planning meeting member for the Capitol Hill Congressional Conference on "New Frontiers in Breast Cancer Imaging and Early Detection," Washington D.C., July 1994.
Chair of the 1993 IJCAI panel on Action, representation, and purpose: Re-evaluating the foundations of computational vision.

**Reviewing**

Reviewed journal papers for:

IEEE Transactions on Biomedical Engineering,
IEEE Transactions on Neural Systems and Rehabilitation Engineering,
International Journal of Computer Vision,
IEEE Transactions on Pattern Analysis and Machine Intelligence,
Computer Vision and Image Understanding,
Machine Vision and Applications,
International Journal of Robotics Research,
IEEE Transactions on Circuits and Systems for Video Technology,
Computer Vision Graphics and Image Processing: Image Understanding,
IEEE Transactions on Image Processing,
Journal of Visual Communication and Image Representation.

Reviewer (conferences and workshops):

International Conference on Computer Vision (1993, 1995, 1999),
Computer Vision and Pattern Recognition (1991, 1997, 1998, 1999, 2010),
European Conference on Computer Vision (2000, 2004),
Int. Conf. on Automatic Face and Gesture Recognition (1996, 1998),

Neural Information Processing Systems (NIPS) (2003, 2006),
SIGGRAPH (1998, 2003),
Graphics Interface, 2000,
Interactive 3D Symposium, I3D, 2000,
IEEE Human Modeling, Analysis and Synthesis Workshop 2000,
VISALGS Workshop – Vision Algorithms: Theory and Practice 1999,
IEEE Workshop on Non-rigid and Articulate Motion 1997,
International Joint Conference on Artificial Intelligence 1993,
IEEE Workshop on Visual Motion 1991.

Reviewed grant applications for:

National Science Foundation (2000, 2006 (CRCNS)),
NSERC Canada (2000, 2001, 2002, 2004, 2005),
National Institutes of Health (2000),
University of California at Berkeley MICRO (Microelectronics Innovation and Computer Research Opportunities) Program (1996).

Reviewed books for Morgan Kaufmann Publishers, Inc.

Reviewed book chapters for: "Motion-Based Recognition," M. Shah and R. Jain (eds.), Kluwer Academic Pub.

**University Service**

Member, The President's Science Council at Brown University (March 2009 – Dec. 2010).

Public Relations Committee, Member, Dept. of Computer Science (Sept. 2010 – Dec. 2010).

Lecture Series Committee, Chair, Dept. of Computer Science (Sept. 2010 – Dec. 2010).

Member, Ethical and Responsible Conduct of Research, Curriculum Development Committee (Oct. 2009 – Dec. 2009).

Director of Graduate Studies, Dept. of Computer Science (Jan. 2008 – Dec. 2009, co-Director Jan. 2010 – June 2010).

Tenure and Promotion Committee, Dept. of Computer Science (May. 2009 – Dec. 2010).

Executive committee member, Brown Institute for Brain Science (formerly Brain Science Program). (May 2002 – Dec. 2010).

Member, Strategic Opportunities Committee, Dept. of Computer Science (Sept. 2008 – May 2009).

Co-Director of Graduate Studies, Dept. of Computer Science (Sept. 2007 – Dec. 2007).

Director, Industrial Partners Program, Dept. of Computer Science. (Jan. 2002 – Sept. 2003); Co-Director (Sept. 2003 – July 2006).

Standing Appeals Committee for the Brown University Patent and Invention Policy, Feb. 2006 – June 2006.

Chair, Computer Science faculty search committee (Machine Learning), 2005–2006.

Member, Faculty search committee (Neuro-technology), Brain Science Program, 2005–2006.

Chair, Computational science concentration committee, Computer Science (July 2005 – July 2007).

Faculty search committee, Affirmative action representative, Dept. of Computer Science. (Sept. 2001 – 2005, 2007 – 2008).

Facilities committee, Dept. of Computer Science (June 2002 – Aug. 2004).

Patent and Invention Advisory Committee, Brown University (Feb 2004 – July 2004).

Digital Initiatives Committee, Brown University (April 2003 – Feb. 2004).

Theoretical Neuroscience recruiting committee, Brain Sciences Program, Brown University (2002–2003).

Recruiting committee, NSF Integrative Graduate Education and Research Training Program, "Learning and Action in the Face of Uncertainty: Cognitive Computational and Statistical Approaches." Brown University (Sept. 2000 – Dec. 2002).

Industrial Partners Program, Dept. of Computer Science, Brown University (Oct. 2000 – Dec. 2001).

Organizer, Industrial Partners Program Symposium on *Vision-based Interfaces*, Dept. of Computer Science (May 2001).

**Undergraduate Advising**

Teodor Mihai Moldovan, Summer 2006 – Spring 2009.

Benjamin Aisen, Fall 2004.

Ben Sigelman, Summer 2002, Fall 2002, Spring 2003. Honors Thesis: "Video-Based Tracking of 3D Human Motion Using Multiple Cameras."

Tiferet Levine, Fall 2002.

Matthew Ivester, Summer 2002.

Timothy Bentley, Summer 2002.

Richard Peter Weistroffer and Dmitri Lemmerman, "Independent Study in the Use of EMG Signals as a Control Device," Spring 2002.

Robert Altshuler, "Tracking Walking People using a Probabilistic Model of Optical Flow," Brown University, Dept. of Computer Science, Spring 2001.

Curren Nachbar, "Hit or Miss: Perspectives on Time-to-Contact Estimation," Brown University, Dept. of Computer Science, Fall 2000.

**Master's Advising**

Siron Vittayakorn, "2D virtual try-on using 3D bodies," Brown University, Dept. of Computer Science, Spring 2009 – Dec. 2010.

Laura Sevilla, "3D bone tracking in bi-plane X-ray sequences," Brown University, Dept. of Computer Science, Fall 2008 – Aug. 2009.

Payman Yadollahpour, Brown University, Dept. of Computer Science, Fall 2005 – Aug. 2006; jointly with Gregory Shakhnarovich.

Sidharth Bhatia, "3D human limb detection using space carving and multi-view eigen models," Brown University, Dept. of Computer Science, Spring 2004.

Robert Altshuler, "Decomposing Image Sequences into Layers According to Motion with the use of an Appearance Model," Brown University, Dept. of Computer Science, Fall 2001 – Spring 2003.

Wei Wu, "Neural Decoding of Motor Cortex using a Kalman Filter," Brown University, Dept. of Computer Science, Spring 2003.

Yun Gao, "Nonparametric Representation of Neural Activity in Motor Cortex," Brown University, Dept. of Computer Science, Spring 2002.

Philip F. Chen, "Statistical Method for Motion Estimation from Omnidirectional Image Sequences," Brown University, Dept. of Computer Science, Spring 2001.

Xuan Ju, "Estimating time-to-contact by detecting and tracking motion boundaries," Sept. 1992 – Jan. 1994, University of Toronto.

**Ph.D. Advising** Aggeliki Tsoli, Nov. 2010 – present, Brown University, Dept. of Computer Science.

Silvia Zuffi, Sept. 2009 – present, Brown University, Dept. of Computer Science.

Oren Freifld, Sept. 2009 – present, Brown University, Division of Applied Mathematics.

Peng Guan, Sept. 2008 – present, Brown University, Dept. of Computer Science.

Deqing Sun, Sept. 2007 – present, Brown University, Dept. of Computer Science.

Payman Yadollahpour, Sept. 2006 – Dec. 2008, Brown University, Dept. of Computer Science; jointly with Gregory Shakhnarovich.

Alexandru Balan, Ph.D. Thesis: "Detailed human shape and pose from images," Jan. 2004 – May 2010, Brown University, Dept. of Computer Science.

Leonid Sigal, Ph.D. Thesis: "Continuous-state graphical models for object localization, pose estimation and tracking," Aug. 2001 – Oct. 2007, Brown University, Dept. of Computer Science.

Frank Wood, Ph.D. Thesis: "Non-parametric Bayesian models of neural data," Jan. 2003 – May 2007, Brown University, Dept. of Computer Science.

Stefan Roth, Ph.D. Thesis: "High-order Markov random fields for low-level vision," Aug. 2001 – May 2007, Brown University, Dept. of Computer Science.

Jessica Fisher, Sept. 2004 – May 2006, Brown University, Dept. of Computer Science.

Wei Wu, Ph.D. Thesis: "Statistical models of neural coding in motor cortex," May 2002 – May 2004, Brown University, Division of Applied Mathematics, jointly with David Mumford.

Hulya Yalcin, Ph.D. Thesis: "Implicit models of moving and static surfaces," March 2002 – May 2004, Brown University, Division of Engineering.

Fernando De la Torre, Ph.D. Thesis: "Robust subspace learning for computer vision," June 1999 – Jan. 2002, La Salle School of Engineering, Universitat Ramon Llull, Barcelona, Spain.

Hedvig C. Sidenbladh, Ph.D. Thesis: "Probabilistic tracking and reconstruction of 3D human motion in monocular video sequences," Apr. 1999 – Nov. 2001, Royal Institute of Technology, Stockholm, Sweden, jointly with Jan-Olof Eklundh.

Shanon X. Ju, Ph.D. Thesis: "Estimating image motion in layers: The Skin and Bones model," Jan. 1994–Jan. 1999, University of Toronto, jointly with Allan Jepson.

**Thesis Committee Member**

Matthias Grundmann, Georgia Inst. of Technology.

Eric Kee, Dartmouth.

Tai-peng Tian, "Efficient techniques for parsing humans in images," Boston University, Jan. 2011.

Carlos Vargas-Irwin, "Motor Cortical Control of Naturalistic Reaching and Grasping Actions," Dept. of Neuroscience, Brown University, May 2010.

Matthew Leotta, "Generic, Deformable Models for 3-D Vehicle Surveillance," Division of Engineering, Brown University, Sept. 2009.

Maixme Taron, "Registration & modeling of shapes with uncertainties: Contributions and applications to knowledge based-segmentation," Ecole Nationale des Ponts et Chaussées, Fall 2007. Rapporteur.

Stewart Andrews, Ph.D., "Learning from ambiguous examples," Brown University, Dept. of Computer Science, Fall 2006.

Leonid Taycher, Ph.D., "Coping with uncertain dynamics in visual tracking: Redundant state models and discrete search methods," MIT CSAIL, July 2006.

Morgan McGuire, Ph.D., "Capture and manipulation of single-center, multi-parameter video," Brown University, Dept. of Computer Science, Fall 2005.

Yun Gao, Ph.D., "Statistical models in neural information processing," Brown University, Division of Applied Mathematics, June 2004.

Peng Chang, Ph.D., "Robust tracking and structure from motion with sampling method," Robotics Institute, Carnegie Mellon University, July 2002.

Cristian Sminchisescu, "Estimation algorithms for ambiguous visual models: Three dimensional human modeling and motion reconstruction in monocular video sequences," Ph.D. Inst. National Polytechnique de Grenoble, France, Jul. 2002. Rapporteur.

Cullen Jackson, Ph.D., Brown University, Department of Psychology, Oct. 2001.

François Bérard, "Vision par ordinateur pour l'interaction homme-machine fortement couplé," Ph.D. Joseph Fourier Univ., Grenoble, France, Nov. 1999.

James Davis, M.S. MIT Media Laboratory, July 1996.

**Ph.D. Thesis Opponent**

Lars Bretzner, Thesis: "Multi-scale feature tracking and motion estimation," Ph.D. Royal Inst. of Tech. (KTH), Sweden, Oct. 1999.

**Host for Postdoctoral Researcher**

Sung-Phil Kim, Brown University, Sept. 2005 – Sept. 2008.

Gregory Shakhnarovich, Brown University, Oct. 2005 – Dec. 2007.

Ronan Fablet, Brown University, Sept. 2001 – July 2002.

Horst Haussecker, Xerox PARC, July 1999 – June 2000.

**Host for Visiting Artist**

Pamela Z, PARC Artist in Residence, 1994-1996. Examining the relationship between human motion and music.

**Associations**

Bernstein Center for Computational Neuroscience Tübingen, since Jan. 2011.
Institute for Electrical and Electronics Engineers: Senior Member: July 2008–present; Member: 1992–2008; Student Member: 1990-1992.
Associate, *Canadian Institute for Advanced Research*, since Feb. 2006.
Center for Restorative and Regenerative Medicine, Brown University, since 2004.
IEEE Engineering in Medicine and Biology Society: Member since 2002
Society for Neuroscience: Member since 2001.
Brain Science Program, Brown University: Member since 2000.
Brown University Neuroscience Graduate Training Program, Nov. 2005 – Jan. 2008.
Computation and Mathematics of Mind, Brown University: Member 2000–2005
American Association for Artificial Intelligence: Member 1985–2002.
Institute for Robotics and Intelligent Systems (IRIS, Canada): Principal Investigator, 1992–1994.

**Patents and Patent Applications**

[7] Black, M. J., Balan, A., Weiss, A., Sigal, L., Loper, M., St Clair, T., *Method and Apparatus for Estimating Body Shape*, US (12/541,898) and PCT patent application, filed August 14, 2009.

[6] Jepson, A. D., Fleet, D. J., and Black, M. J., *Visual motion analysis method for detecting arbitrary numbers of moving objects in image sequences*, US Pat. 6,954,544, Oct. 11, 2005.

[5] Black, M. J., Ju, S., Minneman, S., and Kimber, D., *Method and apparatus for generating a condensed version of a video sequence including desired affordances*, US Pat. 6,560,281, May 6, 2003.

[4] Black, M. J. and Jepson, A. D., *Apparatus and method for identifying and tracking objects with view-based representations*, US Pat. 6,526,156, Feb. 25, 2003.

[3] Black, M. J. and Yacoob, Y., *Apparatus and method for tracking facial motion through a sequence of images*, US Pat. 5,802,220, Dec. 15, 1995.

[2] Black, M. J. and Yacoob, Y., *Apparatus and method for recognizing facial expressions and facial gestures in a sequence of images*, US Pat. 5,774,591, Dec. 15, 1995.

[1] Black, M. J. and Jepson, A. D., *Image segmentation using robust mixture models*, US Pat. 5,802,203, June 7, 1995.

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*Case studies in Bayesian Statistics Workshop 7*, Carnegie Mellon University, Pittsburgh, Sept. 12–13, 2003.

"Inferring 3D people from 2D images,"

*19th Conference on Uncertainty in Artificial Intelligence*, UAI-2003, Acapulco, Mexico, Aug 8-10, 2003.

"People from pictures: Past, present, and future,"

*The 2003 Stockholm Workshop on Computational Vision*, Rosenön, Sweden, July 2003.

"Connecting brains with machines: The neural control of 2D cursor movement,"

Plenary talk, *1st International IEEE EMBS Conference on Neural Engineering*, March 20–22, 2003, Capri Italy.

"Models of neural coding in motor cortex and their application to neural prostheses,"

Plenary talk, *Mathematical Biosciences Institute,* workshop on Neural Coding, Feb 10–14, 2003.

"Learning the appearance and motion of people in video,"

*One-day Workshop on Computer Vision*, INRIA Rhône-Alpes, Grenoble, France, Jul. 2002.
*Workshop of the ECCV Area Chairs* , Lund Univ., Sweden, Feb. 2002.

"Overview of brain-computer interface research at Brown,"

*Directions in Brain-Computer Interface (BCI) Research,* Whistler, BC, Dec. 7, 2001.

"Smoke & mirrors: Grand challenges in motion imagery,"

*Defining a Motion Imagery Research and Development Program Workshop,* Herndon, VA, Nov. 28-30, 2001.

"Probabilistic inference of hand motion from neural activity in motor cortex,"

*The 2001 Stockholm Workshop on Computational Vision,* Rosenön, Sweden, July 30 – August 2, 2001.

"Learning what people look like,"

*Workshop on the Convergence of Vision, Video, and Graphics*, March 28-30, 2001, Berkeley, CA.

"Beyond perceptual user interfaces: Brain-computer interfaces,"

*Workshop on Vision-Based Perceptual Interfaces*, March 19, 2001, Interactive Institute, Stockholm, Sweden.

"Probabilistic modeling of neural activity for brain-computer interfaces,"

*Microsoft Research Vision Symposium*, March 5–6, 2001, Redmond, WA.

"Understanding human behavior,"

Panel presentation, *IEEE Human Modeling, Analysis and Synthesis Workshop*, Hilton Head, June 2000.

"Stochastic tracking of human motion,"

*Beckman Institute Computer Vision Workshop*, February 14–15, 2000, Urbana, IL.

"Generic recognition of human activity,"

*2nd IEEE Workshop on Generic Object Recognition*, September 26, 1999, Corfu, Greece.

"Motion: From estimation to explanation,"

*IEEE Computer Society Workshop on The Interpretation of Visual Motion*, Santa Barbara, June 1998.

"Human motions and computer interfaces,"

*ECCV'98 Workshop on Perception of Human Action,* Freiburg Germany, June 1998.

"The vision frontier in the early detection of breast cancer,"

New Frontiers in Breast Cancer Imaging and Early Detection, Washington D.C., July 1994.

"Robust tracking of multiple affine motions,"

*IRIS–PRECARN* III Annual Conference, Ottawa, June 1993.

"Optic flow and motion discontinuities over long image sequences: Experimental results,"

Panelist: Experimental Session on Optic Flow, *IEEE Workshop on Visual Motion*, Princeton, NJ, Oct. 1991.

"Optic flow and nap of the earth helicopter flight,"

*Workshop on Motion and Autonomous Navigation,* NASA Ames Research Center, July 1990.

**Invited Talks**

"An additive latent feature model for transparent object recognition,"

*Machine Learning Seminar*, Univ. of Toronto, Jan. 2010.

"Decoding the human brain for neural prosthetic control,"

*Univ. of Washington*, Dept. of Comptuer Science, Seattle, WA, April 2010,
*Max Planck Inst. for Biological Cybernetics*, Tübingen, Germany, April 2009.

"Detailed human shape and pose from images"

*ETH*, Zurich, Switzerland, Oct. 2010,
*Microsoft Research*, Redmond, WA, April 2010,
*Dept. of Computer Science*, UC Santa Barbara, CA, Feb. 2010,
*US Army Natick Soldier RD&E Center*, Natick, MA, July 2009,
*Air Force Research Lab.*, Wright-Patterson Air Force Base, Dayton, May 2009,
*Florida State Univ.*, Dept. of Statistics, Mar. 2009,
*Univ. of Southern California*, Dept. of Comp. Sci. Feb. 2009,
*Google*, Tech Talk, New York, NY, Oct. 2008,
*Univ. of British Columbia*, Dept. of Computer Science, Vancouver, Aug. 2008,
*Georgia Inst. Tech.*, Center for Robotics and Intelligent Machines, Feb. 2008,
*Google*, Tech Talk, Mountain View, Jan. 2008,
*Technion*, Dept. of Computer Science, Haifa, Israel, Jan. 2008,
*Weizmann Inst. of Science*, Rehovot, Israel, Jan. 2008,
*University of Oxford*, Engineering, Visual Geometry Group, Nov. 2007,
*Microsoft Research*, Cambridge, UK, Nov. 2007,
*Ecole Normale Supérieure*, Département d'Informatique, Paris, Nov. 2007.

"Learning models of optical flow,"

*Weizmann Inst. of Science*, Rehovot, Israel, Dec. 2008.

"Predicting human body shape under clothing"

*Tech. Univ. Darmstadt*, Darmstadt, Germany, Dec. 2008,
*Willow Garage,* Menlo Park, CA, Nov. 2008,
*Univ. of California at Berkeley,* Vision Seminar, Nov. 2008.

"The development of a human neural interface system: Recent results"

*Hebrew University*, Dept. of Physiology, Jerusalem, Isreal, Jan. 2008.

"Directly connecting brains and machines: The development of a human neural interface system,"

*Tel Aviv University*, Dept. of Electrical Engineering, Tel Aviv, Israel, Jan. 2008,
*The Gerard Salton Lecture*, Cornell University, Dept. of Computer Science, Sept. 2007.

"Restoring movement to the severely disabled with a neural motor interface,"

*Univ. of British Columbia*, Dept. of Computer Science, Vancouver, May 2007.

"Fields of Experts: High-order Markov random field models of natural scenes,"

*Hebrew University*, Comp. Sci. & Eng., Jerusalem, Israel, Jan. 2008,
*Oxford Brookes University*, Oxford, Nov. 2007
*Cornell University*, AI Seminar Series, Dept. of Computer Science, Sept. 2007,
*Hong Kong Univ. of Science and Technology*, Dept. of Computer Science and Engineering and Dept. of Electronic and Computer Engineering, August 2007.
*Univ. of British Columbia*, Dept. of Computer Science, Vancouver, May 2007.
*Stanford Univ.*, The Probabilistic AI Lunch, October 2006.

"Building the bionic body: Restoring movement to the severely disabled with a brain-machine interface,"

*National Hellenic Research Foundation,* Public lecture series on Health and Society, Athens, Greece, November 2006.

"Repairing the damaged brain with computation: The development of a neural motor prosthesis,"

*Dertouzos Lecturer Series*, MIT, CSAIL, April 2006,
*National Technical University of Athens*, June 2006.

"Bayesian denoising of archival films,"

*Intel Research*, Santa Clara, CA, March 2006.

"Fields of experts: A framework for learning image priors,"

*Royal Institute of Technology (KTH)*, CVAP, Stockholm, Sweden, Sep. 2005.

"Neural Motor Prostheses: Directly Coupling Brains and Machines to Restore Lost Function,"

*German Aerospace Center*, DLR, Oberpfaffenhofen, Germany, Jan. 2006,
*Salk Institute*, La Jolla, CA, June 2005,
*Univ. of Maryland*, Dept. of Computer Science, Apr. 2005,
*Gatsby Computational Neuroscience Unit,* Univ. College, London, Feb. 2005,
*Karolinska Inst.*, Nobel Inst. for Neurophys., Stockholm, Sweden, Jan. 2005,
*Oxford University*, Robotics Research Group Seminar, Dec. 2004,
*York University*, Computer Science and Engineering Seminar Series, Nov. 2004,
*Carnegie Mellon*, Robotics Institute Seminar, Sept. 24, 2004.

"Inferring 3D people from 2D images,"

*Royal Institute of Technology (KTH)*, CVAP, Stockholm, Sweden, Jan. 2005,
*Johns Hopkins University*, Center for Imaging Science, April 20, 2004.

"The probabilistic inference of 3D human motion,"

*Columbia Univ.*, Vision and Graphics Center, Distinguished Lecture Series, Apr. 2003.

"Connecting brains with machines: Towards the neural control of 2D cursor movement,"

*McGill Univ.*, Center for Intelligent Machines Seminar, Montreal, April 2003,
*Siemens Corp. Research*, Distinguished Seminar Series, Princeton, Apr. 2003,
*Ohio State University*, Electrical Engineering Colloquium, Feb. 2003,
*MIT*, AI Lab Colloquium, Oct. 2002,
*Middlebury College.*, Dept. of Math. and Comp. Science, Oct. 2002.

"Connecting brains with machines: Intel inside your brain?,"

*Intel Corp.*, Microprocessor Research Labs (MRL), Santa Clara, Media Graphics Seminar, Mar. 2002.

"Connecting brains with machines: The probabilistic inference of hand motion from neural activity,"

*Signals, Sensors, and Systems*, KTH, Stockholm, Feb. 2002,
*La Salle School of Engineering*, Barcelona, Catalonia, Jan. 2002.

"The man who mistook his computer for a hand: The neural control of robotic devices,"

*Royal Institute of Technology (KTH)*, Stockholm, Sweden, Nov. 2001.

"Learning the appearance and motion of people in video,"

*Middlebury College*, Computer Vision (CX 336), guest lecture, Oct. 2002.
*University of Toronto*, Vision group, Dept. of Computer Science, Nov. 2002,
*Siemens*, SRC Distinguished Seminar Series, Princeton, NJ, Aug. 2002,
*Yale University*, Dept. of Computer Science, Feb. 2002,
*University of Rochester*, Dept. of Computer Science, Apr. 2001,
*University of Western Ontario*, Dept. of Computer Science, Apr. 2001.

"Stochastic tracking of humans,"

*University of Pennsylvania*, GRASP Laboratory, Feb. 2001,
*New York University*, Center for Neural Science, Feb. 2001,
*The Robotics Institute*, Carnegie Mellon University, Nov. 2000,
*Brown University*, Dept. of Applied Mathematics, Sept. 2000.

"Generative spatio-temporal models of optical flow events,"

*Imaging Science & Biomedical Eng.,* Univ. of Manchester, Oct. 1999,
*Gatsby Computational Neuroscience Unit,* Univ. College, London, Oct. 1999,
*Smith-Kettlewell Eye Research Institute,* San Francisco, July 1999,
*Brown Univ.,* Dept. of Computer Science, May 1999,
*UCLA*, Mathematics Dept., April 1999,
*Univ. of Southern California*, Dept. of Comp. Sci. April 1999,
*California Institute of Technology*, Vision Seminar, April 1999,
*Univ. of California at Berkeley,* Vision Seminar, Feb. 1999,
*University of Toronto*, Dept. of Computer Science, Feb. 1999,
*Interval Research*, Palo Alto, CA, Feb. 1999.

"Motion: From estimation to explanation,"

*Royal Institute of Technology (KTH)*, Stockholm, Sweden, Sept. 1998.

"A framework for modeling appearance change in image sequences,"

*Royal Institute of Technology (KTH)*, Stockholm, Sweden, Dec. 1998.

"A probabilistic framework for matching temporal trajectories: Condensation-based recognition of gestures and expressions,"

*INRIA Rhônes Alpes*, Grenoble, France, May 1998.

"Human motions and computer interfaces,"

*McGill University*, Center for Intelligent Machines, August 1998,
*Univ. of Heidelberg*, Interdisciplinary Center for Sci. Comp., June 1998,
*Harvard Univ.,* Division of Engineering and Applied Sciences, May 1998,
*Brown Univ.,* Dept. of Computer Science, March 1998,
*Stanford Univ.,* Dept. of Computer Science, March 1998,
*Rutgers Univ.,* Cognitive Science Colloquium, Dec. 1997.

"Looking @ people: Estimation and explanation of human motion,"

*MIT,* AI Lab Colloquium, Nov. 1997,
*Smith-Kettlewell Eye Research Institute,* San Francisco, Oct. 1997,
*Univ. of California at Berkeley,* AI/Robotics/Vision Seminar, Oct. 1997,
*Univ. of Toronto,* Artificial Intelligence Colloquium, Oct. 1997.

"Motion explanation: Learning parameterized models of optical flow,"

*Univ. of Central Florida,* Computer Science Dept. Colloquium, March 1997,
*Univ. of South Florida,* Computer Science Dept., March 1997.

"Introduction to robust statistics with applications in computer vision,"

*CS 348D: Vision and Image Processing*, Stanford University, Dec. 1996.

"EigenTracking: Robust matching and tracking of articulated objects using a view-based representation,"

*Royal Institute of Technology (KTH)*, Stockholm, Sweden, Nov. 1998,
*Courant Institute*, NYU, New York, February 1997,
*Interval Research Corporation*, Palo Alto, CA, Dec. 1996,
*Univ. of British Columbia*, Dept. of Computer Science, Vancouver, Aug. 1996,
*MIT*, Department of Brain and Cognitive Science, Cambridge, MA, May 1996.

"Human gestures and the Digital Office,"

*Univ. of Maryland*, Computer Vision Laboratory, College Park, MD, Sept. 1996.

"If only your computer could see you now: Tracking and recognizing facial expressions in video,"

*Univ. of British Columbia*, Dept. of Computer Science, Vancouver, Jan. 1996,
*Interval Research Corporation*, Palo Alto, CA, Sept. 1995.

"Estimating optical flow in segmented images using variable-order parametric models with local deformations,"

*Interval Research Corporation*, Palo Alto, CA, Sept. 1994,
*Univ. of California at Berkeley*, Dept. of EECS, Aug. 1994,
*Univ. of Maryland*, Computer Vision Laboratory, College Park, MD, July 1994,
*Univ. of British Columbia*, Comp. Science Colloquium, Vancouver, June 1994.

"Robust estimation of multiple motions,"

*Stanford University*, Department of Psychology, Nov. 1993,
*IRISA/INRIA*, Rennes, France, Aug. 1993.

"Robust incremental optical flow,"

*Xerox PARC*, March 1993,
*University of Toronto*, Research Group in Perception, Jan. 1993,
*David Sarnoff Research Center*, Aug. 1992,
*Teleos Research*, July 1992.

"Robust dynamic motion estimation over time,"

*Yale University,* Industry Liaison Meeting, Oct. 1990,
*Yale University,* Vision Lunch, May 1991.

"Motion estimation, Markov random fields, and simulated annealing,"

*Yale University,* Department of Statistics, Sept. 1990.

"Current research in incremental motion estimation,"

*Columbia University,* Sept. 1990, (with P. Anandan).

"Incremental motion estimation,"

*NASA Ames Research Center,* June 1990,
*Advanced Decision Systems,* Aug. 1990.

"Early detection of motion discontinuities,"

*Univ. of California, Berkeley*, June 1990,
*NASA Ames Research Center*, June 1990.

**Other Talks**

"Probabilistic encoding and decoding of motor cortical activity,"

*DARPA Bio:Info:Micro PI Meeting*, Boston, MA, Oct 31–Nov 1, 2002.

"Connecting brains with computers: The neural control of robotic devices,"

*Brown University Mind Brain Retreat,* Killington, VT, Mar. 2002.

"The machine inside,"

*Voyages of Discovery,* Inauguration of Ruth J. Simmons, 18th President of Brown Univ., with E. Bienenstock, D. Sheinberg, and M. Serruya. Providence, RI, Oct. 2001.

"The science of silly walks,"

*Brown University Conference on Stochastic and Deterministic Approaches in Vision, Language, and Cognition,* Whispering Pines, RI, May 2001.

"Condensation-based gesture recognition,"

*3rd San Francisco Bay Area Vision Meeting,* Interval Research, April. 1998.

"Motion: Looking back and moving forward,"

*2nd San Francisco Bay Area Vision Meeting,* Xerox PARC, Dec. 1997.