

Curriculum Vitae: Surya P. N. Singh

Information Technology and Electrical Engineering
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Research Interests

I am interested in the agile control of robot motion. This encompasses both analysis (biomechanics, inverse control) and synthesis (integrated motion planning and optimal control).

Education

- Ph.D.**, Stanford University (School of Engineering) April 2006
Mechanical Engineering
Dissertation: *Self-contained Field Analysis of Dynamic Legged Locomotion*
- M.S.**, Carnegie Mellon University (School of Computer Science) December 2001
Robotics
Thesis: *ARMS: Autonomous Robots for Military Systems*
(published as CMU Technical Report: CMU-RI-01-16)
- B.S.**, The University of Tennessee May 2000
Mechanical Engineering and Economics (minor) – *summa cum laude*

Academic Experience

- The University of Queensland** (Robot Design Laboratory) August 2011-*Present*
Senior Lecturer
Studying optimal control and planning methods so as to leverage analytic models along with probabilistic system identification for agile system performance. This includes applications related to motor control in gait.
- The University of Sydney** (Australian Centre for Field Robotics) 2008-2011
Research Fellow
Agile control methods, which have were applied to autonomous excavation and the first fielded autonomous (blast-hole) drill rig (now in routine commercial operation).
- University of Western Australia** (School of Mechanical Engineering) 2006-2007
Visiting Lecturer & Fulbright Scholar
Field teleoperation and improved “display”/“sensing” tools for humanitarian landmine clearance operations.
- Stanford University** (Mechanical Engineering Design Division) 2002-2006
Research Associate (Robotics Locomotion Laboratory) and Teaching Assistant
Studied in-field sensing and estimation of agile locomotion, particularly galloping, leading to the first hybrid estimator for legged robots with integrated systems identification and online center of mass estimation. Used for motion synthesis on KOLT (robot) and analysis (of galloping dogs outdoors).

Honors and Awards

- U. Sydney AMME Teaching Commendation March 2010
- UWA Individual Teaching Award nomination December 2007
- Fulbright Scholar (to Australia) 2006-2007
- NSF EAPSI Summer Scholar (to the Tokyo Institute of Technology) June-August 2005
- JSPS Invited Scholar (to the Tokyo Institute of Technology) May-August 2004
- National Defense Science and Engineering Graduate (NDSEG) Fellowship 2001-2004
- Tau Beta Pi Fellowship (General Electric #1) 2001
- Barry Goldwater Scholar 1998-2000

Journal:

1. K. Seiler, **S. Singh**, S. Sukkarieh, and H. Durrant-Whyte, "Using Lie Group Symmetries for Fast Corrective Motion Planning", (in press *International Journal of Robotics Research*)
2. **S. Singh**, R. Fitch, and S. Williams, "A Research-Driven Approach to Undergraduate Robotics Education," *Computers in Education Journal*, **20(4)**, Oct-Dec 2010.
3. J. Ma, A. Wittek, **S. Singh**, G. Joldes, T. Washio, K. Chinzei, and K. Miller "Evaluation of accuracy of non-linear finite element computations for surgical simulation: study using brain phantom," *Computer Methods in Biomechanics and Biomedical Engineering*, **13(6)**:783–794, December 2010.
4. K. Waldron, J. Estremera, P. Csonka, and **S. Singh**, "Analyzing Bounding and Galloping Using Simple Models," *Journal of Mechanisms and Robotics*, **1**:011002:1–11, February, 2009.
5. M. Matsuoka, A. Chen, **S. Singh**, *et al.*, "Autonomous Helicopter Tracking and Localization Using a Self-Locating Camera Array," *International Journal of Robotics Research*, **26(2)**:205–215, 2007.
6. J. G. Nichol, **S. Singh**, K. J. Waldron, L. R. Palmer, and D. E. Orin. "System Design of a Quadrupedal Galloping Machine," *International Journal of Robotics Research*, **23(10-11)**:1013–1027, 2004.

Conference (Refereed):

7. G. Maeda, **S. Singh**, D. Rye, "Improving Operational Space Control of Heavy Manipulators via Open-Loop Compensation," (to be presented at IROS 2011).
8. S. O'Callaghan, **S. Singh**, A. Alempijevic, and F. Ramos, "Learning Navigational Maps by Observing Human Motion Patterns," *International Conference on Robotics and Automation*, May 2011.
9. G. Maeda, **S. Singh**, H. Durrant-Whyte, "A Tuned Approach to Feedback Motion Planning with RRTs under Model Uncertainty", *International Conference on Robotics and Automation*, May 2011.
10. K. Waldron and **S. Singh**, "Resolving the Paradox of Asymmetry in the gallop gait," IFToMM 2011 World Congress, June 2011).
11. K. Seiler, **S. Singh**, H. Durrant-Whyte, "Using Lie Group Symmetries for Fast Corrective Motion Planning," Proc. of the Ninth International Workshop on the Algorithmic Foundations of Robotics, Dec. 2010.
12. B. Douillard, **S. Singh**, *et al.*, "A Pipeline for the Segmentation and Classification of 3D Point Clouds," Proc. of the at *International Symposium on Experimental Robotics*, Dec. 2010.
13. S. Singh and K. Axelrod, "Coordinated Steering for an Uncalibrated Pan-Tilt-Zoom Camera Array," Proc. of the *Australian Conference on Robotics and Automation (ACRA)*, Dec. 2010.
14. N. Kirchner, A. Alempijevic, S. Singh, *et al.*, "RobotAssist - a Platform for Human Robot Interaction Research," Proc. of the *Australian Conference on Robotics and Automation (ACRA)*, Dec. 2010.
15. M. Freese, **S. Singh**, F. Ozaki, N. Matsuhira, "V-REP: A Versatile 3D Robot Simulator," Proc. of the Second Int. Conf. on *Simulation, Modeling and Programming for Autonomous Robots (SIMPAN)*, Nov. 2010.
16. G. Maeda, **S. Singh**, H. Durrant-Whyte, "Feedback Motion Planning Approach for Nonlinear Control using Gain Scheduled RRTs," Proc. of the *International Conference on Intelligent Robots and Systems*, Oct. 2010.
17. B. Douillard, **S. Singh**, *et al.*, "Elevation Maps: 3D Surface Models for Segmentation," Proc. of the *International Conference on Intelligent Robots and Systems*, Oct. 2010.
18. X. Fan, **S. Singh**, F. Oppolzer, *et al.*, "Integrated Planning and Control of Large Tracked Vehicles in Open Terrain," Proc. of the *International Conference on Robotics and Automation (ICRA)*, May 2010.
19. **S. Singh** and K. Waldron, "Generalized Dog Motion Measurements to Support a Simple Model of Rotary Galloping Locomotion," Proceedings of the 12th International Conference on Climbing and Walking Robots, (to be published by World Scientific).
20. M. Freese, **S. Singh**, W. Singhose, E. Fukushima, and S. Hirose, "Terrain Modeling and Following Using a Compliant Manipulator for Humanitarian Demining Applications," Proceedings of the 7th International Conference on Field And Service Robotics, (to be published as Springer Tracts in Advanced Robotics series).
21. **S. Singh**, "A Traceable Inertial Calibration Procedure Suited for MEMS Sensing," Proceedings of the RSS 2009 Workshop on Performance Evaluation and Benchmarking for Next Intelligent Robots and Systems.
22. **S. Singh**, S. Trujillo, and K. Waldron, "A Screw Representation for Aiding State Estimation with Application to Dynamic Quadrupedal Locomotion," ROMANSY 2008.
23. **S. Singh**, "Comparison of Field Quadruped Motion Tracking", *Biorobotics Workshop at 2008 International Conference on Robotics and Automation*, May 2008.
24. **S. Singh** and K. Waldron, "Robotic Harness for the Field Assessment of Galloping Gaits," *Proceedings of the 2007 International Conference on Intelligent Robots and Systems (IROS)*, October 2007, 4247-4252.
25. K. Waldron, J. Estremera, P. Csonka, **S. Singh**, "Thinking About Bounding and Galloping Using Simple Models," *Proceedings of the 10th Int. Conference on Climbing and Walking Robots (CLAWAR)*, July 2007.

26. **S. Singh** and K. Waldron, "A Hybrid Motion Model for Dynamic Quadrupedal Locomotion," *Proceedings of the 2007 International Conference on Robotics and Automation (ICRA)*, April 2007, 4337-4342.
27. **S. Singh**, M. Freese, J. Trevelyan, "Contributions on a Design Direction for Future Humanitarian Demining Robots," *Proceedings of the 2007 ICRA*, Workshop on Robotics in Challenging and Hazardous Environments, April 2007.
28. **S. Singh**, P. Csonka, and K. Waldron, "Optical Flow Aided Motion Estimation for Legged Locomotion," *Proc. of the 2006 International Conference on Intelligent Robots and Systems (IROS)*, October 2006, 1738-1743.
29. M. Freese, **S. Singh**, E. Fukushima, and S. Hirose, "Bias-Tolerant Terrain Following Method for a Field Deployed Manipulator," *Proceedings of the 2006 ICRA*, May 2006, 175-180.
30. **S. Singh** and K. Waldron, "Attitude Estimation for Dynamic Legged Locomotion Using Range and Inertial Sensors," *Proceedings of the 2005 ICRA*, April 2005, 3935-3940.
31. ———, "Design and Evaluation of an Integrated Planar Localization Method for Desktop Robotics," *Proceedings of the 2004 ICRA*, April 2004, 1109-1114.
32. ———, "Towards High-Fidelity On-Board Attitude Estimation via a Hybrid Optical and Inertial Approach," In *Experimental Robotics IX*, **21**, M. H. Ang and O. Khatib (Eds.), 2006, 589-598.
33. **S. Singh** and S. Thayer, "Development of an Immunology-Based Multi-Robot Coordination Algorithm for Exploration & Mapping," *Proceedings of the 2002 IROS*, October 2002, 2735-2739.
34. ———, "Kilobot Search and Rescue Using an Immunologically Inspired Approach," *Distributed Autonomous Robotic Systems (DARS)*, **5**, 2002, 300-305.
35. ———, "A Foundation for Kilorobot Exploration." *Proceedings of the Congress on Evolutionary Computation (CEC 2002)*, May 2002, 1033-1038.
36. ———, "Immunology Directed Methods for Distributed Robotics: A Novel, Immunity-Based Architecture for Robust Control & Coordination," *Proceedings of SPIE: Mobile Robots XVI*, **4573**, Nov. 2001, 44-55.
37. **S. Singh**, and C. Riviere, "Physiological Tremor Amplitude During Vitreoretinal Microsurgery," *Proceedings of the 28th Annual Northeast Bioengineering Conference*, April, 2002, 171-172.
38. **S. Singh** and S. Everett, "Sensor, Model, and Variable Velocity Telerobotic Assistance in Surgical and Biomedical Environments," Tennessee Conference on Biomedical Engineering, April 1999.

Patents (Provisional)

1. **2009904465** – A system and method for autonomous navigation of a tracked or skid-steer vehicle
2. **2009901949** – Method and System for Regulating Movement of an Autonomous Entity Between Zones
3. **2009901933** – Control System for Autonomous Operation
4. **2009901656** – Drill Hole Planning

Professional Qualifications

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| 1. Graduate Certificate in Higher Education (University of Sydney) | October 2009 |
| 2. Research Higher Degree Supervision (University of Sydney) | June 2009 |
| 3. Rio-Tinto: Lockholder and PIO | February 2009 |
| 4. Engineer in Training in Mechanical Engineering (NCEES) | June 2000 |

Grants and Research Awards

1. "Bodies in Space," Chief Investigator (with Drs. Dullin and Sinclair)
ARC Linkage Projects 2010 - Round 2, \$210k
2. "Optimal Methods for Miniature Navigation from Multiple Inertial Measurements and Gait-tuned Estimation Software with Biomedical and Robotic Applications," Principal Investigator,
ARC/UWA Research Grants Scheme 2008, \$8k
3. Mechatronics Course Support for "System Configuration & Simulation for Supervised Teleoperation of Automated Ship Loading" project, Principal Investigator, **Rio Tinto Iron Ore**, \$6k
4. Robotic and Autonomous Mines, Improvised Explosive Devices And Counter-Measures, Co-investigator (with Prof. J. Trevelyan), **Defence Systems Analysis Division (DSTO)**, \$50k
5. Mechatronics Infrastructure Support Grant, Principal Investigator,
UWA Teaching and Learning Committee Award, \$8k

Teaching Experience

The University of Queensland

- **Mechatronic System Design Project II (METR 3800)** **2011**
- **Signals, Systems, and Controls (ELEC 3004 – New course starting Semester 1, 2012)** **2012**

The University of Sydney

- **Introduction to Mechatronics (MTRX 1701)** 2008, 2009, 2010, 2011
- **Experimental Robotics (MTRX 4700 -- with Drs. Fitch and Williams)** 2009, 2010, 2011

University of Western Australia

- **Mechatronics Design (MCTX 3420)** 2008
- **Mechanisms and Multibody Systems (MECH3422 – with Prof. K. Miller)** 2008

Stanford University

- **Stress, Strain, and Strength (ME 80 – Teaching assistant under A/Prof. B. Pruitt)** 2004, 2005
- **Introduction to Sensors (ME 220 – Teaching assistant under Prof. T. Kenny)** 2002, 2004

Students Supervised

Doctoral:

- Mr. Guilherme Maeda, U. Sydney, (expected 2012)
- Mr. Konstantin Seiler, U. Sydney, (expected 2012)
- Ms. Joanne Mikl, U. Sydney, (expected 2013)

Masters:

- Mr. Hadrien Vrba, U. Sydney, 2010
Coordinated Motion Control of a Robotic Excavator
- Mr. Jiajie Ma, UWA, 2009 (co-supervised with Dr. Adam Wittek)
Experimental Validation of Viscoelastic Constitutive Models by X-Ray Feature Tracking

Undergraduate Honors:

- Owen Miller (expected 2011)
Optical Flow Tracking of a Fast RC Vehicle
- Damien Stevenson (expected 2011)
Wimote and other Natural interfaces for Remote Control of an Excavator
- David Lee (expected 2011)
Kinect Tracking and Online Mass Center Estimation
- Tanabodee Sriprajittichai (co-advised with Arman Melkumyan, expected 2011)
Gaussian Process Control of a Hydraulically driven Robotic Excavation Arm
- Mr. Sri Puthi, U. Sydney, (2010)
Automatic Driving of a Remote Control Car
- Mr. Kit Axelrod, U. Sydney, (2010)
Pan-Tilt-Zoom Camera Array Calibration and Tracking
- Mr. Alexander Kurukulasuriya, U. Sydney, 2009 (1st honors)
Material Classification by Acoustic Method
- Mr. William Liu, U. Sydney, 2009
Spectral Analysis on Household Materials
- Mr. Shayne Pitting, U. Sydney, 2009
Office Automation Diagnosis
- Mr. Sandy Taylor, U. Sydney, 2009 (1st honors)
Applied Vehicle Route Optimisation
- Mr. Ankur Patel, UWA, 2008 (2nd honors)
Relief Valves: A Methodology for Optimisation of Maintenance, using modified Risk Based Analysis

Collaborators

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| Alen Alempijevic (UTS, Mechatronics) | Damien O'Meara (NWSIS) |
| Alan Bowling (U. Texas, ME) | Florian Oppolzer (Rio Tinto) |
| Stuart Crozier (U. Queensland, ITEE) | Marcus Pandy (U. Melbourne, ME) |
| Bertrand Douillard (U. Sydney, AMME) | Fabio Ramos (U. Sydney, SIT/AMME) |
| Hugh Durrant-Whyte (NICTA) | Peter Sinclair (U. Sydney, Human Movement) |
| Darren Dutto (CalPoly Pomona, Kinesiology) | Russ Tedrake (MIT, CSAIL) |
| Robert Fitch (U. Sydney, AMME) | Kenneth Waldron (Stanford, ME) |
| Ross McAree (U. Queensland, ME) | Adam Wittek (UWA, ME) |
| Karol Miller (UWA, ME) | Stefan Williams (U. Sydney, AMME) |

Outreach and Academic Service

Outreach and Invited Lectures:

1. Robotics Education in Remote Schools Pilot (at Rottneest Island School, Western Australia)
2. Murdoch College Invited Seminar – “Robotics & Design: Today & Tomorrow”
3. Fulbright Seminar – “Robotics for the Everyday from the Everyday”

Press Coverage:

1. Robotics Panelist for ABC TV’s, *New Inventors* (to air ~ Feb 2011).
2. Profiled in E. Klarreich, “Artificial Immune Systems,” *Nature*, **415**:468-470, 2002.

Peer Review:

1. International Journal of Robotics Research
2. Mechanism and Machine Theory
3. IEEE Transactions on Robotics
4. Journal of Field Robotics
5. International Conference on Intelligent Robots and Systems (IROS)
6. International Conference on Robotics and Automation (ICRA)
7. International Symposium on Robotic Research (ISER)
8. Robotica
9. Robotics: Science and Systems

Workshops Organized:

1. Organizer and Chair, **Integrated Planning and Control Workshop**, RSS 2011.
2. Organizer and Chair, **Biorobotics: Research Advances, Standards, & Education** Workshop, ICRA 2008.
3. Organizer, **RAS Chapter and Student Leaders meeting**, ICRA 2008.

Administrative Committees:

1. **Student Activities Chair for IEEE-RAS** (2005-2007) – Advocated for and coordinated increased student participation through the RAS, especially with student chapters. Member of its administrative committee. Highlights include an open [Robotics Jobs Wiki](#) and Chapter & Students leaders workshop (ICRA 2008).
2. **UWA Mechatronics Education Committee** (2006-2007) – Interdepartmental group responsible for Mechatronics education and practice. Lead the draft of a *Survey of Mechatronics Coursework in Australia*.

Governance:

1. **Sustainability Officer**, Engineers Australia (2009-2010)
2. **Mechanical Engineering Design Division Student Representative** (2003-2004)
3. **Stanford Committee on Research** (2002-2005)
4. **Graduate Student Council** (2002-2004)

Professional Society Membership

1. Robotics and Automation Society (RAS)
2. Engineers Australia
3. IEEE
4. ASME
5. Tau Beta Pi

Citizenship

U.S. and Australian citizenship holder