

Ajay Deshpande

RESEARCH INTERESTS

My research interest is in the design of distributed sensor systems with emphasis on sustainability applications. I address problems in sensor placement, sampling, information processing, and control and coordination of sensor actuation. I am interested in theory as well as implementation of sensor systems in application areas such as environmental sampling, mapping plumes of pollutants and hazardous gases, monitoring water distribution systems and electricity metering in buildings. I use theoretical tools from sampling theory, estimation theory, cooperative control, optimization, probability theory and computational geometry.

EDUCATION AND EMPLOYMENT

- **Postdoctoral Associate** Oct 2008 - Present
Laboratory for Manufacturing and Productivity,
Massachusetts Institute of Technology (MIT)
Host : Prof. Sanjay Sarma
- **Doctor of Philosophy (PhD)** Sep 2008
Mechanical Engineering, MIT
PhD Thesis: *Coverage Problems in Mobile Sensing*
Advisors: Prof. Sanjay Sarma (Mechanical Engineering) and
Prof. Daniela Rus (Electrical Engineering & Computer Science)
- **Master of Science (S.M.) - Dual** Jun 2006
Mechanical Engineering, and
Electrical Engineering & Computer Science (EECS), MIT
Advisor : Prof. Sanjay Sarma, EECS Thesis Reader: Prof. Erik Demaine
- **Bachelor of Technology (B.Tech) and Master of Technology (M.Tech)** Jun 2001
Mechanical Engineering, Indian Institute of Technology (IIT) Bombay
M.Tech Specialization: Computer Integrated Manufacturing
Advisor : Prof. Sanjay Pande

RESEARCH EXPERIENCE

- **Postdoctoral Associate, MIT, Cambridge** Oct 2008 - Present
Leak detection in water pipeline networks using a sensor network: Developing an in-pipe mobile acoustic sensor system to detect and localize leaks in water distribution network. Also researching network-based hydraulic models for leak detection using nodal pressure and flow values.
Characterization and network calibration of wireless power meters: Involved in the development of a cheap wireless power meter using a Hall-effect based current sensor. Researching into characterization and calibration these devices at individual and network level. Developing algorithms to disambiguate between appliances based on power consumption profiles.
Error-tolerant sampling of spatio-temporal fields such as plumes of pollutants and hazardous gases: Used proper orthogonal decomposition to obtain a reduced-order model of a spatio-temporal field. Developing algorithms to find sampling arrangements that guarantee estimation error to be less than tolerance. Verifying results using numerical simulation and experimental validation.

Generalized regular sampling of band-limited fields: Proposed a set of geometric transformations on regularly placed samples to obtain sampling arrangements that lead to the optimal reconstruction of band-limited fields. Showed that new arrangements are surprisingly uneven, yet optimal. Verified results using numerical simulation and experimental data collected on real fields.

- **PhD Candidate, MIT, Cambridge**

Jun 2004 - Sep 2008

Error-tolerant arrangements of sensors for sampling fields: Formulated sensor placement problem to address sampling and reconstruction of an unknown spatio-temporal field. Developed an approach for constructing classes of sensor arrangements that guarantee error-tolerant reconstruction of the field. Showed that the approach provides a framework for sampling using mobile sensors. Proposed new classes of optimal as well as error-tolerant arrangements for band-limited fields.

Distributed coverage control in a network of mobile sensors: Developed a distributed algorithm for coverage control of a network of mobile sensors with position-dependent sensing model. Evaluated results on a network of mobile Cyclops cameras.

Coverage and connectivity of a network of floating sensors in rivers: Studied coverage and connectivity of a network of floating sensors moving passively in rivers using analysis, simulations and deployment data.

- **S.M. Candidate, MIT, Cambridge**

Sep 2001 - Jun 2004

Approximation algorithm for art gallery problems: Developed a pseudopolynomial time $O(\log n)$ -approximation algorithm for art gallery problems.

- **Dual Degree Candidate, IIT Bombay, India**

May 2000 - June 2001

WebNC: Developed an Internet-based software system for intelligent auditing and reverse engineering of CNC part programs.

TEACHING AND MENTORING EXPERIENCE

- **Instructor, MIT, Cambridge**

Spring'09

One of the instructors for *Dynamics and Control - I*, a core undergraduate class in Mechanical Engineering.

- **Teaching Assistant, MIT, Cambridge**

Fall'06, Fall'07, Spring'08

Head TA for three semesters for *Dynamics and Control - I* in Mechanical Engineering with Prof. Sanjay Sarma as the main instructor. Developed new problem sets, and conducted regular office hours and exam review sessions. Served as a substitute lecturer on a few occasions.

- **Mentor, MIT, Cambridge**

Sep 2001 - Present

Mentored a number of undergraduate and high-school students in summer projects. Currently mentoring a graduate student and an undergraduate student.

INDUSTRIAL EXPERIENCE

- **Intern, Geometric Software Solutions Limited, Pune, India**

May 1999 - Jul 1999

Developed a prototype software in C++ for extracting midsurface of thin-walled bodies using PARASOLID Kernel.

HONORS AND AWARDS

- *Wunsch Foundation Silent Hoist and Crane Award for Outstanding TAs, June 2008*, awarded by the Department of Mechanical Engineering, MIT.
- Member of Sigma Xi, The Scientific Research Society.
- *MIT Presidential Fellowship, 2001–2002*.

- Institute Scholarship for scoring the second highest CGPA in the Department of Mechanical Engineering at IIT Bombay during junior and senior years.
- *Award Winner in the Indian National Mathematics Olympiad (INMO) 1995*, given by the National Board of Higher Mathematics (NBHM), India.

PUBLICATIONS

- THESES

1. A. A. Deshpande. “Coverage problems in mobile sensing,” Ph.D. Thesis, Department of Mechanical Engineering, Massachusetts Institute of Technology, 2008.
2. A. A. Deshpande. “A pseudo-polynomial time $O(\log^2 n)$ -approximation algorithm for art gallery problems,” S.M. Thesis, Department of Mechanical Engineering, Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, 2006.
3. A. A. Deshpande. “Intelligent CNC machining,” Dual Degree (B.Tech and M.Tech) Thesis, Department of Mechanical Engineering, Indian Institute of Technology Bombay, 2001.

- WORK IN PROGRESS

1. A. Deshpande and S. E. Sarma. “Error-tolerant arrangements of sensors for sampling band-limited fields,” *in preparation*.
2. A. Deshpande, S. Kumar and S. E. Sarma. “Error-tolerant sampling of fields modeled using proper orthogonal decomposition,” *in preparation*.
3. A. Deshpande, V. K. Goyal and S. E. Sarma. “Generalized Regular Sampling of Trigonometric Polynomials and Optimal Sensor Arrangement,” *submitted to the IEEE Signal Processing Letters*, available upon request.
4. A. Deshpande and D. Rus. “Coverage and connectivity of naturally mobile sensor networks in rivers,” *manuscript available upon request*.

- CONFERENCE PUBLICATIONS (REFEREED)

1. A. Deshpande, S. Poduri, D. Rus and G. S. Sukhatme. “Distributed coverage control for mobile sensors with location-dependent sensing models,” in Proceedings of 2009 IEEE International Conference on Robotics and Automation, *Kobe, Japan, May 2009*.
2. S. Poduri, A. Deshpande, D. Rus and G. S. Sukhatme, “Distributed 1D coverage control for a reconfigurable camera network,” ImageSense’08, Workshop on Applications, Systems, and Algorithms for Image Sensing, a part of Sensys’08, Raleigh, *North Carolina, November 2008*, papers available online.
3. A. Deshpande and S. E. Sarma, “Error Tolerant Arrangements of sensors for sampling fields,” in Proceedings of the American Control Conference (ACC) 2008, *Seattle, Washington, June 2008*, pages 2401–08.
4. A. Deshpande, T. Kim, E. D. Demaine, and S. E. Sarma, “A pseudopolynomial time $O(\log n)$ -approximation algorithm for art gallery problems,” in Proceedings of the 10th Workshop on Algorithms and Data Structures (WADS 2007), Lecture Notes in Computer Science, volume 4619, *Halifax, Nova Scotia, Canada, August 15-17, 2007*, pages 163–174.
5. A. A. Deshpande and S. S. Pande, “WebNC - Internet based system for intelligent auditing and reverse engineering of CNC part programs,” the 30th North American Manufacturing Research Conference (NAMRC), May 2002, Purdue University, West Lafayette, Indiana, USA, published in NAMRI/SME Transactions 2002, Vol. 30, pages 439–446.

INVITED TALKS

“Naturally Mobile Sensor Networks in Water Bodies,” joint work with Daniela Rus, Workshop on Robotic Sensor Networks: Principles and Practice, part of Robotics Science and Systems 2007, Atlanta, GA.

PROFESSIONAL ACTIVITIES

- Member
 - Institute of Electrical and Electronics Engineers
 - IEEE Signal Processing Society
 - SIGMOBILE: The ACM Special Interest Group on Mobility of Systems, Users, Data, and Computing
- Reviewer
 - IEEE Transactions on Automation Science and Engineering
 - IEEE International Conference on RFID
 - ACM Transactions on Sensor Networks
 - ACM Transactions on Mobile Computing
 - Autonomous Robots
- Indirect Reviewer
 - International Journal of CAD/CAM
 - International Journal of Computational Geometry and Applications
 - Journal of Computing and Information Science in Engineering
 - Design for Manufacturing Conference

SERVICE

- Member of the screening committee of the Global Indus Technovators Awards 2006 in the information technology category.
- Member of the team of three graduate students of the Laboratory for Manufacturing and Productivity at MIT to renovate the graduate students office space in Spring 2005.

REFERENCES

- Prof. Sanjay Sarma
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- Prof. Daniela Rus
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- Prof. Gaurav Sukhatme
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