

Ketan Savla

Laboratory for Information and Decision Systems
Massachusetts Institute of Technology
Date: July 10, 2009

CONTACT INFORMATION

32-D716, MIT
77 Massachusetts Avenue, Cambridge, MA 02139, USA
Phone: (O) 617-324-0095, (C) 805-729-4301
Email: ksavla@mit.edu
Web: <http://web.mit.edu/ksavla/www>

EDUCATION

Ph.D., Electrical Engineering, University of California at Santa Barbara, 2007

- Thesis: Multi UAV Systems with Motion and Communication Constraints
- Advisor: Professor Francesco Bullo

M.A., Applied Mathematics, University of California at Santa Barbara, 2007

M.S., Mechanical Engineering, University of Illinois at Urbana-Champaign, 2004

- Advisor: Professor Francesco Bullo

B.Tech., Mechanical Engineering, Indian Institute of Technology, Bombay, 2003

- Thesis: Mathematical Modeling of Hysteresis in Piezoceramic Actuators
- Advisor: Professor P. Seshu

HONORS AND AWARDS

Best Student Paper Award Finalist at CDC-ECC'05
Best Presentation in Session Award at several conferences
Distinguished Student Award, Mechanical Engineering, IIT Bombay, 2003
National Scholarship, NCERT, India, 1997-2003

RESEARCH INTERESTS

Dynamic Systems & Controls, Algorithmic & Experimental Mobile Robotics, Humans-in-the-loop Control Systems, Sensor Networks, Game Theoretic Aspects of Multi-Agent Systems.

RESEARCH EXPERIENCE

Postdoctoral Associate, LIDS, MIT, October 07-present
(Hosts: Professor Emilio Frazzoli and Professor Munther Dahleh)

- **Foundations for Reconfigurable & Autonomous Cyber-Physical Systems**
In this project, I am developing novel analysis and design tools for reconfigurable autonomous systems as such systems react to unexpected disruptions. This is being done synergically with the development of a unique socio-engineering testbed that aims at studying the behavior of people during emergency scenarios. The ultimate objective is to design robust control architecture for large scale cyber-physical systems like air traffic management systems, next-generation intelligent cities, etc., with the capability to autonomously reconfigure in response to, possibly adversarial, external conditions.
- **Coordination Policies for Mixed Human-Robot Teams**
In this project, I am designing coordination policies for a team consisting of large number of heterogeneous mobile robots and human operators that provide persistent, real-time, tactical services of interest. My research on coordination algorithms for mobile robots has led to interesting and novel understanding of interactions between some organisms in nature. I am extensively working on humans-in-the-loop

systems, where I am designing several key aspects of decision support systems that coordinate the interaction between human operators and robots. Additionally, I have employed game-theoretic tools to study scenarios where robots can acquire information about the other robots by observing their cumulative effects on the shared environment, thereby getting rid of the need to communicate explicitly.

Graduate Student Researcher, University of California, Santa Barbara, Aug 04-Sep 07
(Advisor: Professor Francesco Bullo)

- **Cooperative Strategies for Mobile Robotic Networks**

I have considered a wide range of applications that require robots to move to initially unknown locations of dynamically generated and spatially distributed tasks in a timely fashion. The proposed strategies rely on partitioning the workspace, distributing them among the robots and designing optimal policies for robots in their own partition. This decomposition not only gives almost optimal performance but also has low computational and implementation complexity.

- **Connectivity Maintenance of Networked Mobile Systems**

I addressed the issue of connectivity maintenance for ad-hoc networks of robotic agents under motion constraints, such as the ones induced by inertia. The methodology developed is generic enough to facilitate the embedding of the connectivity maintaining property in a general cooperative task.

Visiting Graduate Student, California Institute of Technology, Jun 06-Sep 06
(Host: Professor Richard Murray)

- **Experimental Implementation of Motion Coordination Algorithms**

I developed drivers to facilitate the installation of Player (the most widely used robot control interface) on a custom-made robot built at the Caltech Multi Vehicle Wireless Testbed. The success of the project was demonstrated by implementing motion coordination algorithms on a group of robots using the installed Player interface.

Research Assistant, University of Illinois at Urbana-Champaign, Sep 03-Aug 04
(Advisor: Professor Francesco Bullo)

- **Combinatorial Motion Planning for Autonomous Vehicles**

I designed algorithms to give almost optimal paths for motion constrained vehicles to visit a set of static or dynamic arriving target sites. The unique feature of my work was the synergistic focus on the joint dynamic, geometric and combinatorial aspects of these problems.

Undergraduate Researcher, Indian Institute of Technology, Bombay, Jul 02-May 03
(Advisor: Professor P. Seshu)

- **Mathematical Modeling of Hysteresis in Piezoceramic Actuators**

I studied mathematical models for hysteresis in piezoceramic actuators and performed several experiments to validate the models for robotic applications.

MENTORING EXPERIENCE

- Mentored one undergraduate student at UCSB and one graduate student at MIT.
- Currently, mentoring three graduate and two undergraduate students at MIT in various capacities.

PUBLICATIONS All the papers can be downloaded at
<http://web.mit.edu/ksavla/www/publications.html>

Journal Articles

- [6] J. Enright, K. Savla, E. Frazzoli and F. Bullo. Dynamic Routing for multiple-UAV systems. **AIAA Journal of Guidance, Control and Dynamics**, Vol. 32, No. 4, pages 1152-1166, 2009.
- [5] M. Pavone, K. Savla and E. Frazzoli. Sharing the load. **IEEE Robotics and Automation Magazine**, Vol. 16, No. 2, pages 52-61, 2009.
- [4] A. Arsie, K. Savla and E. Frazzoli. Efficient routing of vehicles with no explicit communications. **IEEE Transactions on Automatic Control**, In press.
- [3] K. Savla, F. Bullo and E. Frazzoli. Traveling Salesperson Problems for a double integrator. **IEEE Transactions on Automatic Control**, Vol. 54, No. 4, pages 788-793, 2009.
- [2] K. Savla, G. Notarstefano and F. Bullo. Maintaining limited-range connectivity among second-order agents. **SIAM Journal on Control and Optimization**, Vol. 48, No. 1, pages 187-205, 2009.
- [1] K. Savla, E. Frazzoli and F. Bullo. Traveling Salesperson Problems for the Dubins vehicle. **IEEE Transactions on Automatic Control**, Vol. 53, No. 6, pages 1378-1391, 2008.

In preparation

- [2] K. Savla and E. Frazzoli. Endogenous reconfiguration in mobile robotic networks.
- [1] K. Savla and E. Frazzoli. Efficient cooperative strategies between UAVs and humans in dynamic environments.

Book Chapters

- [2] K. Savla and E. Frazzoli. On endogenous reconfiguration in mobile robotic networks. **Workshop on Algorithmic Foundations of Robotics**, Guanajuato, Mexico, December 2008.
- [1] K. Savla, E. Frazzoli and F. Bullo. On the Dubins Traveling Salesperson Problems: novel approximation algorithms. **Robotics: Science and Systems II**. MIT Press, Cambridge, MA, August 2006.

Refereed Conference Proceedings

- [11] K. Savla and E. Frazzoli. Game-theoretic study of a dynamic routing problem for a network of autonomous vehicles. In **Allerton Conference on Communications, Control and Computing**, Monticello, IL, 2009, To appear.
- [10] K. Savla, T. Temple and E. Frazzoli. Human-in-the-loop vehicle routing policies for dynamic environments. **IEEE Conference on Decision and Control**, Cancun, Mexico, pages 1145-1150, December 2008.
- [9] J. Enright, K. Savla and E. Frazzoli. Coverage Control for Teams of Nonholonomic Agents. **IEEE Conference on Decision and Control**, Cancun, Mexico, pages 4250-4256, December 2008.
- [8] K. Savla, C. Nehme, T. Temple and E. Frazzoli. Efficient routing of multiple vehicles for human supervised services in a dynamic environment. **AIAA Guidance, Navigation and Control Conference**, Hawaii, HI, August 2008. Electronic proceedings.
- [7] K. Savla, F. Bullo and E. Frazzoli. The coverage problem for loitering Dubins vehicles. **IEEE Conference on Decision and Control**, New Orleans, LA, pages 1398-1403, December 2007.
- [6] K. Savla, F. Bullo and E. Frazzoli. On Traveling Salesperson Problems for a double integrator. In **IEEE Conference on Decision and Control**, San Diego, CA, pages 5305-5310, December 2006.
- [5] K. Savla and F. Bullo. On the time complexity of formation control. In **Allerton Conference on Communications, Control and Computing**, Monticello, IL, pages 1310-1314, September 2006.
- [4] G. Notarstefano, K. Savla, F. Bullo and A. Jadbabaie. Maintaining limited-range connectivity among second-order agents. In **American Control Conference**, Minneapolis, MN, pages 2124-2129, June 2006.
- [3] K. Savla, F. Bullo and E. Frazzoli. On traveling salesperson problems for Dubins' vehicle: stochastic and dynamic environments. In **IEEE Conference on Decision and Control and European Control Conference**, Seville, Spain, pages 4530-4535, December 2005. (**Finalist for the Best Student Paper Award**).
- [2] J. Enright, E. Frazzoli, K. Savla and F. Bullo. On multiple UAV routing with stochastic targets: performance bounds and algorithms. In **AIAA Guidance, Navigation and Control Conference**, San Francisco, CA, August 2005. Electronic proceedings.
- [1] K. Savla, E. Frazzoli and F. Bullo. On the point-to-point and traveling salesperson problems for Dubins' vehicle. In **American Control Conference**, Portland, OR, pages 786-791, June 2005.

PROFESSIONAL SERVICE Reviewer for IEEE Transactions on Automatic Control, IEEE Transactions on Robotics, SIAM Journal on Control and Optimization, Automatica, Robotics and Automation Magazine, IEEE Conference on Decision and Control, American Control Conference, Hybrid Systems: Computation and Control.