Michael C. Rotkowitz

CURRICULUM VITAE

CONTACT
INFORMATION

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RESEARCH
INTERESTS

Synthesis of decentralized controllers for complex interconnected systems. In particular, classification of information structures for which convex synthesis of optimal controllers is possible, and computational methods for such synthesis. Control over communication networks with delays. Applications of interest include formation flight.

EDUCATION

Stanford University

Ph.D. Aeronautics and Astronautics, expected June 2005

- Dissertation Topic: "Tractable Problems in Optimal Decentralized Control"
- Advisor: Sanjay Lall
- Thesis Committee: Stephen Boyd, Claire Tomlin

M.S. Statistics, March 2005
- GPA: 4.0
M.S. Aeronautics and Astronautics, June 2000
- GPA: 4.0

Stanford University

B.S. Mathematical and Computational Science, June 1996
- Interdisciplinary major comprised Statistics, Mathematics, Computer Science, and Operations Research
- Advisor: Brad Efron
- GPA: 4.0 in major; 3.8 overall

ACADEMIC
EXPERIENCE

Stanford University   Stanford, California USA

Networked Systems and Control Laboratory   **January 2001 - present**
Includes current Ph.D. research. Perform research in the theory of decentralized control, with a focus on classifying structures for which optimal controllers may be found in a computationally tractable manner. Determined a simple algebraic condition, named quadratic invariance, under which decentralized controller optimization may be cast as a convex program. This unified many previously identified tractable problems, and also elucidated many new ones. When applied to distributed control problems, or cooperative control over networks, the result yields that optimal controllers may be found via convex synthesis as long as the controllers may communicate faster than their dynamics propagate, and the result still holds in the presence of computational delay. This holds great promise for aerospace systems, such as control of tight formation flight, and a large amount of interest has also been expressed from the paper machining community. Initial papers on quadratic invariance have been highly cited in the decentralized control literature.

Defined topologies, induced by families of semi-norms, in which convergence to unstable operators is well-defined, thus enabling the extension of the above results to many classes of systems. Found specific Youla parameterizations which allowed these results to be used in conjunction with constraints on internal stability. Developed computational methods to reduce resulting convex but constrained optimization problems to convex unconstrained problems, which may be readily solved.

Used these results and techniques to examine the trade-offs between the costs of reducing communication and computational delays, and the improvements in optimal performance.

Statistical Consultant   **June 2004 - December 2004**
Worked at a free weekly drop-in consulting service for members of the university community. Provided assistance in areas including experimental design, data analysis, interpretation of results, model fitting, time series, classification, and prediction. Later reviewed cases with faculty members. A large portion of the clients came from the medical school.

Course Assistant   **September 2002 - December 2002**
Engineering 210A: Robust Control Analysis and Synthesis. Regular duties included holding weekly problem sessions and biweekly office hours, grading, sharing administrative responsibilities with faculty instructor, and fielding all student inquiries. Also gave several class lectures and helped with course design, including preparation of course materials, assignments, and examinations.

GPS Laboratory   **January 1999 - May 1999**
Studied the effects of orbit perturbations due to unreported satellite thrusting on Local Area Differential GPS for automatic precision aircraft landings.

Space Systems Development Laboratory   **January 1999 - May 1999**
Constructed solar panels for OPAL (Orbiting Picosatellite Automated Launcher), a student-built satellite that was successfully launched from Vandenberg Air Force Base on January 26, 2000.

PUBLICATIONS   M. Rotkowitz, R. Cogill, and S. Lall. A Simple Condition for the Convexity of Optimal Control over Networks with Delays, (invited paper), submitted to *IEEE Conference on Decision and Control / European Control Conference*, December 2005.

M. Rotkowitz and S. Lall. Affine Controller Parameterization for Decentralized Control over Banach Spaces, *IEEE Transactions on Automatic Control*, submitted for publication.

M. Rotkowitz and S. Lall. A Characterization of Convex Problems in Decentralized Control, *IEEE Transactions on Automatic Control*, submitted for publication.

M. Rotkowitz and S. Lall. Decentralized Control Subject to Communication and Propagation Delays, *Proceedings of the IEEE Conference on Decision and Control*, December 2004.

R. Cogill, M. Rotkowitz, B. Van Roy, and S. Lall. An Approximate Dynamic Programming Approach to Decentralized Control of Stochastic Systems, *Proceedings of the Allerton Conference on Communication, Control, and Computing*, September 2004.

M. Rotkowitz and S. Lall. On Computation of Optimal Controllers Subject to Quadratically Invariant Sparsity Constraints, *Proceedings of the American Control Conference*, pp. 5659-5664, June 2004.

M. Rotkowitz and S. Lall. Decentralized Control of Unstable Systems and Quadratically Invariant Information Constraints, (invited paper), *Proceedings of the IEEE Conference on Decision and Control*, pp. 2865-2871, December 2003.

M. Rotkowitz and S. Lall. Decentralized Control Information Structures Preserved Under Feedback, *Proceedings of the IEEE Conference on Decision and Control*, pp. 569-575, December 2002.

L. Lipera, J. Colbourne, M. Tischler, M. Mansur, M. Rotkowitz, and P. Patangui. The Micro Craft iSTAR Micro Air Vehicle: Control System Design and Testing, *Proceedings of the American Helicopter Society 57th Annual Forum*, May 2001.

S. Matsumoto, S. Pullen, M. Rotkowitz, and B. Pervan. GPS Ephemeris Verification for Local Area Augmentation System (LAAS) Ground Stations, *Proceedings of the Institute of Navigation GPS Conference*, pp. 691-703, September 1999.

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<tr><td>OTHER
PRESENTATIONS</td><td>Convex Synthesis of Optimal Controllers for Complex Systems, invited mini-symposium on Optimal & Robust Control Methods for Distributed and Structured Design, *SIAM Conference on Control and Its Applications*, New Orleans, LA, July 2005.</td></tr>
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Convex Synthesis of Optimal Controllers for Complex Systems, invited mini-symposium on Optimal & Robust Control Methods for Distributed and Structured Design, *SIAM Conference on Control and Its Applications*, New Orleans, LA, July 2005.

Title TBA, Royal Institute of Technology (KTH), Stockholm, Sweden, June 2005.

Tractable Problems in Optimal Decentralized Control, *Stanford University Seminar on Guidance, Navigation, and Control*, Stanford, CA, May 2005.

Convex Problems in Optimal Decentralized Control, *UCSC School of Engineering Control Group Seminar*, Santa Cruz, CA, May 2005.

Optimal Control of Communicating Vehicles, *Forty-Fifth Annual Meeting of the Stanford Affiliates*, Stanford, CA, April 2004.

Optimization of Control Systems with Information Constraints, *Future of Air and Space Travel (FAST) Forum*, Stanford, CA, July 2003.

Optimal Communicating Controllers for Vehicles in Formation, *Forty-Fourth Annual Meeting of the Stanford Affiliates*, Stanford, CA, April 2003.

The Algebra of Convex Decentralized Control Problems, *AFOSR Dynamics and Control Workshop*, Pasadena, CA, August 2002.

PROFESSIONAL
ACTIVITIES

Session Chair, Communication Systems with Delays, IEEE Conference on Decision and Control, Paradise Island, Bahamas, December 2004

Reviewer: IEEE Transactions on Automatic Control; Automatica; AIAA Journal of Guidance, Navigation, and Control; Systems and Control Letters; IEEE Conference on Decision and Control; American Control Conference

Student Member: IEEE Control Systems Society, AIAA, SIAM, ASA, IMS

Resource Specialist Panel Member, Congressman Mike Honda / Controller Steve Westly Blue Ribbon Task Force on Nanotechnology

PROFESSIONAL
EXPERIENCE

Capri Cafaro for Congress   Mentor, Ohio USA
Consultant and Advisor   **March 2004 - November 2004**
Advised candidate on issues including technology, aerospace, energy, the environment, and voting machines. Provided statistical consulting. Helped with debate preparation.

NASA Ames Research Center   Moffett Field, California USA
Graduate Student Trainee - Engineering, GS-11   **June 2000 - September 2000**
Flight Controls Technology Group, Army / NASA Rotorcraft Division. Developed control laws for a nine-inch UAV, the Lift Augmented Ducted Fan (LADF), later renamed the iSTAR Micro Air Vehicle, designed to both hover and cruise like a harrier. Modeled vehicle, actuator, and sensor dynamics. Designed both an attitude command system and a rate command system. Helped train RC pilot for test flights.

ThoughtStore.com · New York, New York USA

Vice President · **December 1999 - December 2000**

Directed West Coast marketing for ThoughtStore, a company which allowed inventors to license their patents over the internet. Merged to form AnIdea.com.

JP Morgan Investment Management · New York, New York USA

Analyst (Statistician and Software Engineer) · **August 1996 - September 1998**

Fixed Income Sector, Capital Markets Research Group, the only member of this team who did not hold a Ph.D. Projects included:

- Revamped the prepayment model for fixed-rate mortgages, greatly improving both the short-term and long-term accuracy of the model, as well as improving the efficiency of the code. Original research included work with partial prepayments (curtailments) and with maximum likelihood estimates of prepayment model coefficients.
- Developed option-adjusted analytics for adjustable-rate mortgages (ARMs), including a prepayment model for GNMA ARMs. Shortly thereafter, began to generate and evaluate trading strategies within the ARM sector.
- Revamped methods for estimating mortgage rates, both on a daily basis, and for use with a stochastic interest rate term structure model. New models were extremely accurate even throughout periods of unprecedented bond rallies and yield curve flattening.

HONORS AND AWARDS

Best Technical Presentation, Session on Computational Methods, American Control Conference 2004

Best Paper Award, Session on Local Area Augmentation Systems, Institute of Navigation GPS Conference 1999

Stanford Graduate Fellowship / Cleve B. Moller Fellowship, 1999-2002

Successfully completed all three levels of the Chartered Financial Analyst (CFA) Exam, 1997-1999

Received the only degree in Mathematical and Computational Science to be conferred both with Departmental Honors, for completing a sufficient amount of graduate coursework, and with Distinction, for maintaining a high GPA, 1996

Best score worldwide, Actuarial Examination 100, a test of calculus and linear algebra administered by the Casualty Actuarial Society and the Society of Actuaries, 1994

Scholar Athlete Award, Stanford Track and Field, 1993