Curriculum Vitae of Kwang-Ki K. Kim

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CONTACT INFORMATION II	77 Massachusetts Avenue, Room 66-060 Department of Chemical Engineering Massachusetts Institute of Technology Cambridge, MA 02139 USA	*Voice:* (617) 253-3112 *Fax:* (617) 258-0546 *E-mail:* kwangki@mit.edu *Webpage:*

RESEARCH INTERESTS

- Robust Control Theory: Structure singular value (μ) theory, Integral quadratic constraints (IQCs) (including full-block S-procedure and quadratic separators), Lyapunov-based analysis and control
- Large-scale Interconnected/Networked Systems Analysis and Synthesis (Robust control perspective approaches for scalable and decomposable robust stability and performance guarantees)
- Analysis and Synthesis Problems of Nonlinear Dynamical Systems
- Real-time Model-based Predictive Suboptimal Control (a.k.a. "Model Predictive Control (MPC)")
- Model-based Statistical Fault Detection and Diagnosis with Integration into Stochastic Robust Model Predictive Control or Approximate Dynamic Programming
- Bayesian and Non-Bayesian Inference, and Information Theory
- Approximate Dynamic Programming (Dual Adaptive Control, Neuro-dynamic Programming, Temporal Difference Learning (TD(λ)), Q-Learning, etc.)
- Optimization of Nonlinear Robust Controllers (a.k.a. "Adaptive Control")
- Optimization Theory and Algorithms (LP, QP, SDP, SOS, etc.)
- Robust Optimization
- Stochastic Programming
- Convex Relaxation for Non-Convex Optimization
- Deterministic and Stochastic Reachability Analysis and Viability Theory
- Parameter Estimation for Mathematical System Models (a.k.a. "System Identification")
- Identification for Deterministic/Stochastic Robust Control: Dual Control Approaches
- Robust Model Invalidation and Fault Detection & Diagnosis
- Behavioral Approaches for Analysis and Control of Uncertain Systems
- *Applications*
    - Nonlinear Internal Model Control
    - Formation and Collision Avoidance Control for Large-scale Multi-agent Systems
    - Analysis and Control of Interconnected Gene Regulatory Systems
    - Analysis and Control of Power Flow and Distribution Algorithms
    - Parameter and State Estimation for Detecting Local Concentration using Biosensors
    - Parameter Estimation and Sensitivity Analysis for Multidimensional Population Balance Models
    - Quality by Design for Manufacturing Process

University of Illinois, Urbana-Champaign, Illinois USA

Ph.D. Candidate, Aerospace Engineering, August 2009 (expected graduation date: February 2013)

- Dissertation Topic: "Deterministic and Stochastic, Model-based Robust and Adaptive Control of Uncertain Systems: Optimization Approaches"
- Advisor: Prof. Richard D. Braatz (MIT)

M.S., Aerospace Engineering, August 2009

- Dissertation: "Robust Control for Systems with Sector-bounded, Slope-restricted, and Odd Monotonic Nonlinearities Using Linear Matrix Inequalities"
- Advisor: Prof. Richard D. Braatz (MIT)

Massachusetts Institute of Technology, Cambridge, Massachusetts USA

Visiting Graduate Student, November 2010 – May 2012

- Research Projects: "Stochastic Robust Fault Tolerant Model Predictive Control", "Optimal Experiment Design for System Identification and Fault Detection & Diagnosis", and "Robust Approximate Dynamic Programming"
- Advisor: Prof. Richard D. Braatz (MIT)

Yonsei University, Seoul, Korea

B.S., Astronomy (Concentration on Astrophysics including Celestial Mechanics and Minor degree in Mechanical Engineering), February 2007

Graduate Student, Astronomy, February 2007 – August 2007

- Research Projects: "Optimal Trajectory Generation and Trajectory Estimation of Spacecrafts" and "Attitude Control of Small Satellites Using Magnetic Actuators"
- Advisor: Prof. Sang-Young Park (Yonsei University)

- IEEE Multi-Conference on Systems and Control (MSC) Best Student Paper Award Finalist, 2012

- IFAC 3rd Workshop on Distributed Estimation and Control in Networked Systems (aka NECSYS) Best Student Paper Award Finalist, 2012

- IEEE Multi-Conference on Systems and Control (MSC) Best Student Paper Award Finalist, 2011

- Yonsei University: Highest Honors (The highest 1% GPA students honors), 2007

- Brain Korea (BK) Scholarship (awarded by Korean Ministry of Education), 2007

- National Research Laboratory (NRL) Fellowship (awarded by Korean Science and Engineering Foundation), 2007

Yonsei University, Seoul, Korea
Graduate Student   **February 2007 - August 2007**
Includes research projects sponsored by Ministry of Science and Technology of Korea.

University of Illinois, Urbana-Champaign, Illinois USA
Graduate Student   **August 2007 - present**
Includes current Ph.D. research, Ph.D. and Masters level coursework (concentration on mathematical system and control theory, and optimization theory and algorithms) and research/consulting projects.

Massachusetts Institute of Technology, Cambridge, Massachusetts USA
Visiting Graduate Student   **November 2010 - May 2012**
Includes current Ph.D. research and research/consulting projects.

1. **K.-K. K. Kim**, E. R. Petron and R. D. Braatz. "Robust Nonlinear Internal Model Control of

Wiener Systems." Journal of Process Control, 22(8): 1468–1477, 2012

2. **K.-K. K. Kim**, E. R. Petron and R. D. Braatz. "Universal Approximation with Error Bounds, Standard Representation, and Unified Stability Analysis for Dynamic Artificial Neural Network Models." International Journal of Robust and Nonlinear Control (under review)

3. **K.-K. K. Kim** and R. D. Braatz. "Robust Static and Fixed-order Dynamic Output Feedback Control of Discrete-time Parametric Uncertain Lure Systems: SDP Approaches." International Journal of Robust and Nonlinear Control (under review)

4. **K.-K. K. Kim** and R. D. Braatz. "Observer-based Output Feedback Control of Discrete-time Lure Systems with Sector-bounded Slope-restricted Nonlinearities." International Journal of Robust and Nonlinear Control (accepted with minor revision)

5. **K.-K. K. Kim**, S. Skogestad, M. Morari, and R. D. Braatz. "Necessary and Sufficient Conditions for Robust Reliable Control in the Presence of Model Uncertainties and Actuator/Sensor Faults and Failures." Computer & Chemical Engineering (forthcoming)

6. **K.-K. K. Kim** and R. D. Braatz. "Computational Complexity and Related Topics of Robustness Margin Calculation using SSV Theory: A Review of Theoretical and Algorithmic Developments." Computer & Chemical Engineering (forthcoming)

7. **K.-K. K. Kim** and N. Hovakimyan "Multi-Criteria Optimization for Filter Design of L1 Adaptive Control." Journal of Optimization Theory and Applications (under review)

CONFERENCE PROCEEDINGS (REFEREED)

1. **K.-K. K. Kim** and N. Hovakimyan. "Development of Verification and Validation Approaches for $\mathcal{L}_1$ Adaptive Control: Multi-Criteria Optimization for Filter Design." AIAA Guidance, Navigation, and Control Conference, Toronto, Canada, 2010

2. **K.-K. K. Kim** and R. D. Braatz. "Observer-based Output Feedback Control of Discrete-time Luré Systems with Sector-bounded Slope-restricted Nonlinearities." American Control Conference, San Francisco, SF, 2011

3. **K.-K. K. Kim** and R. D. Braatz. "Robust Static and Fixed-order Dynamic Output Feedback Control of Discrete-time Luré Systems." IFAC World Congress, Milano, Italy, 2011

4. **K.-K. K. Kim**, E. R. Petron and R. D. Braatz. "Universal Approximation with Error Bounds for Dynamic Artificial Neural Network Models: A Tutorial and Some New Results." IEEE Multi-Conference on Systems and Control, Denver, CO, 2011

5. **K.-K. K. Kim**, E. R. Petron and R. D. Braatz. "Standard Representation and Stability Analysis of Dynamic Artificial Neural Networks: A Unified Approach." IEEE Multi-Conference on Systems and Control, Denver, CO, 2011

6. E. Kharisov, **K.-K. K. Kim**, X. Wang and N. Hovakimyan. "Limiting Behavior of $\mathcal{L}_1$ Adaptive Controllers." AIAA Guidance, Navigation, and Control Conference, Portland, Oregon, 2011

7. **K.-K. K. Kim**, E. Kharisov and N. Hovakimyan. "Filter Design for $\mathcal{L}_1$ Adaptive Output-Feedback Controller." IEEE Conference on Control and Decision, Orlando, FL, 2011

8. **K.-K. K. Kim** and R. D. Braatz. "Probabilistic Analysis and Control of Uncertain Dynamic Systems: Generalized Polynomial Chaos Expansion Approaches." American Control Conference, Montreal, Canada, 2012

9. **K.-K. K. Kim**, K. S. Cheong, K. Chen and R. D. Braatz. "Parameter Estimation, Analysis, and Design of Synthetic Gene Switching Models: System Behavior- and Performance-based Approaches." IFAC ADCHEM, Singapore, 2012

10. **K.-K. K. Kim** and R. D. Braatz. "On the Robustness of Interconnected or Networked Uncertain Multi-agent Systems." 20th International Symposium on Mathematical Theory of Networks and Systems, Melbourne, Australia, 2012

11. **K.-K. K. Kim** and R. D. Braatz. "Remarks on Convex Stability Conditions for Interconnected or Networked Linear Multi-agent Systems." 3rd IFAC Workshop on Distributed Estimation and Control in Networked Systems, Santa Barbara, SF, 2012

12. **K.-K. K. Kim** and R. D. Braatz. "Generalized Polynomial Chaos Expansion Approaches to Approximate Stochastic Receding Horizon Control with Applications to Probabilistic Collision Checking and Avoidance." IEEE Multi-Conference on Systems and Control, Dubrovnik, Croatia, 2012

13. **K.-K. K. Kim** and R. D. Braatz. "Continuous- and Discrete-time D-Stability, and Joint D-Stability of Interconnected Systems: μ Theory and Diagonal Stability Approaches." IEEE Conference on Control and Decision, Hawaii, 2012

14. H. Jang, **K.-K. K. Kim**, J. H. Lee and R. D. Braatz. "Fast Moving Horizon Estimation for a Distributed Parameter System." 12th International Conference on Control, Automation and Systems, Jeju Island, Korea, 2012

15. **K.-K. K. Kim** and R. D. Braatz. "Further Remarks on Robustness Analysis of Uncertain Linear Descriptor Systems: Unified Approaches using gLFT, LMI, and SSV." American Control conference, Washington, DC, 2013 (under review)

16. **K.-K. K. Kim** and R. D. Braatz. "Convex Relaxation of Sequential Optimal Input Design for a Class of Structured Large-scale Systems: Process Gain Estimation." American Control conference, Washington, DC, 2013 (under review)

17. **K.-K. K. Kim** and R. D. Braatz. "Optimal Input Design for System Identification via Adaptation and Receding Horizon Methods: Semidefinite Programming Relaxation Approaches." American Control conference, Washington, DC, 2013 (under review)

18. **K.-K. K. Kim** and R. D. Braatz. "Semidefinite Programming Relaxation of Optimum Active Input Design for Fault Detection and Diagnosis: Model-based Finite Horizon Prediction." European Control Conference, Zurich, Switzerland, 2013 (under review)

19. **K.-K. K. Kim** and R. D. Braatz. "Linear Lyapunov Functional for Cone Invariant LTI Systems: An Alternative to Copositive Quadratic Lyapunov Solutions." European Control Conference, Zurich, Switzerland, 2013 (under review)

20. **K.-K. K. Kim**, Davide M. Raimondo and R. D. Braatz. "Optimum Input Design for Fault Detection and Diagnosis: Model-based Prediction and Statistical Distance Measures." European Control Conference, Zurich, Switzerland, 2013 (under review)

CONFERENCE PROCEEDINGS (ABSTRACT)

1. H. Jang, **K.-K. K. Kim**, J. H. Lee and R. D. Braatz. "Design of a Parameter and State Estimation Method for Detecting Local Concentration On the Surface of a Carbon-Nanotube Based Sensor." AIChE 2012 Annual Meeting, Pittsburgh, PA, 2012

2. M. Jiang, X. Zhu, M. Molaro, M. L. Rasche, D. M. Raimondo, **K.-K. K. Kim**, H. Zhang, K. Chadwick, L. Zhou, Z. Zhu, M. Wong, D. O'Grady, D. Hebrault, J. Tedesco. and R. D. Braatz. "A multidimensional population balance model for growth and dissolution identified from a designed temperature-cycling experiment." AIChE 2012 Annual Meeting, Pittsburgh, PA, 2012. Abstract 604g.

PAPERS IN PREPARATION

1. **K.-K. K. Kim** and R. D. Braatz. "Fault Tolerant Stochastic Robust Model Predictive Control: Bayesian Tests and Model Switching." IEEE Conference on Control and Decision, Firenze, Italy, 2013 (under preparation for conference proceedings)

2. **K.-K. K. Kim** and R. D. Braatz. "Approximate Dynamic Programming Approaches to Chance Constrained Stochastic MPC." IEEE Conference on Control and Decision, Firenze, Italy, 2013 (under preparation for conference proceedings)

3. **K.-K. K. Kim** and R. D. Braatz. "Conic Lyapunov Theory: Dissipation Inequalities and Robustness." IEEE Conference on Control and Decision, Firenze, Italy, 2013 (under preparation for conference proceedings)

4. **K.-K. K. Kim** and R. D. Braatz. "Mathematical Programs for Characterizing Design Space of Quality-by-Design: A Unification." IEEE Conference on Control and Decision, Firenze, Italy, 2013 (under preparation for conference proceedings)

5. **K.-K. K. Kim** and R. D. Braatz. "Statistical Approaches for Characterizing Design Space of Quality-by-Design." IEEE Conference on Control and Decision, Firenze, Italy, 2013 (under preparation for conference proceedings)

6. **K.-K. K. Kim** and R. D. Braatz. "Bayesian Inference Problems for Identification of Biochemical Reaction Networks." IEEE Conference on Control and Decision, Firenze, Italy, 2013 (under preparation for conference proceedings)

INVITED TALKS
- **MIT Process Systems Engineering Laboratory Seminar Series** **March, 2012**
  "Robust Static and Fixed-order Dynamic Output Feedback Control of Discrete-time Uncertain Luré Systems: SDP Approaches"

PROFESSIONAL EXPERIENCE

Journal of Process Control, IFAC: *Reviewer* **2008 - Present**

Automatica, IFAC: *Reviewer* **2009 - Present**

IEEE Transaction on Control Systems Technology, IEEE CSS: *Reviewer* **2009 - Present**

IEEE Transaction on Automatic Control, IEEE CSS: *Reviewer* **2011 - Present**

IEEE Control Systems Magazine, IEEE CSS: *Reviewer* **2012 - Present**

IEEE CDC, **IEEE MSC**, **ACC**, **AIAA GNC**, **IFAC**: *Reviewer* **2008 - Present**

IEEE Multi-Conference on Systems and Control **2011**
Session Co-Chair for "Robust Model-Based Control"

American Control Conference **2012**
Session Chair for "Stochastic Systems"

MEMBERSHIP

American Institute of Aeronautics and Astronautics: *Student Member* **2009 - Present**

Institute of Electrical and Electronics Engineers: *Student Member* **2010 - Present**

Society for Industrial and Applied Mathematics: *Student Member* **2011 - Present**

American Institute of Chemical Engineers: *Student Member* **2012 - Present**