

Proceedings of the
1994 American Control Conference

The Stouffer Harborplace Hotel, Baltimore, Maryland
June 29—July 1, 1994

Sponsoring Organization

The American Automatic Control Council

US. National Member Organization of the

International Federation of Automatic Control (IFAC)

MEMBER ORGANIZATIONS

American Institute of Aeronautics and Astronautics

American Institute of Chemical Engineers

Association of Iron and Steel Engineers

American Society of Mechanical Engineers

Institute of Electrical and Electronic Engineers

Instrument Society of America

Society of Computer Simulation

The 1994 ACC is held in cooperation with *IFAC*

5:40 - 6:00

Global Regulation Performance Indices and the Orthogonality of the Eigenvectors Set 2372

Dahai Wang *Hebei Academy of Sciences*
Haiming Qiu *Univ. of Alberta*
Ming Rao *Univ. of Alberta*

Friday Morning Session

Plenary Session III

Chair Hassan Khalil *Michigan State Univ.*
Cochair Jeff Kantor *Univ. of Notre Dame*

8:30 - 9:30

Manufacturing Systems: Too Many Problems..., Too Few Solutions... *

Semyon Meerkov *University of Michigan*

FA01 — Salon A
 H_{∞} Algorithms

Chair Franco Blanchini *Universita degli Studi di Udine*
Cochair Theodore Theodosopoulos *Massachusetts Inst. of Tech.*

10:00 - 10:20

H_{∞} Control and Estimation Problems with Delayed Measurements - State-Space Solutions 2379

K. Nagpal *Univ. of Iowa*
R. Ravi *GE R&D Center*

10:20 - 10:40

An Algorithm for Constant I/O Scaled H_{∞} Optimization Problems 2384

Y.A. Jiang *Univ. of New South Wales*
D.J. Clements *Univ. of New South Wales*

10:40 - 11:00

H_{∞} Filtering of Two-Time Scale Systems 2389

Abdul H. Azzo *Wichita State Univ.*
Wayne L. Stout *Wichita State Univ.*
M. Edwin Sawan *Wichita State Univ.*

11:00 - 11:20

Design of H_2 and H_{∞} Controllers with Two Degrees of Freedom 2391

Urs Christen *Swiss Federal Institute of Technology*
Martin F. Weilenmann *Swiss Federal Institute of Technology*
Hans P. Geering *Swiss Federal Institute of Technology*

11:20 - 11:40

Explicit Controller Formulas for LMI-Based H_{∞} Synthesis 2396

Pascal M. Gahinet *INRIA*

11:40 - 12:00

Numerical Investigation of Algorithms for H_2/H_{∞} Controllers Synthesis 2401

Antonio Carlos de Lima *Escola Politecnica da USP*

FA02 — Salon B
Robust Control - I

Chair J. C. Geromel *State Univ. of Campinas*
Cochair Oscar R. Gonzalez *Old Dominion Univ.*

10:00 - 10:20

Worst-Case and Average H_2 Performance Analysis Against Real Constant Parametric Uncertainty 2406

Jonathan H. Friedman *Univ. of Michigan*
Pierre T. Kabamba *Univ. of Michigan*
P.P. Khargonekar *Univ. of Michigan*

10:20 - 10:40	Robust State Feedback H_2/H_∞ Control for Systems with Real Parameter Uncertainties	2411
	Seung H. Lee	Univ. of Michigan
10:40 - 11:00	Robust Control of Linear Systems with Constraints	2416
	Alex Zheng Manfred Morari	California Inst. of Technology
11:00 - 11:20	H_∞-Design with Two-Degrees-of-Freedom Controllers	2421
	Oscar R. Gonzalez	Old Dominion Univ.
11:20 - 11:40	Robust Active Damping of Vibration Systems with Uncertainties	2424
	William W. Zhang Feng Lin	Wayne State Univ. Wayne State Univ.
11:40 - 12:00	H_2 Output Feedback Control for Discrete-Time Systems ..	2429
	Pedro L. D. Peres J. C. Geromel S. R. Souza	State Univ. of Campinas State Univ. of Campinas UFG

FA03 — Salon C

DSP Applications in Control: Benchmarks and Case Studies

Organizer	Warren White	Kansas State Univ.
Chair	Warren White	Kansas State Univ.
Cochair	Herbert Hanselmann	dSPACE GmbH

10:00 - 10:20	Multivariable Control of a Compact Disc Player using DSP's	2434
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	Maarten Steinbuch	Philips Research Laboratories
	Pieter J. M. Van Groos	Delft Univ. of Technology
	Gerrit Schootstra	Philips Research Laboratories
	Okko H. Bosgra	Delft Univ. of Technology

10:20 - 10:40	Application of a Digital Signal Processor in Compliant Cartesian Control of an Industrial Manipulator	2439
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	Ty A. Lasky	Univ. of California at Davis
	T. C. Hsia	Univ. of California at Davis

10:40 - 11:00	Software for Embedded DSP's	2444
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	Klas Nilsson	Lund Inst. of Technology
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11:00 - 11:20	Digital Implementation of Robust μ-Control for a Robot Manipulator	2450
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	Masayuki Fujita	Japan Advance Inst. of Science and Technology
	Toru Namerikawa	Kanazawa Univ.
	Kenko Uchida	Waseda Univ.

11:20 - 11:40	Digital Control of an Experimental Hydraulic Manipulator	2455
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	Gert-Wim van der Linden	Delft Univ. of Technology
	Peter Valk	Delft Univ. of Technology

11:40 - 12:00	Investigation of Kinematics and Inverse Dynamics Algorithm with a DSP Implementation of a Neural Network	2460
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	De Dong	Kansas State Univ.
	Warren White	Kansas State Univ.
	Hongbin Luo	Kansas State Univ.

FA04 — Salon D

Application of Neural Networks and Fuzzy Logic to Chemical Processes

Organiser	Yuris O. Fuentes	Univ. of Colorado-Boulder
Chair	Yuris O. Fuentes	Univ. of Colorado-Boulder
Cochair	Sheyla L. Rivera	Stevens Institute of Technology

10:00 - 10:20	Auto-Tuned Fuzzy Logic Control	2465
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	S. Joe Qin	Fisher-Rosemount Systems Division
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10:20 - 10:40	An Adaptive Process Control System Based on Fuzzy Logic and Genetic Algorithms	2470
C. L. Karr		<i>U.S. Bureau of Mines, TRC</i>
S. K. Sharma		<i>U.S. Bureau of Mines, TRC</i>
10:40 - 11:00	The Experimental Verification of the Model-Based Fuzzy Gain Scheduling Technique	2475
Cheng Ling		<i>Univ. of Texas, Austin</i>
Thomas F. Edgar		<i>Univ. of Texas, Austin</i>
11:00 - 11:20	Stability and Robustness of Pseudo-Fuzzy Logic Control Systems	*
Tomas B. Co		<i>Mich. Technological Univ.</i>
11:20 - 11:40	Stability of Neural Net Based Model Predictive Control ..	2481
John W. Eaton		<i>Univ. of Texas, Austin</i>
James B. Rawlings		<i>Univ. of Texas, Austin</i>
Lyle H. Ungar		<i>Univ. of Pennsylvania</i>
11:40 - 12:00	Neural Networks as Process Controllers-Optimization Aspects	2486
Tariq Samad		<i>Honeywell SSDC</i>
T. Su		<i>Honeywell SSDC</i>

FA05 — Salon E

Flight Control

Chair	Johnny Evers	<i>Wright Laboratory, WL/MNAG</i>
Cochair	Darren A. Schumacher	<i>USAF-WL/MNAG</i>
10:00 - 10:20	Robust Helicopter Position Control At Hover	2491
Martin F. Weilenmann		<i>Swiss Federal Institute of Technology</i>
Urs Christen		<i>Swiss Federal Institute of Technology</i>
Hans P. Geering		<i>Swiss Federal Institute of Technology</i>
10:20 - 10:40	Multirate Eigenstructure Assignment with Application to an Aircraft Lateral SAS/Autopilot	2496
Jean-Eugene Piou		<i>The City College of New York</i>
Kenneth Sobel		<i>The City College of New York</i>
Eliezer Y. Shapiro		<i>HR Textron</i>
10:40 - 11:00	Design of an Autoland Controller for a Carrier-Based F-14 Aircraft using H_{∞} Output-Feedback Synthesis	2501
Robert Jay Niewoehner		<i>Naval Postgraduate School</i>
Isaac Kammer		<i>Naval Postgraduate School</i>
11:00 - 11:20	Design, Analysis and Hardware-in-the-Loop Simulation of a MIMO Controller for a VTOL Unmanned Aerial Vehicle using H_{∞} Synthesis	2506
N. Sivashankar		<i>Univ. of Michigan</i>
Isaac Kammer		<i>Naval Postgraduate School</i>
D. Kuechenmeister		<i>Georgia Inst. of Tech.</i>
11:20 - 11:40	A Study of Neural Networks for Flight Control	2511
D. McGrane		<i>Wright-Patterson AFB</i>
R. Smith		<i>Wright-Patterson AFB</i>
M. Mears		<i>Wright-Patterson AFB</i>
11:40 - 12:00	Experimental Design of H_{∞} Weighting Functions for Flight Control Systems	2516
Ciann-Dong Yang		<i>National Cheng Kung Univ.</i>
Hann-Shing Ju		<i>Aeronautical Research Lab/AIDC</i>
Shin-Whar Liu		<i>Aeronautical Research Lab/AIDC</i>

FA06 — Salon F

Motion and Vibration Control using Command Shaping Methods

Organiser	Peter H. Meckl	<i>Purdue Univ.</i>
Chair	Peter H. Meckl	<i>Purdue Univ.</i>
Cochair	Wayne J. Book	<i>Georgia Inst. of Technology</i>

10:00 - 10:20	Trajectory Determination for Vibration-Free Motions of a Flexible-Joint Robot	2521
Peter H. Meckl		<i>Purdue Univ.</i>
Roberto Kinceler		<i>Purdue Univ.</i>
10:20 - 10:40	Initial Investigations Into the Effects of Input Shaping on Trajectory Following	2526
William Singhose		<i>Convolve, Inc.</i>
Neil Singer		<i>Convolve, Inc.</i>
10:40 - 11:00	A Zero-placement Technique for Designing Shaped Inputs to Suppress Multiple-mode Vibration	2533
Timothy Tuttle		<i>Massachusetts Inst. of Tech.</i>
Warren P. Seering		<i>Massachusetts Inst. of Tech.</i>
11:00 - 11:20	Filtering Schilling Manipulator Commands to Prevent Flexible Structure Vibration	2538
David P. Magee		<i>Georgia Institute of Technology</i>
Wayne J. Book		<i>Georgia Institute of Technology</i>
11:20 - 11:40	Input Shaping for Heavy Payload Slew Maneuvers using a Hydraulic Manipulator	*
Rick Eisler		<i>Sandia National Laboratories</i>
Rush D. Robinett		<i>Sandia National Laboratories</i>
11:40 - 12:00	Input Shaping for Three-Dimensional Slew Maneuvers of a Precision Pointing Flexible Spacecraft	2543
Clark R. Dohrmann		<i>Sandia National Laboratories</i>
Rush D. Robinett		<i>Sandia National Laboratories</i>

FA07 — Federal Hill

Applications of Neural Networks in Robotics

Chair	R. Russell Rhinehart	<i>Texas Tech. Univ.</i>
Cochair	Stelios Thomopoulos	<i>Pennsylvania State Univ.</i>
10:00 - 10:20	A Neural Network Approach to Electromyographic Signal Processing for a Motor Control Task	2548
Benito Fernandez		<i>Univ. of Texas-Austin</i>
W.T. Lester		
R.V. Gonzalez		
R.E. Barr		
10:20 - 10:40	Real-Time Control of an Inverted Pendulum System using Complementary Neural Network and Optimal Techniques	2553
John Nelson		<i>Univ. of New Hampshire</i>
L. Gordon Kraft		<i>Univ. of New Hampshire</i>
10:40 - 11:00	Mechanical System Tracking using Neural Networks	2555
Jesus De Leon		<i>FIME, Univ. Autonoma de Nuevo Leon</i>
Edgar N. Sanchez		<i>FIME, Univ. Autonoma de Nuevo Leon</i>
Adeline Chataigner		<i>Univ. Claude Bernard Lyon I</i>
11:00 - 11:20	Nonlinear Adaptive Control using Neural Networks: Estimation with a Smoothed Form of Simultaneous Perturbation Gradient Approximation	2560
James C. Spall		<i>The Johns Hopkins Univ.</i>
John A. Cristion		<i>The Johns Hopkins Univ.</i>
11:20 - 11:40	Monitoring of Tool Wear using Artificial Neural Networks	2565
K. Venkatesh		<i>New Jersey Institute of Technology</i>
M.C. Zhou		<i>New Jersey Institute of Technology</i>
R. Caudill		<i>New Jersey Institute of Technology</i>

11:40 - 12:00

Neural Network Designs with Genetic Learning for Control of a Single Link Flexible Manipulator 2570

Sandeep Jain *Polytechnic Univ.*
Pei-Yuan Peng *Polytechnic Univ.*
Anthony P. Tzes *Polytechnic Univ.*
Farshad Khorrami *Polytechnic Univ.*

**FA08 — Fells Point
Intelligent Control**

Chair Jay A. Farrell *Charles Stark Draper Lab.*
Cochair Michael Lemmon *Univ. of Notre Dame*

10:00 - 10:20

Learning Feedforward Control 2575

K. Mike Tao *Integrated Systems, Inc.*
Robert L. Kosut *Integrated Systems, Inc.*
Gurcan Aral *Integrated Systems, Inc.*

10:20 - 10:40

An Architecture for Intelligent Control Based on Epistemic Utility Theory 2580

Richard L. Frost *Brigham Young Univ.*
Wynn C. Stirling *Brigham Young Univ.*

10:40 - 11:00

An Intelligent Multi-Controller Structure Implementation 3572

H.H. Abdalla *Univ. of Newcastle Upon Tyne*
Karam Z. Karam *Univ. of Newcastle Upon Tyne*
Mohammad Farsi *Univ. of Newcastle Upon Tyne*

11:00 - 11:20

An Indirect Adaptive Predictive Controller for Linear and Nonlinear Plants 2585

R. Pickhardt *Ruhr-Univ. Bochum*
Heinz Unbehauen *Ruhr-Univ. Bochum*

11:20 - 11:40

Vibration Control of a Composite Beam using a Distributed Piezofilm Actuator and Sensor 2590

Seung-Bok Choi *Inha Univ.*
Chae-Cheon Cheong *Inha Univ.*
Seung-Han Kim *Inha Univ.*

11:40 - 12:00

A P-Type Iterative Learning Controller for Robust Output Tracking of Nonlinear Time-Varying Systems 2595

Chiang-Ju Chien *Hua Fan College of Humanities & Tech.*
Jing-Sin Liu *Academia Sinica*

FA09 — Guilford

Modeling for Control Design - Theory & Experiments

Chair Jeffrey L. Stein *Univ. of Michigan*
Cochair Richard M. Murray *California Inst. of Tech.*

10:00 - 10:20

Disk Drive Pivot Nonlinearity Modeling Part I: Frequency Domain 2600

Daniel Y. Abramovitch *Hewlett-Packard Laboratories*
Feei Wang *Hewlett-Packard Laboratories*
Gene F. Franklin *Stanford Univ.*

10:20 - 10:40

Disk Drive Pivot Nonlinearity Modeling Part II: Time Domain 2604

Feei Wang *Hewlett-Packard Laboratories*
Terril Hurst *Hewlett-Packard Laboratories*
Daniel Y. Abramovitch *Hewlett-Packard Laboratories*
Gene F. Franklin *Stanford Univ.*

10:40 - 11:00

Coupling Between the Modeling and Controller-Design Problems, Part I: Analysis 2608

Gerald A. Brusher *Ford Motor Co.*
Pierre T. Kabamba *Univ. of Michigan*
A. Galip Ulsoy *Univ. of Michigan*

11:00 - 11:20
Coupling Between the Modeling and Controller-Design Problems, Part II: Design 2613
 Gerald A. Brusher *Ford Motor Co.*
 Pierre T. Kabamba *Univ. of Michigan*
 A. Galip Ulsoy *Univ. of Michigan*

11:20 - 11:40
Design and Construction of a Small Ducted Fan Engine for Nonlinear Control Experiments 2618
 Henry Choi *California Inst. of Tech.*
 Peter Sturdza *California Inst. of Tech.*
 Richard M. Murray *California Inst. of Tech.*

11:40 - 12:00
Dynamic Modelling Analysis for Control of Chemical Vapor Deposition 2623
 M.A. Gevelber *Boston Univ.*
 M. Bufano
 M. Toledo-Quinones
 D. Brown
 R. Pasaro

FA10 — Mt. Washington
Fault Detection and Isolation

Chair Daniel E. Rivera *Arizona State Univ.*
Cochair Y.E. Fatahian *Univ. of Notre Dame*

10:00 - 10:20
A Finite Memory Observer Approach to the Design of Fault Detection Algorithms 3574
 F. Kratz *Univ. de Nancy*
 S. Bousghiri *Univ. de Nancy*
 G. Mourot *Univ. de Nancy*

10:20 - 10:40
An On-Line Fault Detection Scheme for Systems with Known Nonlinear State-Space Models 2628
 E. Gomez
 Heinz Unbehauen *Ruhr-Univ. Bochum*

10:40 - 11:00
A Fault Detection, Isolation, and Identification Technique for Complex MISO Linear Systems 2633
 Daniel W. Apley *Univ. of Michigan*
 Jianjun Shi *Univ. of Michigan*

11:00 - 11:20
Computing Bounds on Thresholds in a Fault Detection Scheme 2638
 Y.E. Fatahian *Univ. of Notre Dame*
 S. Thapliyal *Univ. of Notre Dame*
 Jeffrey C. Kantor *Univ. of Notre Dame*

11:20 - 11:40
Sliding Control Algorithm for Fault-Tolerant Robotic System
 Benito Fernandez *Univ. of Texas-Austin*
 Yung Ting

11:40 - 12:00
An Approach to Failure Isolation in Nonlinear Uncertain Systems 3577
 Alexey Ye. Shumsky *Far Eastern State Technical Univ.*

FA11 — Kent
Control of Distributed Parameter Systems

Chair Hans-Juerg U. Reinhart *Univ. of Queensland*
Cochair G.R. Sarbangi *Wichita State Univ.*

10:00 - 10:20
Hyperbolic Equations in Joined Domains with Boundary Energy Dissipation 2643
 G.R. Sarbangi *Wichita State Univ.*
 H. Wang *Wichita State Univ.*
 M. Edwin Sawan *Wichita State Univ.*

10:20 - 10:40
Approximation Results for Robust Control Problems of Constrained Heat-Diffusion Equations 2648
 Boris Mordukhovich *Wayne State Univ.*
 Kaixia Zhang *Wayne State Univ.*

10:40 - 11:00	Model Reference Active Optimal Distributed Tracking System for the Linear Distributed Parameter Systems	2650
	Allen Moshfegh	Naval Sea Systems Command
11:00 - 11:20	Control of Thermal System Through Finite Element Based State Space Model	2655
	Arvind Srinivasan	Univ. of Akron
	Celal Batur	Univ. of Akron
	Bruce Rosenthal	NASA Lewis Research Center
11:20 - 11:40	Combinational Quick JPDA Algorithm	2660
	Q. Pan	Northwestern Polytechnical Univ.
	H. Zhang	Northwestern Polytechnical Univ.
	Y. Xiang	Northwestern Polytechnical Univ.
11:40 - 12:00	Performance Evaluation of Distributed, Intelligent Real-Time Control Systems	2662
	H. Westphal	Univ. of Bremen
	D. Popovic	Univ. of Bremen

FA12 — Pride of Baltimore
Computational Issues in Optimal Control

	Chair S. Naidu	Idaho State Univ.
	Cochair Thomas J. Meyer	State Univ. of New York, Buffalo
10:00 - 10:20	Speed-Up of Linear Programming for Time-Optimal Control	2667
	M.H. Kim	Fraunhofer Inst. fuer Informations
	Sebastian Engell	Univ. of Dortmund
10:20 - 10:40	Solving Bellman's Equation by the Method of Continuity	2671
	Michael Duff	Univ. of Massachusetts
10:40 - 11:00	Convergence of the Kiefer-Wolfowitz Algorithm Under Arbitrary Disturbances	2673
	S.R. Kulkarni	Princeton Univ.
	Charlie Horn	Princeton Univ.
11:00 - 11:20	Optimal Tradeoff Between H_2 Performance and Tracking Accuracy in Servocompensator Synthesis	2675
	Andrew G. Sparks	Univ. of Michigan
	Dennis S. Bernstein	Univ. of Michigan
11:20 - 11:40	Sensitivity Analysis and Computable Bounds for the Generalized Algebraic Riccati Equation	2680
	Ravi Aripirala	Univ. of Hawaii at Manoa
	Vassilis L. Syrmos	Univ. of Hawaii at Manoa
11:40 - 12:00	Adaptive Control of Linear Constrained Systems with Inaccessible States	2685
	Hannah H. Michalska	McGill Univ.
	David Q. Mayne	Univ. of California, Davis

FA13 — James
Nonlinear Tracking

	Chair Gilmer L. Blankenship	Univ. of Maryland
	Cochair Andrew R. Teel	Univ. of Minnesota
10:00 - 10:20	Robust Output Tracking by Dynamic Compensation	2690
	Rafael Castro-Linares	Cinvestav-IPN
	Claude H. Moog	Universite de Nantes
10:20 - 10:40	Input-Output Linearization of General Nonlinear Control Systems	2695
	M. Guay	
	P. James McLellan	Queen's Univ.

10:40 - 11:00	Parameter Variations in Nonlinear Decoupling	2700
	Shaopeng Wang	Beijing Univ. of Aeronautics & Astro.
	Xiaohua Xia	Beijing Univ. of Aeronautics & Astro.
	Weibing Gao	Beijing Univ. of Aeronautics & Astro.
11:00 - 11:20	Minimum-Energy Approach to Stable Inversion of Nonminimum Phase Systems	2705
	Hongchao Zhao	Iowa State Univ.
	Degang Chen	Iowa State Univ.
11:20 - 11:40	On Output Tracking for Nonlinear Systems with Singular Points	2710
	Reza Ghanadan	Univ. of California
	Gilmer L. Blankenship	Univ. of Maryland
11:40 - 12:00	Controlled Invariance of Nonlinear Systems: Generalized Concepts	2712
	H. J. C. Huijberts	Eindhoven Univ. of Tech.
	Claude H. Moog	Universite de Nantes

FA14 — Gibson
Applications of CAD

	Chair J. Douglas Birdwell	Univ. of Tennessee
	Cochair Raja Kadiyala	Univ. of California, Berkeley
10:00 - 10:20	Interactive Visualization of the Regions of Validity and Attraction of Nonlinear Systems	2717
	Raja Kadiyala	CH2M-Hill
10:20 - 10:40	Design of Optimal and Reliable PI-Type Compensators	2722
	Shahram M. Shahruz	Berkeley Engg. Research Institute
10:40 - 11:00	A Modification of Conventional Control Algorithms for Improved Performance	2724
	Jonathan E. Whitlow	Florida Institute of Technology
11:00 - 11:20	A Useful PC Based Educational Tool for Missile Performance Evaluation and Control System Design	2726
	Armando A. Rodriguez	Arizona State Univ.
	Mitchell Sonne	Arizona State Univ.
11:20 - 11:40	Integrated Control Design, Analysis and Simulation Software Toolkit	2731
	Steven Banks	U.S. Army Armament Research
	G. Papanagopoulos	U.S. Army Armament Research
	M. Devito	U.S. Army Armament Research
11:40 - 12:00	The Inverse Output Feedback LQ Problem	2736
	Abdul-Razzaq S Arar	Wichita State Univ.
	Mahmoud S. Sawan	Wichita State Univ.
	Rafat A. Rob	Wichita State Univ.

FA15 — St. George
Linear Systems - II

	Chair Bing Zheng	Univ. of Cincinnati
	Cochair Sophie Tarbouriech	LAAS/CNRS
10:00 - 10:20	Consistency of Experimental Frequency Response Data with Coprime Factor Plant Models	2738
	Benoit Boulet	Univ. of Toronto
	Bruce A. Francis	Univ. of Toronto
10:20 - 10:40	On Positive Invariance and Output Feedback Stabilization of Input Constrained Linear Systems	2740
	E. B. Castelan	UFSC
	Sophie Tarbouriech	LAAS/CNRS

10:40 - 11:00	Perturbation Analysis for the Determination of Observability Indices	2745
Michael Barker		<i>Itek Optical Systems</i>
Ian B. Rhodes		<i>Univ. of California, Santa Barbara</i>
11:00 - 11:20	The 4-Parameter Controller: A Linear, Time-Varying Treatment	2747
Bing Zheng		<i>Univ. of Cincinnati</i>
Arthur Helmicki		<i>Univ. of Cincinnati</i>
11:40 - 12:00	Stabilizing Controller and Observer Synthesis for Uncertain Strongly Coupled Symmetric Composite Systems	2753
Guang Hong Yang		<i>Northeast Univ. of Technology</i>
Si-Ying Zhang		<i>Northeast Univ. of Technology</i>

Friday Mid-day Session

FM01 — Salon A
Numerical Issues in H_{∞} Design

Chair	Hans P. Geering	<i>Swiss Federal Institute of Technology</i>
Cochair	Edmond A. Jonckheere	<i>Univ. of Southern California</i>

1:30 - 1:50	Computing LQG/H_{∞} Bounded Control with Guaranteed Convergence	2755
Kliffon M. Black		<i>The Univ. of Texas, Arlington</i>
Siquan Q. Zhu		<i>Univ. of Texas, Arlington</i>
Frank L. Lewis		<i>Univ. of Texas, Arlington</i>

1:50 - 2:10	Successive Approximation for H_{∞}	2757
Yong Liu		<i>Ohio State Univ.</i>
Rama K. Yedavalli		<i>Ohio State Univ.</i>

2:10 - 2:30	Monotonicity and Convexity of H_{∞} Riccati Solutions in General Case	2762
R. Zong		<i>Drexel Univ.</i>
Bor-Chin Chang		<i>Drexel Univ.</i>

2:30 - 2:50	H_{∞}-Optimal Sampled-Data Control: Computation and Design	2767
Tongwen Chen		<i>Univ. of Calgary</i>
Bruce A. Francis		<i>Univ. of Toronto</i>

2:50 - 3:10	Stabilizing Solutions of the H_{∞} Algebraic Riccati Equation	2772
Anton Stoorvogel		<i>Eindhoven Univ. of Tech.</i>

3:10 - 3:30	Use of the Extended Genetic Algorithm to Solve the Modified General Mixed H_2/H_{∞} Control Problem	2777
Yuan Lisong		<i>East China Univ. of Sci. & Tech.</i>
Jiang Weisun		<i>East China Univ. of Sci. & Tech.</i>

FM02 — Salon B
Robust Control - II

Chair	Hitay Ozbay	<i>Ohio State Univ.</i>
Cochair	Emmanuel G. Collins, Jr.	<i>Harris Corp.</i>

1:30 - 1:50	Behavioral Approach to Robustness Analysis	2782
Fernando Paganini		<i>California Inst. of Tech.</i>
Raffaello D'Andrea		<i>California Inst. of Tech.</i>
John C. Doyle		<i>California Inst. of Tech.</i>

1:50 - 2:10	On Synthesizing Robust Decentralized Controllers	2787
Jose E. Lopez		<i>Massachusetts Inst. of Tech.</i>
Michael Athans		<i>Massachusetts Inst. of Tech.</i>

2:10 - 2:30	Evaluating D-K Iteration for Control Design	2792
	Richard C. Lind	<i>Univ. of Minnesota</i>
	Gary John Balas	<i>Univ. of Minnesota</i>
	Andy Packard	<i>Univ. of California</i>
2:30 - 2:50	Structured Singular Value Controller Synthesis using Constant D-Scales Without D-K Iteration	2798
	Wassim M. Haddad	<i>Florida Inst. of Tech.</i>
	Emmanuel G. Collins, Jr.	<i>Harris Corp.</i>
	Raymond Moser	<i>Florida Inst. of Tech.</i>
2:50 - 3:10	Further Results on Rational Approximations of L_1-Optimal Controllers	2803
	Zi-Qin Wang	<i>Pennsylvania State Univ.</i>
	Mario Sznajder	<i>Pennsylvania State Univ.</i>
	Franco Blanchini	<i>Universita degli Studi di Udine</i>
3:10 - 3:30	A New Iteration Scheme for Robust Performance Problem: E-K Iteration	2809
	Chia-Yuan Chang	<i>National Cheng Kung Univ.</i>
	Ciann-Dong Yang	<i>National Cheng Kung Univ.</i>
	Chin Lin	<i>National Cheng Kung Univ.</i>

FM03 — Salon C

Numerical and Computational Issues

Organizer	Pradeep Pandey	<i>RelMan</i>
Chair	Pradeep Pandey	<i>RelMan</i>
Cochair	Pradeep Misra	<i>Wright State Univ.</i>

1:30 - 1:50	Stable Partial Realization via an Implicitly Restarted Lanczos Method	2814
	E. J. Grimme	<i>Univ. of Illinois</i>
	D. C. Sorensen	<i>Rice Univ.</i>
	Paul Van Dooren	<i>Univ. of Illinois</i>

1:50 - 2:10	Efficient Solution of Linearly Coupled Lyapunov Equations	2819
	Emmanuel G. Collins, Jr.	<i>Harris Corp.</i>
	A. Scott Hodel	<i>Auburn Univ.</i>

2:10 - 2:30	Iterative Quadratic Maximum Likelihood Approach to Frequency Response Shaping	2824
	Pradeep Misra	<i>Wright State Univ.</i>

2:30 - 2:50	On the Generalized Eigenvalue Problem	2828
	Ravi Aripirala	<i>Univ. of Hawaii</i>
	Vassilis L. Syrmos	<i>Univ. of Hawaii at Manoa</i>

2:50 - 3:10	Application of E-Decomposition to Solving Algebraic Riccati Equations	*
	Pradeep Pandey	<i>RelMan</i>

3:10 - 3:30	Smoothly Time Varying Systems and Least Square Systems Identification	2832
	M. Stewart	<i>Univ. of Illinois</i>
	Paul Van Dooren	<i>Univ. of Illinois</i>

FM04 — Salon D

Model Predictive Control - I

Chair	Francis J. Doyle	<i>Purdue Univ.</i>
Cochair	Babatunde A. Ogunnaiké	<i>DuPont Polymer Products</i>

1:30 - 1:50	The Stability of Constrained Receding Horizon Control with State Estimation	2837
	Kenneth R. Muske	<i>Univ. of Texas-Austin</i>
	Edward S. Meadows	<i>Univ. of Texas-Austin</i>
	James B. Rawlings	<i>Univ. of Texas-Austin</i>

1:50 - 2:10	Constrained Predictive Control with Guaranteed Stability and Convex Optimization	2842
R.A.J. de Vries		<i>Delft Univ. of Technology</i>
T.J.J. van den Boom		<i>Delft Univ. of Technology</i>
2:10 - 2:30	Global Stabilization of Linear Discrete-Time Systems with Bounded Controls—A Model Predictive Control Approach	2847
Alex Zheng		<i>California Inst. of Technology</i>
Manfred Morari		<i>California Inst. of Technology</i>
2:30 - 2:50	Frequency Domain Design of Robustly Stable Constrained Model Predictive Controllers	2852
Hung-Wen Chiou		<i>Univ. of Maryland</i>
Evangelos Zafiriou		<i>Univ. of Maryland</i>
2:50 - 3:10	Stabilizing Predictive Control with Output Feedback for Asymptotic Tracking	2857
Thomas J. Manayathara		<i>Univ. of Illinois, Urbana</i>
Joseph Bentsman		<i>Univ. of Illinois, Urbana</i>
3:10 - 3:30	Feasible Suboptimal Model Predictive Control for Linear Plants with State Dependent Constraints	2862
V. Nevistic		<i>Swiss Federal Inst. of Tech</i>
L. Del Re		<i>Swiss Federal Inst. of Tech.</i>

FM05 — Salon E
Spacecraft Control

Chair F.Y. Hadaegh	<i>California Inst. of Technology</i>
Cochair R.Y. Chiang	<i>California Inst. of Technology</i>

1:30 - 1:50	Adaptive Nonlinear Control of Spacecraft	2867
Jyh-Jong Sheen		<i>National Taiwan Ocean Univ.</i>
Robert H. Bishop		<i>Univ. of Texas, Austin</i>

1:50 - 2:10	Suppression of Critical Mode Vibrations in Large Flexible Space Structures	2872
David Yong D. Song		<i>NASA Center for Aerospace Research</i>
T. L. Mitchell		<i>NASA Center for Aerospace Research</i>

2:10 - 2:30	Spacecraft Spin Axis Attitude Determination via Genetic Algorithm	2877
N. Bowe		<i>North Carolina A&T St. Univ.</i>
A. Homaifar		<i>North Carolina A&T St. Univ.</i>
Y.D. Song		<i>North Carolina A&T St. Univ.</i>

2:30 - 2:50	Disturbance Learning Control for Small Satellites	2882
Dale A. Lawrence		<i>Univ. of Colorado</i>
Francois Padiou		<i>Univ. of Colorado</i>
Penina Axelrad		<i>Univ. of Colorado</i>
Michael Holden		<i>Univ. of Colorado</i>
Michael Malone		<i>Univ. of Colorado</i>

2:50 - 3:10	On-Orbit Calibration of Inductosyn Error	2887
Yeong-Wei Andy Wu		<i>Hughes Aircraft Co.</i>

3:10 - 3:30	Singularity Avoidance Control Laws for a Multiple CMG Spacecraft Attitude Control System	2892
Mark D. Kuhns		<i>Arizona State Univ.</i>
Armando A. Rodriguez		<i>Arizona State Univ.</i>

FM06 — Salon F

Modeling and Control of Manufacturing Processes - I

Organiser Richard J. Furness	<i>Ford Research Laboratory</i>
Chair Richard J. Furness	<i>Ford Research Laboratory</i>
Cochair A. Galip Ulsoy	<i>Univ. of Michigan</i>

1:30 - 1:50	High-Speed End Mill Boring and Rounded Corner Cutting	2894
E. D. Tung	<i>Univ. of California at Berkeley</i>	
Masayoshi Tomizuka	<i>Univ. of California at Berkeley</i>	
Y. Urushisaki	<i>Matsuura Machinery Corp.</i>	
1:50 - 2:10	Control Input Shaping for Coordinate Measuring Machines	2899
Steven D. Jones	<i>Ford Motor Co.</i>	
A. Galip Ulsoy	<i>Univ. of Michigan</i>	
2:10 - 2:30	Application of Repetitive Control to Eccentricity Compensation in Rolling	2904
Srinivas Garimella	<i>Alcoa</i>	
K. Srinivasan	<i>Ohio State Univ.</i>	
2:30 - 2:50	Transient Response of Repetitive Control Systems	2909
Srinivas Garimella	<i>Alcoa</i>	
K. Srinivasan	<i>Ohio State Univ.</i>	
2:50 - 3:10	Integrated Error Correction System for Machine Performance Improvement	2914
J. Mou	<i>National Instit. of Standards and Tech.</i>	
M. A. Donmez	<i>National Instit. of Standards and Tech.</i>	
Sabri Cetinkunt	<i>Univ. of Illinois</i>	
3:10 - 3:30	Modeling and Feedback Control of a Plasma Spray Deposition Process	2919
S.M. Pandit	<i>Michigan Technological Univ.</i>	
T. M. Demeny	<i>Michigan Technological Univ.</i>	
A. R. Kashani	<i>Michigan Technological Univ.</i>	

FM07 — Federal Hill

Neural Network Controllers

Chair	S. Joe Qin	<i>Fisher-Rosemount Systems Division</i>
Cochair	S. Jagannathan	<i>Univ. of Texas at Arlington</i>
1:30 - 1:50	Real-Time Nonlinear Optimal Control using Neural Networks	2926
Jaipaul Antony	<i>Univ. of Missouri, Rolla</i>	
Levent Acar	<i>Univ. of Missouri, Rolla</i>	
1:50 - 2:10	Neural-Net Based Adaptive PID Regulator with Attenuating Excitation Signal	2931
Ming Wang Zhao	<i>Wuhan Iron and Steel Univ.</i>	
2:10 - 2:30	A Neural Network Approach of Input-Output Linearization of Affine Nonlinear Systems	2933
Wei-Song Lin	<i>National Taiwan Univ.</i>	
2:30 - 2:50	Back-Propagation Neural Networks for the Inverse Control of Discrete-Time Nonlinear Plant	2938
Zeng-Ren Yuan	<i>Tsinghua Univ.</i>	
Xin-Gang Guo	<i>Tsinghua Univ.</i>	
2:50 - 3:10	Time Optimal Control using CMAC Neural Networks	2943
L. Gordon Kraft	<i>Univ. of New Hampshire</i>	
Darryl H. Deitz	<i>Univ. of New Hampshire</i>	
3:10 - 3:30	Practical Stability Issues in CMAC Neural Network Control System	2945
Fu-Chuang Chen	<i>National Chiao Tung Univ.</i>	
Chih-Horng Chang	<i>National Chiao Tung Univ.</i>	

FM08 — Fells Point

Applications of Robust Control

Chair	Oscar D. Crisalle	<i>Univ. of Florida</i>
Cochair	Theodore E. Djaferis	<i>Univ. of Massachusetts</i>

- 1:30 - 1:50
An Experimental Comparison Between Q-Parameterization, H_∞ Synthesis and Servo Control System Designs 2947
 Abdelfatah M. Mohamed *Assiut Univ.*
 Ilene Busch-Vishniac *Univ. of Texas - Austin*
 B. Vestgaard *Univ. of Texas - Austin*
- 1:50 - 2:10
Imbalance Compensation and Automatic Balancing in Magnetic Bearing Systems using the Q-Parameterization Theory 2952
 A. M. Mohamed *Assiut Univ.*
 Ilene Busch-Vishniac *Univ. of Texas - Austin*
- 2:10 - 2:30
FIT Synthesis Applied to an Automatic Bus Steering Problem 2958
 R. D. Kaminsky *Univ. of Massachusetts*
 Theodore E. Djaferis *Univ. of Massachusetts*
- 2:30 - 2:50
Augmented System Approach to Measurement-Based Robust Tracking 2960
 Russel W. Benson *Univ. of California - Irvine*
 William E. Schmitendorf *Univ. of California - Irvine*
- 2:50 - 3:10
Robust H_∞ Control of a Traction Drive System for Precision Motion 2965
 Paul I. Ro *North Carolina State Univ.*
 Quan Ma
- 3:10 - 3:30
Sub-Micrometer Control of a Traction Drive using State Feedback and Estimation 2967
 Paul I. Ro *North Carolina State Univ.*
 Ganesh S. Rao

FM09 — Guilford

Adaptive Control

Chair H.J. Chizeck *Case Western Reserve Univ*
Cochair Ramon R. Costa *COPPE/UFRJ*

- 1:30 - 1:50
Estimation and Adaptive Control in the Presence of Mean Square Bounded Disturbances 2972
 Sergei V. Gusev *St. Petersburg Univ.*
- 1:50 - 2:10
Performance Improvement of Robust Adaptive Control using Orthogonal Functions 2979
 F. Giri *Ecole Mohammadia d'Ingenieurs*
 Mohammed M'Saad *Laboratoire d'Automatique de Grenoble*
 F. Ikhouane *Ecole Mohammadia d'Ingenieurs*
- 2:10 - 2:30
Control of Unknown Systems using Switching Controllers: An Experimental Study 2984
 M. Chang *Univ. of Toronto*
 E. J. Davidson *Univ. of Toronto*
- 2:30 - 2:50
A New Indirect Adaptive Algorithm for Feedforward Control 2990
 Wei Ren *Univ. of California, Berkeley*
 A.K. Wang
- 2:50 - 3:10
Periodic Adaptive Stabilization of the Unstable Nonminimum Phase System 2995
 Dimitry M. Gorinevsky *Univ. of Toronto*
- 3:10 - 3:30
Absolute Stability Under Uncertainties Satisfying Reciprocal Relations 3000
 Keqin Gu *Southern Illinois Univ.*

FM10 — Mt. Washington

Identification and Model (In)validation

Chair Robert E. Skelton *Purdue Univ.*
Cochair Engin Yaz *Univ. of Arkansas*

1:30 - 1:50	Least-Squares Parameter Set Estimation for Robust Control Design	3002
	Robert L. Kosut	<i>Integrated Systems, Inc.</i>
	Brian D.O. Anderson	<i>Australian National Univ.</i>
1:50 - 2:10	Real-Time Evaluation of an Iterative Scheme for Closed-Loop Identification and Control Design	3007
	Alina Voda	<i>Laboratoire d'Automatique de Grenoble</i>
	Ioan D. Landau	<i>Laboratoire d'Automatique de Grenoble</i>
2:10 - 2:30	Closed-Loop Identification of Restricted Complexity Models for Feedback/Feedforward Control using Iterative Refinement	3012
	S. Bhatnagar	<i>Arizona State Univ.</i>
	Daniel E. Rivera	<i>Arizona State Univ.</i>
2:30 - 2:50	A Framework for Robust Control Based Model Invalidation	3017
	M. M. Livstone	<i>Massachusetts Inst. of Tech.</i>
	Munther A. Dahleh	<i>Massachusetts Inst. of Tech.</i>
	Jay A. Farrell	<i>Charles Stark Draper Lab.</i>
2:50 - 3:10	An Approach to Model Validation in the μ Framework ..	3021
	Gary John Balas	<i>Univ. of Minnesota</i>
	Arun Kumar	<i>Univ. of Minnesota</i>
3:10 - 3:30	A Model Validation Approach to Fault Detection	3027
	S. Thapliyal	<i>Univ. of Notre Dame</i>
	Y.E. Fatah	<i>Univ. of Notre Dame</i>
	Jeffrey C. Kantor	<i>Univ. of Notre Dame</i>

FM11 — Kent

Control Systems for Heating Ventilating and Air Conditioning

Organizer	M. Zaheer-uddin	<i>Concordia Univ.</i>
Chair	M. Zaheer-uddin	<i>Concordia Univ.</i>
Cochair	R. V. Patel	<i>Concordia Univ.</i>
1:30 - 1:50	Neural Networks Applied to Local and Global HVAC System Control	3029
	S. Curtiss	<i>Univ. of Colorado</i>
	Jan F. Kreider	<i>Univ. of Colorado</i>
	Micheal J. Brandemuehl	<i>Univ. of Colorado</i>
1:50 - 2:10	Efficient Operation of Multizone Cooling Systems with Storage	3045
	R. E. Rink	<i>Univ. of Alberta</i>
	N. Li	<i>Univ. of Alberta</i>
2:10 - 2:30	Decentralised Control of a Variable Air Volume System ..	3050
	M. Zaheer-uddin	<i>Concordia Univ.</i>
	S. A. K. Al-Assadi	<i>Concordia Univ.</i>
	R. V. Patel	<i>Concordia Univ.</i>
2:30 - 2:50	An SQC Approach to Monitoring and Fault Detection in HVAC Control Systems	3055
	Paul Shin Fasolo	<i>Univ. of California, Santa Barbara</i>
	Dale E. Seborg	<i>Univ. of California, Santa Barbara</i>
2:50 - 3:10	Fuzzy-Based Self-Organizing Control for Building Systems	3060
	Larry J. Brackney	<i>Purdue Univ.</i>
	Rahmat Shoureshi	<i>Purdue Univ.</i>

3:10 - 3:30
Tuning of PID DDC Controllers 3065
 Gideon Shavit *Honeywell Inc.*

FM12 — Pride of Baltimore
Optimization and Optimal Control

Chair Hannah H. Michalska *McGill Univ.*
Cochair Siva S. Banda *Wright-Patterson AFB*

1:30 - 1:50
Comparative Study of Gradient-Free Algorithms for System Optimization 3070
 Daniel C. Chin *Johns Hopkins Univ.*

1:50 - 2:10
State Feedback Synthesis for On-Line Optimization of Batch Reactors with a Non-Affine Manipulated Input and Free Terminal Time 3076
 Srinivas Palanki *Florida State Univ.*
 A.K.M. Shamsur Rahman

2:10 - 2:30
On Time-Optimal Feedback Control 3080
 Zvi Shiller *Univ. of California, Los Angeles*
 Satish Sundar

2:30 - 2:50
Minimax Boundary Control Problem for Parabolic Systems with State Constraints 3085
 Boris Mordukhovich *Wayne State Univ.*
 Kaixia Zhang *Wayne State Univ.*

2:50 - 3:10
Realization of Closed-Loop Specific Optimal Control 3090
 Thomas J. Meyer *State Univ. of New York, Buffalo*
 D. Joseph Mook *State Univ. of New York, Buffalo*

3:10 - 3:30
Global Optimality Conditions for Two Classes of Nonconvex Optimal Control Problems *
 Alexandre Strelakovsky *Irkutsk State Univ.*

FM13 — James
Nonlinear Control - II

Chair Derek P. Atherton *Univ. of Sussex*
Cochair Michael S. Branicky *Massachusetts Inst. of Tech.*

1:30 - 1:50
Position Tracking Control of a Switched Reluctance Motor using Partial State Feedback 3095
 M. D. Leviner *Clemson Univ.*
 Darren M. Dawson *Clemson Univ.*
 Jun Hu *Clemson Univ.*

1:50 - 2:10
Resonance Control of Aircraft Instabilities by Smooth and Continuous Feedback 3100
 Mark A. Pinsky *Univ. of Nevada, Reno*
 Bill Essary *Univ. of Nevada, Reno*

2:10 - 2:30
Trajectory Planning and Control for a Five-Degree-of-Freedom Biped Locomotion System 3105
 Jiann-shiou Yang *Univ. of Minnesota*
 Ahmed Shahabuddin *Univ. of Minnesota*

2:30 - 2:50
Analyzing Continuous Switching Systems: Theory and Examples 3110
 Michael S. Branicky *Massachusetts Inst. of Tech.*

2:50 - 3:10
Design of Nonlinear Controllers using Harmonic Balance Plant Models 3115
 Derek P. Atherton *Univ. of Sussex*

3:10 - 3:30

Air/fuel Ratio Controller Design using the Describing Function Approach 3117

Mohammed Sami Fadali

Univ. of Nevada

Y.A. Ghoneim

GM Research and Development Labs

FM14 — Gibson

Applications

Chair B. Wayne Bequette

Rensselaer Polytechnic Inst.

Cochair Sheyla L. Rivera

Stevens Institute of Technology

1:30 - 1:50

Experimental Comparison of Model Based and Conventional Pressure Control for a Plasma Reactor 3122

Hoshang Subwalla

Texas Tech Univ.

R. Russell Rhinehart

Texas Tech Univ.

1:50 - 2:10

Gain Scheduled Control of Magnetic Suspension System . 3127

Young Chol Kim

Chungbuk National Univ.

Kook Hun Kim

Korea Electrotech. Research Institute

2:30 - 2:50

Experimental Evaluation of Friction Estimation and Compensation Techniques 3132

Sofia Mentzelopoulou

New Jersey Institute of Technology

Bernard Friedland

New Jersey Institute of Technology

2:50 - 3:10

PH Control using Heuristic Model: A Pilot Scale Demonstration 3137

Mehul M. Desai

Texas Tech Univ.

R. Russell Rhinehart

Texas Tech Univ.

3:10 - 3:30

Robust Control of Rigid-Link Electrically-Driven Robot Manipulators 3142

Yury Stepanenko

Univ. of Victoria

Chun-Yi Su

Univ. of Victoria

FM15 — St. George

Linear Systems - III

Chair Ali Saberi

Washington State Univ.

Cochair Kameshwar Poola

Univ. of California, Berkeley

1:30 - 1:50

Spectral Power Distribution using Time-Varying Operators 3147

Kameshwar Poola

Univ. of California, Berkeley

Gregory Jon Wolodkin

Univ. of California, Berkeley

1:50 - 2:10

Semi-Global Exponential Stabilization of Linear Discrete-Time Systems Subject to "Input Saturation" via Linear Feedbacks 3152

Zongli Lin

Washington State Univ.

Ali Saberi

Washington State Univ.

2:10 - 2:30

Zeros of Discretized Continuous Systems Expressed in the Euler Operator - an Asymptotic Analysis 3157

A. Tesfaye

Univ. of California at Berkeley

Masayoshi Tomizuka

Univ. of California at Berkeley

2:30 - 2:50

Row-by-Row Decoupling with Stability for Linear Periodic Discrete-Time Systems 3159

Oswaldo M. Grasselli

Univ. di Roma "Tor Vergata"

Paolo Valigi

Univ. di Roma "Tor Vergata"

2:50 - 3:10

On the Computation of Mansour Normal Form in Time Domain 3164

Venkatappa Sreeram

Univ. of Western Australia

R. Doraiswami

Univ. of New Brunswick

FP01 — Salon A
Robust H_∞/L_1 Control

Chair Bor-Chin Chang
Cochair

Drexel Univ.

4:00 – 4:20

Synthesis of Robust Servo Compensator Based on H_∞ Control **3166**
 Shinji Hara *Tokyo Institute of Technology*
 Hisaya Fujioka *Tokyo Institute of Technology*
 T. Kosugiyama *Tokyo Institute of Technology*

4:20 – 4:40

Lagrange Multipliers Method in Robust Control: The L_1 -Setting **3171**
 Mustafa H. Khammash *Iowa State Univ.*
 A. Megretski *Iowa State University*

4:40 – 5:00

Robust H_∞ Control of Uncertain Linear Systems with Structured Uncertainty **3176**
 Andrey V. Savkin *Australian Defense Force Academy*
 Ian R. Petersen *Australian Defense Force Academy*

5:00 – 5:20

Submarine H_∞ Depth Control Under Wave Disturbances . **3178**
 Eduardo L. Castro *Univ. of Strathclyde*
 Gerrit M. van der Molen *Univ. of Strathclyde*
 M.J. Grimble *Univ. of Strathclyde*

5:20 – 5:40

Suboptimal Robustness in the Gap Metric for MIMO Delay Systems **3183**
 O. Toker *The Ohio State Univ.*
 Hitay Ozbay *Ohio State Univ.*

5:40 – 6:00

Optimal Control Under Restrictions on Correlation Coefficients of Disturbances **3188**
 Sergei V. Gusev *St. Petersburg Univ.*

FP02 — Salon B

Experimental Results with Robust Control Implementation

Organizer Peter M. M. Bongers *Delft Univ. of Technology*
Chair Maarten Steinbuch *Philips Research*
Cochair Peter M. M. Bongers *Delft Univ. of Technology*

4:00 – 4:20

The Design of Helicopter Flight Control Systems using Advanced H_∞ Control **3193**
 Ian Postlethwaite *Univ. of Leicester*
 D. J. Walker- *Leicester Univ.*

4:20 – 4:40

Experimental Robust Control Studies on an Unstable Magnetic Suspension System **3198**
 Kyong B. Lim *NASA Langley Research Center*
 David E. Cox *NASA Langley Research Center*

4:40 – 5:00

Design and Implementation of a QFT Controller for a Compact Disc Player **3204**
 Yossi Chait *Univ. of Massachusetts*
 Myoung Soo Park *Univ. of Massachusetts*
 Maarten Steinbuch *Philips Research*

5:00 – 5:20

Limits of Implementation — A Case Study **3209**
 Maarten Steinbuch *Philips Research*
 Pepijn Wortelboer *Philips Research*
 Pieter J. M. Van Groos *Delft Univ. of Technology*
 Okko H. Bosgra *Delft Univ. of Technology*

5:20 – 5:40

Experimental Robust Control of a Flexible Wind Turbine System **3214**
 Peter M. M. Bongers *Delft Univ. of Technology*

5:40 - 6:00

- Real Time Implementation of a Robust H_{∞} Controller for a
2-DOF Magnetic Micro-Levitation Positioner** 3219
Abdelfatah M. Mohamed *Assiut University*
Ilene Busch-Vishniac *Univ. of Texas - Austin*
B. Vestgaard

FP03 — Salon C
Sampled Data Systems

Chair J.S. Freudenberg *Univ. of Michigan*
Cochair Engin Yaz *Univ. of Arkansas*

4:00 - 4:20

- A Study on the Optimal Generalized Sampled and Hold State
Feedback Controller** 3224
Kjell Nordstrom *Uppsala Univ.*

4:20 - 4:40

- Inherent Design Limitations for Linear Sampled-Data Feedback
Systems** 3227
J.S. Freudenberg *Univ. of Michigan*
R.H. Middleton *Univ. of Newcastle*
J.H. Braslavsky *Univ. of Newcastle*

4:40 - 5:00

- Loop Transfer Recovery for Sampled-Data Systems** 3232
Peng Shi *Univ. of Newcastle*
Minyue Fu *Univ. of Newcastle*
Carlos E. de Souza *Univ. of Newcastle*

5:00 - 5:20

- Sampled-Data Repetitive Control Systems** 3234
Alireza Langari *Univ. of Toronto*
Bruce A. Francis *Univ. of Toronto*

5:20 - 5:40

- Passivity of a Class of Sampled-Data Systems: Application to
Haptic Interfaces** 3236
James E. Colgate *Northwestern Univ.*
Gerd Schenkel

5:40 - 6:00

- Stability Analysis of Multirate Sampled-Data Systems** ... 3241
Yuguang Fang *Case Western Reserve Univ.*
Xuedao Chu *Qufu Normal Univ.*

FP04 — Salon D
Model Predictive Control - II

Chair James B. Rawlings *Univ. of Texas-Austin*
Cochair D. Grant Fisher *Univ. of Alberta*

4:00 - 4:20

- Identified Predictive Control** 3243
Jan T. Bialasiewicz *Univ. of Colorado-Denver*
Lucas G. Horta *NASA Langley Research Center*
Minh Q. Phan *Lockheed Engineering & Sciences Company*

4:20 - 4:40

- State Estimation Nonlinear QDMC with Input-Output Models**
..... 3248
Gangadhar Gattu *Univ. of Maryland*
Evangelos Zafiriou

4:40 - 5:00

- A Nonlinear Model Predictive Control Scheme using Second
Order Volterra Models** 3253
Bryon R. Maner *Purdue Univ.*
Francis J. Doyle *Purdue Univ.*
Babatunde A. Ogunnaike *DuPont Polymer Products*
Ronald K. Pearson *DuPont Polymer Products*

5:00 - 5:20

- Robust Stability of Model Predictive Control** 3258
Kent Z. Qi *Univ. of Alberta*
D. Grant Fisher *Univ. of Alberta*

5:20 - 5:40

- A Design Method of Self-Tuning PID Controller** 3263
Toru Yamamoto *Osaka Univ.*
Sigeru Omatu *Univ. of Tokushima*
M. Kaneda *Okayama Prefectural Univ.*

5:40 - 6:00

Multirate Control for a Gasification Process 3268
K.Y. Zhu *Nanyang Tech. Univ.*
K.V. Ling *Nanyang Tech. Univ.*

FP05 — Salon E

Missile Guidance and Control

Chair James R. Cloutier *Wright Laboratory*
Cochair A.S. Politopoulos *American GNC Corp.*

4:00 - 4:20

Planar Autopilot Design for the EMRAAT Missile using Sliding Mode 3273
Darren A. Schumacher *USAF-WL/MNAG*
N. Harris McClamroch *Univ. of Michigan*

4:20 - 4:40

Autopilot Design for a Tail-Controlled Missile using LQG/LTR with Eigenstructure Reassignment 3278
James Brown *Air Force Inst. of Tech./Eny*
D. Brett Ridgely *Air Force Inst. of Tech./Eny*
Randall N. Paschall *Wright Labs Avionics Directorate*

4:40 - 5:00

Non-Conservative Robustness Evaluation of a Multivariable H_{∞} Missile Autopilot 3283
G. Ferreres *Aerospatiale Missiles*
V. Fromion *Aerospatiale Missiles*
G. Duc *Ecole Superieure D'Electricite-Service*
Mohammed M'Saad *Laboratoire d'Automatique de Grenoble*

5:00 - 5:20

A Multisensor Tracking System with an Image-Based Maneuver Detector 3288
Shreenath Shetty *Tennessee Technological Univ.*
Ali T. Alouani *Tennessee Technological Univ.*

5:20 - 5:40

Linearized Kappa Guidance 3293
Demetrios Serakos *Naval Surface Warfare Center*
Ching-Fang Lin *American GNC Corp.*

5:40 - 6:00

A Modified CLOS Guidance Law via Right Inversion 3298
Jie Huang *American GNC Corp*
Ching-Fang Lin *American GNC Corp.*

FP06 — Salon F

Modeling and Control of Manufacturing Processes - II

Organizer Richard J. Furness *Ford Research Laboratory*
Chair Richard J. Furness *Ford Research Laboratory*
Cochair A. Galip Ulsoy *Univ. of Michigan*

4:00 - 4:20

Dynamic Stiffness Enhancement of Direct Linear Motor Feed Drives for Machinig 3303
David M. Alter *Univ. of Illinois*
Tsu-Chin Tsao *Univ. of Illinois*

4:20 - 4:40

Model Error Compensation and Robust Observer Design Part II: Bearing Temperature and Preload Estimation 3308
J.F. Tu *Purdue Univ.*
Jeffrey L. Stein *Univ. of Michigan*

4:40 - 5:00

Chip Geometry Based Tool Force Variation Model for Dynamic Error Correction in Diamond Turning 3313
Jeffrey A. Ablter *North Carolina State Univ.*
Paul I. Ro *North Carolina State Univ.*

5:00 - 5:20

Applications of Continuum-Based Models of Machine-Tool Spindle Drives 3318
Bruce Wilson *Northeastern Univ.*
Gao Gao *Hefei Univ. of Technology*

5:20 - 5:40

System-Theoretic Properties of the Process of Continuous Improvement in Production Systems 3323
David Jacobs *Ford Motor Company*
Semyon M. Meerkov *Univ. of Michigan*

5:40 - 6:00

- MDARTS: A Real-Time Database for the Control and Monitoring of Manufacturing Systems** 3328
Victor B. Lortz *Univ. of Michigan*
Kang G. Shin *Univ. of Michigan*

FP07 — Federal Hill

Analysis of Neural Network Controllers

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- Chair** Jennie Si *Arizona State Univ.*
Cochair Benito Fernandez *Univ. of Texas-Austin*
- 4:00 - 4:20
Discrete-Time Neural Net Controller with Guaranteed Performance 3334
S. Jagannathan *Univ. of Texas at Arlington*
Frank L. Lewis *Univ. of Texas at Arlington*
- 4:20 - 4:40
Diagonal Recurrent Neural Networks Based Control: Convergence and Stability 3340
Chao-Chee Ku *Pennsylvania State Univ.*
Kwang Y. Lee *Pennsylvania State Univ.*
- 4:40 - 5:00
Some Stability Properties of Recurrent Neural Networks . 3346
Jennie Si *Arizona State Univ.*
Ching-Fang Lin *American GNC Corp.*
- 5:00 - 5:20
On Disturbance Rejection in Nonlinear Control 3351
C. J. Goh *Univ. of Western Australia*
P. Podsiadlo *Univ. of Western Australia*
- 5:20 - 5:40
Lyapunov Functions for Rotor Neural Networks 3355
Ibrahim M. Elfadel *Massachusetts Inst. of Tech.*
- 5:40 - 6:00
Supervised and Unsupervised Learning Applied to Robotic Manipulator Control 3357
Lifford L.L. McLaughlan *Texas A&M Univ.*
Rajab Chaloo *Texas A & M Univ.*
S. Iqbal Omar *Texas A&M Univ.*
Robert McLaughlan *Texas A&M Univ.*

FP08 — Fells Point

Decentralized Control and Estimation

-
- Organizer** Vasilios Manousiouthakis *Univ. of California, Los Angeles*
Chair Vasilios Manousiouthakis *Univ. of California, Los Angeles*
Cochair
- 4:00 - 4:20
Reliable Decentralized Control 3359
A. Nazli Gundes *Univ. of California, Davis*
Guntekin M. Kabuli *Integrated Systems Inc.*
- 4:20 - 4:40
Best Achievable Low Order Decentralized Performance .. 3364
Dennis D. Sourlas *Univ. of California, Los Angeles*
Thomas F. Edgar *Univ. of Texas at Austin*
Vasilios Manousiouthakis *Univ. of California, Los Angeles*
- 4:40 - 5:00
Optimal Decentralized Control 3369
V.S. Savastuyk *Univ. of Santa Clara*
Dragoslav D. Siljak *Univ. of Santa Clara*
- 5:00 - 5:20
A Reconciliation Between Quantitative Feedback Theory and Robust Multivariable Control 3374
Richard D. Braatz *DuPont Advanced Control Group*
- 5:20 - 5:40
Decentralized Estimation Based on an Exponential Criterion 3379
Jason L. Speyer *Univ. of California, Los Angeles*

5:40 - 6:00

Robust Reliable Decentralized Control 3384
Richard D. Braatz *DuPont Advanced Control Group*
Manfred Morari *California Inst. of Technology*
Sigurd Skogestad

FP09 — Guilford

Adaptive Control of Decentralized & Distributed Parameter Systems

Chair Petros A. Ioannou *Univ. of Southern California*
Cochair Anuradha M. Annaswamy *Massachusetts Inst. of Tech.*

4:00 - 4:20

New Decentralized MRAC Algorithms for Large-Scale Uncertain Dynamic Systems 3389
A-Cheng Wu *National Taiwan Univ.*
Li-Chen Fu *National Taiwan Univ.*

4:20 - 4:40

Decentralized Adaptive Control in a Game Situation for Discrete-Time, Linear, Time-invariant Systems 3394
W.Y. Yang *Univ. of Southern California*
George P. Papavassilopoulos *Univ. of Southern California*

4:40 - 5:00

Model Reference Adaptive Control of Abstract Nonlinear Distributed Parameter Systems 3400
Michael A. Demetriou *North Carolina State Univ.*

5:00 - 5:20

The Use of Finite Element Modeling and Decentralized Techniques in Control of Long-reach Manipulators ... 3402
Maj Mirmirani *California State Univ., Los Angeles*
Helen Ryaciotaki-Boussalis *California State Univ., Los Angeles*

5:20 - 5:40

A New Algorithm for Decentralized Adaptive Control ... 3407
Gang Feng *Univ. of New South Wales*
Y.A. Jiang *Univ. of New South Wales*

5:40 - 6:00

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Gang Feng *Univ. of New South Wales*
Y.A. Jiang *Univ. of New South Wales*

FP10 — Mt. Washington

Model Reduction

Chair Hossny El-Sherief *TRW Systems Integration Group*
Cochair Ching-Chih Tsai *National Chung-Hsing Univ.*

4:00 - 4:20

Construction of Low Authority, Nearly Non-Minimal LQG Compensators for Reduced-Order Control Design 3411
Emmanuel G. Collins, Jr. *Harris Corp.*
Wassim M. Haddad *Florida Inst. of Tech.*
Sidney S. Ying *Florida Inst. of Tech.*

4:20 - 4:40

Singular Perturbation Approximation of Bounded Real and of Positive Real Transfer Matrices 3416
Giovanni Muscato *Univ. degli Studi di Catania*
G. Nunnari *Univ. degli Studi di Catania*
L. Fortuna *Univ. degli Studi di Catania*

4:40 - 5:00

Maximal Stability Range of Singularly Perturbed Systems using the Block Lyapunov Sum 3421
Denis Mustafa *Univ. of Oxford*

5:00 - 5:20

Model Reduction of Positive Real Systems 3423
Xin Chen *Rensselaer Polytechnic Inst.*
John T. Wen *Rensselaer Polytechnic Inst.*

5:20 - 5:40

Model Reduction by Subsystem Balancing: Application to the Space Station 3428
Trevor Williams *Univ. of Cincinnati*

5:40 - 6:00

- Optimal Closed-Loop Approximation by Reduced Order
Controllers** 3433
Agnes Cohen-Jalfon *Technion*
Yoram Halevi *Technion*

FP11 — Kent

**Controls in an Interdisciplinary/Multidisciplinary
Environment**

-
- Organizer** Carl F. Lorenzo *NASA Lewis Research Center*
Chair Carl F. Lorenzo *NASA Lewis Research Center*
Cochair Sarkis Barkhoudarian *Rockwell International*

4:00 - 4:20

- Interdisciplinary Modelling using Computational Fluid
Dynamics and Control Theory** 3438
A. Chicatelli *Univ. of Akron*
Tom T. Hartley *Univ. of Akron*
G. Cole *NASA Lewis Research Center*
K. Melcher *NASA Lewis Research Center*

4:20 - 4:40

- Acoustic Noise Control: A Marriage of Acoustics & Control**
..... 3444
Rahmat Shoureshi *Purdue Univ.*

4:40 - 5:00

- Damage Mitigating Control - an Interdisciplinary Thrust
Between Controls and Material Science** 3449
Asok Ray *Pennsylvania State Univ.*
X. Dai *The Pennsylvania State Univ.*
M. Carpino *The Pennsylvania State Univ.*
Carl F. Lorenzo *NASA Lewis Research Center*

5:20 - 5:40

- A Distributed-Parameter-Model Approach to Optimal Comfort
Control in Air Conditioning Systems** 3454
Sheng Liu *Massachusetts Inst. of Tech.*
Xiangdong He *Massachusetts Inst. of Tech.*

5:40 - 6:00

- Constrained H_{∞} Optimal Control Over an Infinite Horizon**
..... 3459
Anthanasios Sideris *Univ. of California, Irvine*
Hector P. Rotstein *Technion*

FP12 — Pride of Baltimore

Optimal Control

-
- Chair** Srinivas Palanki *Florida State Univ.*
Cochair Vassilis L. Syrmos *Univ. of Hawaii at Manoa*

4:00 - 4:20

- The SISO LQG Compensator for Lightly Damped Structures**
..... 3464
Mark Campbell *Massachusetts Inst. of Tech.*
Edward F. Crawley *Massachusetts Inst. of Tech.*

4:20 - 4:40

- Linear-Quadratic Optimal Model-Following Control of a
Helicopter in Hover** 3470
Jeff K. Pieper *Univ. of Calgary*
S. Baillie *National Research Council*
Kevin R. Goheen *Carleton Univ.*

4:40 - 5:00

- Adaptive Linear Quadratic Control using Policy Iteration**
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Steven J. Bradtke *Univ. of Massachusetts*
B. Erik Ydstie *Carnegie Mellon Univ.*
Andrew G. Barto *Univ. of Massachusetts*

5:00 - 5:20

- On Pole Assignment in Discrete-Time Optimal Control Systems**
..... 3480
Hardev Singh *Idaho State Univ.*
S. Naidu *Idaho State Univ.*

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	Guoming Zhu	Purdue Univ.
	Karolos Grigoriadis	Purdue Univ.
	Robert E. Skelton	Purdue Univ.
5:40 - 6:00	Optimal Access Control of Simple Integrated Networks with Incomplete Observations	3487
	Dong-Ryeol Shin	Samsung Data Systems Co. Ltd.
	Erik I. Verriest	Georgia Inst. of Technology

FP13 — James
Nonlinear Control - III

	Chair Zhihua Qu	Univ. of Central Florida
	Cochair Mark A. Pinsky	Univ. of Nevada, Reno
4:00 - 4:20	Robust Stabilization of Positively Constrained Uncertain Systems	3489
	Martin Pleau	Queen's Univ.
	P. James McLellan	Queen's Univ.
4:20 - 4:40	Continuous Robust Control Design for Nonlinear Uncertain Systems Without a Priori Knowledge of Control Direction	3494
	J.H. Kaloust	Univ. of Central Florida
	Zhihua Qu	Univ. of Central Florida
4:40 - 5:00	Self-Tuning Control of Nonlinear Systems	3499
	Mohammad Farsi	Univ. of Newcastle Upon Tyne
5:00 - 5:20	Attenuation of Nonlinearly State-Dependent Uncertainties: Robust Control Design and its Application to Robotic Manipulators	3504
	J.H. Kaloust	Univ. of Central Florida
	Zhihua Qu	Univ. of Central Florida
5:20 - 5:40	A High Gain PI Controller for a Class of Nonlinear Systems	3506
	S.X. Xing	Univ. of Toronto
	E. J. Davidson	Univ. of Toronto
5:40 - 6:00	A Local Small Gain Theorem and its Use for Robust Stability of Uncertain Feedback Volterra Systems	3511
	Qingsheng Zheng	Univ. of Maryland
	Evanghelos Zafriou	Univ. of Maryland

FP14 — Gibson
Process Control Applications

	Chair Masoud Soroush	Drexel Univ.
	Cochair Coleman B. Brosilow	Case Western Reserve Univ.
4:00 - 4:20	Nonlinear and Adaptive Multivariable Control of a Distillation Column	3516
	K.B. Stromborg	Abo Akademi Univ.
	K.E. Haggblom	Abo Akademi Univ.
	H.T. Toivonen	Abo Akademi Univ.
	K.V. Waller	Abo Akademi Univ.
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	Brad Lehman	Mississippi State Univ.
4:40 - 5:00	Implementation Techniques for an In-Line pH Controller ..	3523
	Siva Natarajan	Texas Tech Univ.
	R. Russell Rhinehart	Texas Tech Univ.
5:00 - 5:20	Nonlinear Control of Optical Fiber Diameter Variations ..	3528
	Arun Mulpur	Univ. of Massachusetts, Lowell
	Charles Thompson	Univ. of Massachusetts, Lowell

5:20 - 5:40
**Experimental Demonstration of Nonlinear Model Based Control
of a Heat Exchanger** 3533
Venkateswara Paruchuri *Texas Tech Univ.*
R. Russell Rhinehart *Texas Tech Univ.*

5:40 - 6:00
**Application of Vibrational Control to Chemical Reactions in a
CSTR with Delayed Recycle Stream** 3538
Brad Lehman *Mississippi State Univ.*
Irwan Widjaya *Mississippi State Univ.*
Khalil Shujaee *Mississippi State Univ.*

**FP15 — St. George
Linear Systems - IV**

Chair Paul Van Dooren *Univ. of Illinois*
Cochair Mahmoud S. Sawan *Wichita State Univ.*

4:00 - 4:20
Computing the Exponential of Matrices 3543
Hon-Wing Cheng *Univ. of Illinois, Chicago*
Stephen S.T. Yau *Univ. of Illinois, Chicago*

4:20 - 4:40
Structural Invariants of Generalized State Space Systems
..... 3548
Pradeep Misra *Wright State Univ.*
Paul Van Dooren *Univ. of Illinois*
Andras Varga *DLR-oberpfaffenhofen*

4:40 - 5:00
Design of High-Gain Compensators in Multivariable Systems
..... 3553
Hongyi Zhang *Univ. of Toronto*
E. J. Davidson *Univ. of Toronto*

5:00 - 5:20
**Optimization of Continuous System with Closed-Loop Poles
Inside a Rectangular Region** 3559
Abdul-Razzaq S Arar *Wichita State Univ.*
Mahmoud S. Sawan *Wichita State Univ.*
Rafat A. Rob *Wichita State Univ.*

5:20 - 5:40
On State Feedback Controller Design 3561
Omid Ansary *Pennsylvania State Univ., Harrisburg*