Control

and   Its   Applications

Sponsored by SIAM Activity Group on Control and Systems Theory

September 17-19, 1992
Radisson Hotel Metrodome
Minneapolis, Minnesota

CONFERENCE THEMES

Adaptive Control
Applications of Nonsmooth Analysis to Control Theory
Computational and Algorithmic Methods
Discrete-Event Systems
Distributed Parameter Systems
H^∞ Control
Industrial Applications
Nonlinear Systems
Signal Processing
Stochastic Control

Science and Industry Advance with Mathematics

Ѕіᴀᴍ Society for Industrial and Applied Mathematics

Contents

Deadline Dates

Hotel Reservations
August 28, 1992

Advance Conference Registration
September 4, 1992

Funding Agency

This conference is being held with partial support from the National Science Foundation.

Get-Togethers

SIAM Welcoming Reception
Wednesday, September 16, 1992
7:00 PM - 9:00 PM
University Ballroom D
Cash Bar and assorted mini
hors d'oeuvres

Banquet Dinner
Saturday, September 19, 1992
6:30 PM
Hubert Humphrey Room,
Radisson Hotel Metrodome
Featured Speaker: Avner Friedman
Institute for Mathematics
and Its Applications
University of Minnesota, Minneapolis

SIAM sometimes uses outside mailing lists in an effort to reach as many interested individuals as possible. If you receive more than one copy of this brochure as a result, please pass any extras along to your friends or colleagues. Thank you.

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Upcoming SIAM Events

---- **1992** ----

June 8-11, 1992
Sixth SIAM Conference on Discrete Mathematics
University of British Columbia, Vancouver, Canada

July 19, 1992
Tutorial on Multigrid Methods and Applications
Tutorial on Numerical Optimization and Software
Century Plaza Hotel and Towers, Los Angeles, CA

July 20-24, 1992
SIAM 40th Anniversary Meeting
Century Plaza Hotel and Towers, Los Angeles, CA

September 21-23 1992
SIAM Workshop on Evolution of Phase Boundaries and Microstructure
Xerox Training Center, Leesburg, VA

October 15-19, 1992
SIAM Conference on Applications of Dynamical Systems
Snowbird Resort and Conference Center
Snowbird, UT

---- **1993** ----

January 25-27, 1993
Fourth ACM-SIAM Symposium on Discrete Algorithms (SODA)
Radisson Plaza Hotel, Austin, TX

March 21-24, 1993
Sixth SIAM Conference on Parallel Processing for Scientific Computing
Marriott Hotel, Norfolk, VA

April 19-21, 1993
SIAM Conference on Mathematical and Computational Issues in the Geosciences
Hyatt Regency Hotel, Houston, TX

June 7-10, 1993
SIAM Conference on Mathematical and Numerical Aspects of Wave Propagation Phenomena
University of Delaware, Newark, DE

July 12-16, 1993
SIAM Annual Meeting
Wyndham Franklin Plaza Hotel, Philadelphia, PA

August 4-6, 1993
SIAM Conference on Simulation and Computational Probability
Cathedral Hill Hotel, San Francisco, CA

August 16-19, 1993
Third SIAM Conference on Linear Algebra in Signals, Systems and Control
University of Washington, Seattle, WA

October 25-29, 1993
Third SIAM Conference on Geometric Design
Seattle, WA (tentative)

For more information, contact SIAM.
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Following are subject classifications for the sessions. The codes in parentheses designate session type and number. The session types are Invited Plenary (IP), Invited Concurrent (IC), Contributed Presentations (CP) and Minisymposium (MS).

Adaptive Control

Adaptive Linear Control (MS10, page 8)

Noninvertibility and the Dynamics of Adaptively Controlled Systems (IC4, page 10)

Nonlinear Problems in Adaptive Linear Control Theory (IC2, page 10)

Recent Advances in Adaptive Control and Estimation (MS5, page 7)

Stochastic and Deterministic Adaptive Control of Distributed Parameter Systems (MS29, page 17)

Applications of Nonsmooth Analysis to Control Theory

Applications of Nonsmooth Analysis to Control Theory (IP3, page 7)

Applications of Nonsmooth Analysis to Optimal Control Theory—Parts 1 and 2 (MS25 and 30, pages 16 and 17)

Computational and Algorithmic Methods

Computational Control of Distributed Parameter Systems (MS24, page 16)

Iterative Nonlinear Programming Algorithms for Optimal Control Problems (IC6, page 11)

Numerical and Experimental Methods for Distributed Parameter Control Systems (MS18, page 12)

Numerical Linear Algebra and Control (MS33, page 18)

Numerical Methods (CP13, page 13)

Numerical Methods in Optimal Control (MS21, pages 12-13)

Computational Complexity

Computational Complexity and Control Problems (IC7, page 15)

Discrete Event Systems

Control of Discrete Event Systems (CP17, page 16)

Supervisory Control of Discrete and Continuous Systems (IC8, page 15)

Supervisory Control of Discrete-Event Dynamical Systems (MS31, page 17)

Distributed Parameter Systems

Control of Multibody Flexible Systems (MS2, page 6)

Control Theory for Partial Differential Equations (MS7, page 7)

Distributed Parameter Modeling and Controllability of Multiple-Link Flexible Structures (IP2, page 6)

Distributed Parameter Systems I, II, and III (CP6, CP16, CP20, pages 9, 14, 18)

Parameter Identification in Distributed Systems (MS13, page 10)

Dynamical Systems and Control

Control, Chaos, and Dynamical Systems Parts 1 and 2 (MS12, MS17, pages 10, 12)

System Theoretic Models for the Analysis of Physical Systems (MS22, page 15)

H^∞/ Robust Control

Control System Design Using H^∞ Methods (IC1, page 10)

H^∞/Robust Control (CP3, page 8)

Interpolation and Robust Control in Time-Varying Systems (MS20, page 12)

LFTs, LMIs, and Mμ: Real Parameters and Uncertain Nonlinearities (MS15, page11)

Robust Control (CP14, page 13-14)

Industrial Applications

Applications (CP8, page 9)

Control Systems on the Automobile: More Value for the Motorist (IP4, page 17)

Fault Detection and Diagnosis (for Automobiles) (MS26, page 16)

Modeling and Control of Flexible Robots (MS23, page 15)

Nonlinear Control of Visual Feedback Systems (IC3, page 10)

Nonlinear Process Control (MS27, page 16)

Process Control (CP19, page 18)

Theory and Practice of Process Control (IC9, page 15)

Linear Systems

Linear Systems I and II (CP9, CP11, pages 11, 13)

Neural Nets and Control

Dynamics and Stability of Neural Networks (MS9, page 8)

Neural Nets and Control (MS4, page 6-7; CP12, page 13)

Nonlinear Systems

Computational Nonlinear Control (MS11, page 10)

Feedback Stabilization of Nonlinear Systems (MS28, page 17)

Geometric Methods in Nonlinear Control Theory (MS6, page 7)

Nonholonomic Control Systems (MS16, page 12)

Nonlinear Systems I and II (CP5, CP10, page 9, 11)

Stabilization and Stability of Nonlinear Systems (CP18, page 16)

Optimal Control Theory

Geometric Techniques in Optimal Control (MS1, page 6)

New Tools for Old Problems: The Use of Geometric Methods in Optimal Control Theory (IP1, page 6)

Optimal Control (CP2, page 8)

Signal Processing

Advances in Signal Processing (MS32, page 17-18)

Estimation, Filtering, and Control (CP15, page 14)

Image and Signal Analysis as Dynamic Estimation Problem (IC10, page 15)

Tracking and Related Topics (CP1, page 7)

Stochastic Control and Related Topics

Convergence Analysis for Stochastic Systems (MS14, page 11)

HJB Equations and Viscosity Solutions: Theory and Applications (MS19, page 12)

New Directions in Markov Decision Processes (MS8, page 8)

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Program-At-A-Glance

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7:00 PM-9:00 PM	**Registration opens** *University Ballroom Foyer*

7:30	**Registration opens** *University Ballroom Foyer*
7:45 *University Ballroom*	**Opening Remarks** Kevin A. Grasse and Andre Z. Manitius
8:00 IP1 *University Ballroom*	**INVITED SPEAKER** **New Tools for Old Problems: The Use of Geometric Methods in Optimal Control Theory** Hector Sussmann
9:00 IP2 *University Ballroom*	**INVITED SPEAKER** **Distributed Parameter Modelling and Controllability of Multiple-Link Flexible Structures** John E. Lagnese
10:00	**Coffee / Hubert Humphrey Room**
10:45-12:45 MS1 *Ballroom A*	**CONCURRENT SESSIONS** **Geometric Techniques in Optimal Control** Organizer: Gerardo A. Lafferriere
MS2 *Ballroom B*	**Control of Multi-Body Flexible Systems** Organizer: Günter Leugering
MS3 *Ballroom C*	**Piecewise Deterministic Markov Processes** Organizer: Mark H.A. Davis
MS4 *Ballroom D*	**Neural Nets and Control** Organizers: Eduardo D. Sontag and David L. Elliott
MS5 *Nolte Room*	**Recent Advances in Adaptive Control and Estimation** Organizer: George Yin
CP1 *Faculty Room*	**Tracking and Related Topics**

12:45	**Lunch**
1:45 IP3 *University Ballroom*	**INVITED SPEAKER** **Applications of Nonsmooth Analysis to Control Theory** Richard B. Vinter
2:45	**Coffee / Hubert Humphrey Room**
3:30-6:00 MS6 *Ballroom A*	**CONCURRENT SESSIONS** **Geometric Methods in Nonlinear Control Theory** Organizers: Henk Nijmeijer and Henri J.C. Huijberts
MS7 *Ballroom B*	**Control Theory for Partial Differential Equations** Organizers: Roberto Triggiani and Andre Z. Manitius
MS8 *Ballroom C*	**New Directions in Markov Decision Processes** Organizers: Eugene A. Feinberg and Adam Shwartz
MS9 *Ballroom D*	**Dynamics and Stability of Neural Networks** Organizer: Anthony N. Michel
MS10 *Nolte Room*	**Adaptive Linear Control** Organizer: B. Erik Ydstie
CP2 *Regents Room*	**Optimal Control**
CP3 *Faculty Room*	**H^∞/Robust Control**
CP4 *Medical Room*	**Stochastic Control**

6:00	**Dinner Break**
7:30-10:10	**CONCURRENT SESSIONS**
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CP6 *Faculty Room*	**Distributed Parameter Systems I**
CP7 *Regents Room*	**Nondeterministic Processes**
CP8 *Presidents Room*	**Applications**

7:30	**Registration opens** *University Ballroom Foyer*
8:00-8:50 **IC1** *Ballrooms A & B* **IC2** *Ballrooms C & D*	**CONCURRENT INVITED SPEAKERS** **Control System Design Using** H_∞ **Methods** *Keith Glover* **Nonlinear Problems in Adaptive Linear Control Theory** *Laurent Praly*
8:55-9:45 **IC3** *Ballrooms A & B* **IC4** *Ballrooms C & D*	**CONCURRENT INVITED SPEAKERS** **Nonlinear Control of Visual Feedback Systems** *Hidenori Kimura* **Noninvertibility and the Dynamics of Adaptively Controlled Systems** *Yannis G. Kevrekidis*
9:45	**Coffee** / *Hubert Humphrey Room*
10:30-12:30 **MS11** *Ballroom A* **MS12** *Ballroom B* **MS13** *Ballroom C* **MS14** *Ballroom D* **MS15** *Nolte Room* **CP9** *Faculty Room* **CP10** *Regents Room*	**CONCURRENT SESSIONS** **Computational Nonlinear Control** *Organizer: Arthur J.Krener* **Control, Chaos, and Dynamical Systems (Part 1 of 2)** *Organizer: Mahesh G. Nerurkar* **Parameter Identification in Distributed Systems** *Organizer: Luther W. White* **Convergence Analysis for Stochastic Systems** *Organizer: Halil M. Soner* **LFTs, LMIs, and** μ**: Real Parameters and Uncertain Nonlinearities** *John C. Doyle* **Linear Systems I** **Nonlinear Systems II**

12:30	**Lunch**
1:55-2:45 **IC5** *Ballrooms A & B* **IC6** *Ballrooms C & D*	**CONCURRENT INVITED SPEAKERS** **Stochastic Control with Applications to Modeling of Financial Markets** *Steven E. Shreve* **Iterative Nonlinear Programming Algorithms for Optimal Control Problems** *Joseph C. Dunn*
2:45	**Coffee** / *Hubert Humphrey Room*
3:30-6:00 **MS16** *Ballroom A* **MS17** *Ballroom B* **MS18** *Ballroom C* **MS19** *Ballroom D* **MS20** *Nolte Room* **MS21** *Faculty Room* **CP11** *Regents Room* **CP12** *Medical Room*	**CONCURRENT SESSIONS** **Nonholonomic Control Systems** *Organizers: Anthony M. Bloch and Peter E. Crouch* **Control, Chaos, and Dynamical Systems (Part 2 of 2)** *Organizer: Mahesh G. Nerurkar* **Numerical and Experimental Methods for Distributed Parameter Control Systems** *Goong Chen* **HJB Equations and Viscosity Solutions: Theory and Applications** *Organizer: Panagiotis E. Souganidis* **Interpolation and Robust Control in Time Varying Systems** *Organizer: Gilead Tadmor* **Numerical Methods in Optimal Control** *Organizer: William W. Hager* **Linear Systems II** **Neural Nets and Control** **Poster Session** / *UniversityBallroom Foyer*

6:00	**Dinner Break**
7:30-10:10 **CP13** *Nolte Room* **CP14** *Faculty Room* **CP15** *Regents Room* **CP16** *Presidents Room*	**CONCURRENT SESSIONS** **Numerical Methods** **Robust Control** **Estimation, Filtering, and Control** **Distributed Parameter Systems II**

7:30	**Registration opens** *University Ballroom Foyer*
8:00-8:50 **IC7** *Ballrooms A & B* **IC8** *Ballrooms C & D*	**CONCURRENT INVITED SPEAKERS** **Computational Complexity and Control Problems** *John N. Tsitsiklis* **Supervisory Control of Discrete and Continuous Systems** *Peter J. Ramadge*
8:55-9:45 **IC9** *Ballrooms A & B* **IC10** *Ballrooms C & D*	**CONCURRENT INVITED SPEAKERS** **Theory and Practice of Process Control** *Manfred Morari* **Image and Signal Analysis as Dynamic Estimation Problems** *Alan S. Willsky*
9:45	**Coffee** / *Faculty/Foyer*
10:30-12:30 **MS22** *Ballroom A* **MS23** *Ballroom B* **MS24** *Ballroom C* **MS25** *Ballroom D* **MS26** *Nolte Room* **MS27** *Regents Room* **CP17** *Presidents Room* **CP18** *Medical Room*	**CONCURRENT SESSIONS** **System Theoretic Models for the Analysis of Physical Systems** *Organizer: Jan C. Willems* **Modeling and Control of Flexible Robots** *Organizer: John T. Wen* **Computational Control of Distributed Parameter Systems** *Organizers: Kenneth L. Bowers and John R. Lund* **Applications of Nonsmooth Analysis to Optimal Control Theory (Part 1 of 2)** *Organizer: Peter R. Wolenski* **Fault Detection and Diagnosis (for Automobiles)** *Organizer: Janos J. Gertler* **Nonlinear Process Control** *Organizers: Costas Kravaris and Prodromos Daoutidis* **Control of Discrete-Event Systems** **Stabilization and Stability of Nonlinear Systems**

12:30	**Lunch**
1:30 **IP4** *University Ballroom*	**INVITED SPEAKER** **Control Systems on the Automobile: More Value for the Motorist** *Donald J. Dobner*
2:30	**Coffee** / *Faculty/Foyer*
3:15-6:15 **MS28** *Ballroom A* **MS29** *Ballroom B* **MS30** *Ballroom C* **MS31** *Ballroom D* **MS32** *Nolte Room* **MS33** *Regents Room* **CP19** *Presidents Room* **CP20** *Medical Room*	**CONCURRENT SESSIONS** **Feedback Stabilization of Nonlinear Systems** *Organizer: Andrea Bacciotti* **Stochastic and Deterministic Adaptive Control of Distributed Parameter Systems** *Organizer: Bozenna J. Pasik-Duncan* **Applications of Nonsmooth Analysis to Optimal Control Theory (Part 2 of 2)** *Organizer: Peter R. Wolenski* **Supervisory Control of Discrete-Event Dynamical Systems** *Organizers: Vijay K. Garg and Steven I. Marcus* **Advances in Signal Processing** *Organizer: A.H. Tewfik* **Numerical Linear Algebra and Control** *Organizer: Ralph Byers* **Process Control** **Distributed Parameter Systems III**

6:30	**Banquet** *Hubert Humphrey Room*

7:30/University Ballroom Foyer
Registration opens

7:45/University Ballroom
Opening Remarks

Kevin A. Grasse, University of Oklahoma, Norman and Andre Z. Manitius, George Mason University

8:00/University Ballroom
IP1/Chair: Kevin A. Grasse, University of Oklahoma, Norman

New Tools for Old Problems: The Use of Geometric Methods in Optimal Control Theory

In the last ten years, thanks to the systematic use of geometric methods, the power of the classical techniques of control theory has been significantly enhanced. An important example is the development of new theories that make it possible to get much more detailed information about optimal trajectories and optimal synthesis for large classes of nonlinear problems than could be obtained using the Pontryagin Maximum Principle and other classical necessary conditions for optimality.

The speaker will illustrate the power of these new methods by reviewing some well known examples, such as Chow's theorem, and comparing its power with that of the classical tools. He will present more recent examples, such as the theory of envelopes and piecewise regularity theorems with choice, and apply them to problems such as the "Reeds-Shepp car" and the structure of synthesis for some sub-Riemannian problems.

Hector Sussmann
Department of Mathematics
Rutgers University

9:00/University Ballroom
IP2/Chair: Kevin A. Grasse, University of Oklahoma, Norman

Distributed Parameter Modelling and Controllability of Multiple-Link Flexible Structures

The speaker will discuss aspects of a theory of controllability and stabilization of the transient motion of flexible structures based on distributed parameter models. The sort of structures of interest are multiple-link constructs that are composed of flexible beams, plates, shells or combinations of such elastic elements, and are representative of trusses, frames, robot arms, solar panels, deformable mirrors and other compound elastodynamic structures. The speaker will address several issues, including appropriate distributed parameter modelling of individual components and of their interactions with other components and the locations and types of sensors and actuators to be used.

John E. Lagnese
Department of Mathematics
Georgetown University

10:00/Hubert Humphrey Room
Coffee

10:45 AM-12:45 PM
Concurrent Sessions

MS1/Ballroom A
Geometric Techniques in Optimal Control

The systematic use of techniques from differential geometry, such as Lie brackets, Lie algebras, liftings, and integral manifolds, has resulted in new insights for optimal control and a variety of applications. Researchers have gone beyond the Pontryagin Maximum Principle using these techniques to determine the optimality of singular extremals.

The speakers will present recent results on the use of techniques from differential geometry in optimal control theory. They will discuss the use of connections in nonlinear control, new results in feedback equivalence, the regularity of nonoptimal controls, and a new application of these techniques to the study of optimal controls for chemical batch reactors.

Organizer: Gerardo A. Lafferriere
Portland State University

10:45 **Connections to Control**
Henry Hermes, University of Colorado, Boulder

11:15 **Geometric Time Optimal Control with Target of Codimension One, Application to Batch Reactors**
B. Bonnard, Université de Bourgogne, France and Jerome de Morant, Shell Recherche s.a., Grand-Couronne, France

11:45 **Regularity Properties of Controls that Steer to the Interior of the Attainable Set**
Kevin A. Grasse, University of Oklahoma, Norman

12:15 **Some Problems in Feedback Equivalence**
Ivan Kupka, University of Toronto, Canada

MS2/Ballroom B
Control of Multi-Body Flexible Systems

The focus of this minsymposium is distributed parameter modelling of multi-body flexible systems and their boundary controllability and stability properties, identifiability of system parameters by boundary observation, and related industrial applications. The speakers will provide an overview of a broad spectrum of different mathematical methods for the modelling and the control problems. They will discuss a geometrically exact theory and its numerical implementation for rods in contact with their environment, a moment theory for vector-valued non-harmonic Fourier series, and energy estimates obtained by the method of characteristics in the 1-dimensional case and by multiplier techniques in the n-dimensional case.

Organizer: Günter Leugering
Georgetown University

10:45 **Modelling and Control of Vibrating Networks of Strings or Beams and Masses**
E.J.P. Georg Schmidt, McGill University, Canada

11:15 **Control and Inverse Problems for Multichannel Hyperbolic Systems**
Sergey A. Avdonin, St. Petersburg State University, Russia, Michael I. Belishev, Mathematical Institute, Russia and Sergey A. Ivanov, St. Petersburg State University, Russia

11:45 **Exact Controllability for Some Models of Multidimensional Vibrating Structures**
Jean Pierre Puel, Universite d'Orleans et Centre de Mathematiques Appliquees, France and Enrique Zuazua Iriondo, Universidad Complutense, Spain

12:15 **Impact and Force Control for a Flexible Arm**
P.S. Krishnaprasad and Ioanis Salmatjidis, University of Maryland, College Park

MS3/Ballroom C
Piecewise Deterministic Markov Processes

Piecewise-deterministic processes (PDPs) are a class of Markov models suitable for problems in which the basic source of randomness is a sequence of point events. There is a huge variety of applications in queueing networks, resource allocation, production planning and scheduling, insurance and risk analysis and many other areas. Optimization theory for PDPs has developed rapidly in the last few years and is now reaching the stage of useful applicability.

The speakers will discuss important new topics: computational methods for impulse control and production systems and unified theories of continuous and impulse control.

Organizer: Mark H.A. Davis
Imperial College, England

10:45 **Approximations for Impulse Control of Piecewise Deterministic Processes**
Oswaldo Luiz do Valle Costa, Universidade de Sao Paulo, Brazil

11:15 **Turnpike Improvement Techniques in PDCS and PDDG**
Alain Haurie, M. Roche, and Ch. van Delft, University of Geneva, Switzerland

11:45 **Impulse Control of Piecewise Deterministic Markov Processes**
Jane Juan-Juan Ye, Université de Montréal, Canada

12:15 **Controlled Piecewise Deterministic Processes with Time Splitting**
Alex A. Yushkevich, University of North Carolina, Charlotte

MS4/Ballroom D
Neural Nets and Control

Artificial neural nets (ANNs) as control system components have progressed considerably since the ADALINE's and Perceptrons of the 1960s, and the design of adaptive control systems using ANN technology has become a challenging mathematical problem. The usual adaptive control algorithms do well with a few unknown parameters and linear plants, but the large memory capability of ANNs make them interesting in larger and nonlinear systems such as manufacturing and vehicle systems. The speakers in this minisymposium will consider problems of stabilization, including stabilizing reconfigurable control systems, learning feedback laws, and new treatments of adaptive control from the ANN standpoint.

Organizers: Eduardo D. Sontag
Rutgers University and
David L. Elliott
Washington University

10:45 **Neural Networks Learning Rules for Control: Uniform Dynamic Backpropagation, and the Heavy Adaptive Learning Rule**

Nicholas Seube, Thomson Sintra ASM, France, and *Jean-Pierre Aubin*, Université de Paris-Dauphine, France

11:15 Stabilization of Nonlinear Systems Using 2-Hidden Layer Nets
Eduardo D. Sontag, Organizer

11:45 Differentiable Local Models for Reconfigurable Control
Donald A. Sofge, NeuroDyne, Inc., Boston, MA

12:15 Gaussian Networks for Direct Adaptive Control: Theory and Applications
Robert M. Sanner and *Jean-Jacques E. Slotine*, Massachussetts Institute of Technology

MS5/Nolte Room
Recent Advances in Adaptive Control and Estimation

In various applications arising in science and engineering, the systems under consideration are often subject to random disturbances and have unknown parameters. In order to control these systems, one utilizes adaptive techniques, updating the parameter estimates, controlling the systems with the unknown parameters replaced by their estimates, and carrying out this procedure recursively. A great deal of attention has been devoted to this subject and many significant contributions have been made. It is conceivable that adaptive control and estimation will increasingly continue to play an important role in the development of stochastic systems theory and applications.

In this minisymposium, the speakers will address some of the most recent developments in the field of adaptive control, including change point detection and adaptive control of time-varying systems, stochastic flows and second order minimum principles, and many related problems in identification and optimization.

Organizer: George Yin
Wayne State University

10:45 Stochastic Flows and Second Order Minimum Principles
Robert J. Elliott and Michael Kohlmann, University of Alberta, Canada

11:15 Change-Point Detection and Adaptive Control of Time-Varying Stochastic Systems
Tze Leung Lai, Stanford University

11:45 Continuous-Time Stochastic Adaptive Control
Bozenna Pasik-Duncan, University of Kansas, Lawrence

12:15 Optimal Policies for Stochastic Production Problems whose Demand Processes Involve a Hidden Markov Model
Raymond W. Rishel, University of Kentucky, Lexington

CP1/Faculty Room
Tracking and Related Topics
Chair: Stephen L. Campbell, North Carolina State University

10:45 Data Fusion: Applications to Target Tracking
Kwang H. Kim, The MITRE Corp., Bedford, MA and J. Hansen, Northeastern University

11:05 Optimal Model Reference Controller
Yuzo Yamane, Yuichi Nakajyo and P.N. Nikiforuk, Ashikaga Institute of Technology, Japan and University of Saskatchewan, Canada

11:25 Stable Algorithms for Parameter Tracking
Anatoli Juditsky, IRISA, France and Pierre Priouret, Universite Paris VI, France

11:45 Approximation Methods for Feedback Control of Noise Fields
H.Thomas Banks, North Carolina State University and *Fariba Fakhroo*, University of Southern California

12:05 Kalman Filtering for Broad Band 3D Active Noise Control
Richard H. Burkhart, Boeing Computer Services and Anders Andersson, Boeing Commercial Airplane Company

12:45-1:45
Lunch

1:45/University Ballroom
IP3/Chair: Leonard D. Berkovitz, Purdue University, West Lafayette
Applications of Nonsmooth Analysis to Control Theory

Nonsmooth analysis arises from the systematic study of "differential" properties of functions that are not differential in the usual sense. Nonsmooth analysis has been applied in many fields, but nowhere with greater success than in optimal control. The new methods have a direct bearing on control problems that are formulated directly in terms of nonsmooth functions. But, more significantly, they provide fresh insights into all principal areas of inquiry in optimal control (existence theory, regularity of minimizers, necessary conditions and dynamic programming), relating to both smooth and nonsmooth problems.

The speaker will show how many fundamental questions hinge on the differential properties of some derived function - the Hamiltonian, an exact penalty function, or a value function. The derived function is often not differentiable, even for a smooth problem! He will discuss specific control problems, some old and some new, to whose solution nonsmooth analysis has made a notable contribution.

Richard B. Vinter
Department of Electrical Engineering
Imperial College, London, England

2:45/Hubert Humphrey Room
Coffee

3:30-6:00
Concurrent Sessions

MS6/Ballroom A
Geometric Methods in Nonlinear Control Theory

This minisymposium will focus on the use of (differential) geometric methods in nonlinear system and control theory and applications of these methods to nonholonomic systems, feedback stabilization of symmetric homogenous systems, the integration of rigid body motion, and the dynamic disturbance decoupling problem for nonlinear systems. The speakers will emphasize differential geometry as a suitable frame for addressing seemingly very different problems.

Organizers: Henk Nijmeijer
University of Twente, The Netherlands and
Henri J.C. Huijberts
Eindhoven University of Technology, The Netherlands

3:30 Symmetries, Homogeneity and Asymptotic Stabilization
W.P. Dayawansa, University of Maryland, College Park, Clyde Martin, Texas Tech University, Lubbock, and Sandy Samelson, University of Minnesota, Minneapolis

4:00 Integration of Controlled Rigid Body Equations
Peter E. Crouch, Y. Yan and R. Grossman, Arizona State University

4:30 Geometric Phase Computations Arising in Control Problems for Nonholonomic Caplygin Systems
Mahmut Reyhanoglu and Harris McClamroch, University of Michigan, Ann Arbor

5:00 Nonlinear Disturbance Decoupling and Linearization: A Partial Justification of Integral Feedback
H.J.C. Huijberts and H. Nijmeijer, Organizers, and A.C. Ruiz, University of Twente, The Netherlands

MS7/Ballroom B
Control Theory for Partial Differential Equations

The focus of this minisymposium is boundary control theory for partial differential equations. There has been intense research activity in this field over the past several years due in part to the potential of applications to physical and engineering sciences, particularly in the area of flexible structures.

The speakers will discuss a variety of related topics, including the notion of viscosity solutions of infinite dimensional Hamilton-Jacobi equations, the principle that "local smoothing + reversibility + uniqueness" implies exact controllability, the computational questions arising in the boundary control and observation of a flexible beam, and the use of psuedo-differential and microlocal analysis techniques to obtain sharp trace estimates.

Organizers: Roberto Triggiani
University of Virginia, Charlottesville and
Andre Z. Manitius
George Mason University

3:30 The Dynamic Programming Equation for Semilinear Boundary Control Problems of Parabolic Type
Piermarco Cannarsa, University of Rome, Italy

4:00 New Results in Boundary Control via "Smoothing"
Walter Littman, University of Minnesota, Minneapolis

4:30 Computational Issues in the Control and Observation of Euler Bernoulli Beam
Andre Z. Manitius, Organizer

5:00 Sharp Trace Estimates for PDE and Exact Controllability without Geometrical Conditions
Roberto Triggiani, Organizer

5:30 Existence and Characterization of Optimal Controls for Some Free Boundary Problems
Thomas I. Seidman, University of Maryland, Baltimore County

MS8/Ballroom C
New Directions in Markov Decision Processes

Markov Decision Processes (MDPs) are a key model for controlled systems under uncertainty. They have a variety of applications, including applications to communication networks, computer systems, production, finance, and management. The speakers in this minisymposium will discuss recent and future developments in MDPs, including new theoretical methods, new procedures for computing optimal strategies, new models which are more suitable for applications, such as, option pricing and weighted discounted criteria for production, budget, and project management.

Organizers: Eugene A. Feinberg
State University of New York,
Stony Brook, and
Adam Shwartz,
Technion - Israel Institute of
Technology, Israel

3:30 **Policy Iteration and Modified Policy Iteration for Markov Decision Processes with Expected Total Reward Criteria**
Martin L. Puterman, University of British Columbia, Canada

4:00 **On Cost Criteria for Option Pricing**
Manfred Schal, University of Bonn, Germany

4:30 **Markov Strategies in Markov Decision Processes**
Isaác Sonin, University of North Carolina, Charlotte

5:00 **Markov Decision Processes with Weighted Discounted Rewards**
Eugene A. Feinberg and Adam Shwartz, Organizers

MS9/Ballroom D
Dynamics and Stability of Neural Networks

Artificial neural networks may be divided into two broad classes: feedforward neural networks and feedback neural networks. The latter constitute special classes of dynamical systems.

This minisymposium is concerned with artificial feedback neural networks. In such networks, attractors are used to store information, to classify information, to perform tasks optimally, and the like. Applications for these networks include pattern recognition, A/D conversion and optimal routing them.

The speakers will discuss systematic treatments of artificial feedback neural networks including qualitative analysis and synthesis.

Organizer: Anthony N. Michel
University of Notre Dame

3:30 **Dynamical Neural Networks and the Circle Criterion**
Irwin W. Sandberg, University of Texas, Austin

4:00 **The Synthesis of Arbitrary Stable Dynamics in Artificial Neural Networks**
Michael A. Cohen, Boston University

4:30 **Dynamics of High Order Neural Networks**
Clark Jeffries, Clemson University

5:00 **Analysis and Synthesis of Artificial Neural Networks for Associative Memories**
Anthony N. Michel, Organizer

5:30 **Identifiability of Neural Nets**
Francesca Albertini, Rutgers University

MS10/Nolte Room
Adaptive Linear Control

In this minisymposium, the speakers will address the problem of adaptively stabilizing a linear system and in particular on aspects that concern the robustness of algorithms with respect to terms that are not possible or practical to model using finite dimensional representations which are linear in the parameters. The speakers will discuss stochastic problems and the use of Kalman/Recursive Least Squares algorithms, robustness issues from an identification viewpoint, and a self-stabilization property of closed loop adaptive systems. All of the speakers will address fundamental issues for practical applications. Currently, stability problems are addressed in an ad hoc fashion and, while successful applications of adaptive control have been reported, the underlying theory for these algorithms is poorly understood.

Organizer: B. Erik Ydstie
University of Massachusetts, Amherst

3:30 **Model Reference Adaptive Control of Time Varying and Stochastic Systems**
Sean P. Meyn and Lyndon J. Brown, University of Illinois, Urbana

4:00 **Robustness of the Astrom-Wittenmark Self-tuning Controller**
Miloje Radenkovic, University of Colorado, Denver

4:30 **Limitation of Robust Adaptive Pole Placement Control**
Jan Willem Polderman, University of Twente, The Netherlands, Iven M.Y. Mareels, Australian National University, Australia, and Erik Weyer, Norwegian Institute of Technology, Norway

5:00 **Self-Excitation in Adaptive Control Systems**
B. Erik Ydstie, Organizer

CP2/Regents Room
Optimal Control

Chair: Leonard D. Berkovitz, Purdue University, West Lafayette

3:30 **The Time-Optimal Problem for a Force-Free System of Two Symmetric Rigid Bodies in Three Space**
Michael J. Enos, Fields Institute for Research in Mathematical Sciences, Canada

3:50 **Nonlinear Constrained Optimal Control Problem A New Approach to Necessary and Sufficient Conditions**
Gianna Stefani, and *PierLuigi Zezza*, University of Naples, Italy

4:10 **Second Order Optimality Conditions for Abnormal Extremals**
Andrej A. Agrachev, Steklov Mathematical Institute, Russia

4:30 **Optimality Conditions for a Controlled Nonlinear Two Point Boundary Value Problem**
M. Goebel, Martin Luther Universitaet, Germany

4:50 **Necessary and Sufficient Suboptimality Conditions for a Class of Singularly Perturbed Optimal Control (SPOC) Problems**
Vladimir Gaitsgory, Bar-Ilan University, Israel

5:10 **Towards the Optimal Control of Dynamic Manufacturing Systems**
Joao Tasso Borges de Sousa and *Fernando Lobo Pereira*, Porto University, Portugal

CP3/Faculty Room
H ~/ Robust Control

Chair: Gilead Tadmor, Northeastern University

3:30 **Robustness of Repetitive Controllers: An H^∞ Perspective**
Hitay Ozbay, Ohio State University

3:50 **Rational Approximation of the Transfer Functions for a Viscoelastic Rod**
Kenneth B. Hannsgen and Robert L. Wheeler, Virginia Polytechnic Institute and State University and Olof J. Staffans, Helsinki University of Technology, Finland

4:10 **Rational Suboptimal Compensators for Vibration Damping in a Viscoelastic Rod**
Kenneth B. Hannsgen and *Robert L. Wheeler*, Virginia Polytechnic Institute and State University and Olof J. Staffans, Helsinki University of Technology, Finland

4:30 **The State-Feedback H_∞-Problem at Optimality**
Carsten Scherer, Mathematisches Institut Am Hubland, Germany

4:50 **Robust Receding Horizon Control**
John C. Allwright, Imperial College of Science, Technology and Medicine, United Kingdom

5:10 **H_∞ Optimal Control Theory Over a Finite Horizon**
M. Bala Subrahmanyam, Naval Air Warfare Center, Warminster, PA

5:30 **On Some Existence Conditions for QFT Controllers**
Ronald A. Perez, University of Wisconsin, Milwaukee; O. D. I. Nwokah and D.F. Thompson, Purdue University, West Lafayette

5:50 **Nonlinear H^∞ Theory: Definitions and Conditions**
Pin Liu and Zhong-Jun Zhang, Shanghai Jiao Tong University, Shanghai, People's Republic of China

CP4/Medical Room
Stochastic Control

Chair: Steven E. Shreve, Carnegie Mellon University

3:30 **Some Results in the S.D.E. with Discontinuous Paths and Reflecting Boundary Conditions, with Applications**
Jin Ma, University of Minnesota, Minneapolis

3:50 **Optimal Control and Replacement with State-Dependent Failure Rate: An Invariant Measure Approach**
Arthur C. Heinricher and *Richard H. Stockbridge*, University of Kentucky

4:10 **The Stochastic Maximum Principle and Consumption-Investment Problems**
Abel Cadenillas, Columbia University

4:30 **The Parameterization of All Stabilizing Compensators for Stochastic Hybrid Systems**
Engin Yaz, University of Arkansas, Fayetteville, and Ilke Yaz, Centenary College, Shreveport, LA

4:50 **Relationship Between Probabilistic and Deterministic Optimal Control Problems for Systems with Leading Stochastic Disturbance**
Leonid Khilyuk, Phoenix International Inc., Los Angeles, CA

5:10 **A Theory of Stochastic Linear Controlled Systems**
Shuping Chen, Zhejiang University, People's Republic of China; *Xunjing Li*, Fudan University, People's Republic of China; Shige Peng Shandong University, People's Republic of China; Jiongmin Yong, Fudan University, People's Republic of China

5:30 **A New Stochastic Multivariable Adaptive Pole-Placement Control Algorithm with Parameter Reduction**
Tian You Chai, Northeast University of Technology, People's Republic of China and Xiang Hong He, Shenyang Polytechnic University, People's Repbulic of China

THURSDAY EVENING, SEPTEMBER 17

6:00-7:30
Dinner Break

7:30-10:10
Concurrent Sessions

CP5/Nolte Room
Nonlinear Systems I
Chair: W.P. Dayawansa, University of Maryland

7:30 **Normal Forms of Nonlinear Control Systems**
Wei Kang, Washington University

7:50 **New Combinatorial Results for Nonlinear Control Systems**
Matthias Kawski, Arizona State University

8:10 **Variations and Small Time Local Controllability**
Rosa Maria Bianchini, Università di Firenze, Italy

8:30 **Linearization of Implicit Control Systems**
Stephen L. Campbell, North Carolina State University

8:50 **Observability Indices in Terms of First-Order Representations**
Margreet Kuijper, University of Gröningen, The Netherlands

9:10 **Parallel Cascade Nonlinear Control of Nonlinear Systems: Application to an Unstable Bioreactor**
M. Chidambaram, Indian Institute of Technology, India

CP6/Faculty Room
Distributed Parameter Systems I
Chair: Günter Leugering, Georgetown University

7:30 **Study of the Stabilizability of the Suspension System Due to Different Boundary Conditions**
M. Najafi, G.R. Sarhangi and H. Wang, Wichita State University

7:50 **Riccati Equations for Hyperbolic Partial Differential Equations with Persistent Disturbances and Controls Acting on the Boundary**
Christine A. McMillan, University of Virginia

8:10 **Regional Observability of Parabolic Systems**
M. Amouroux, *A. El Jai* and E. Zerrik, University of Perpignan, France

8:30 **Two-Phase Periodic Solutions for a General Thermostat Control Problem**
Walter Allegretto, University of Alberta, Canada and Paolo Nistri, Università di Firenze, Italy

8:50 **Pontryagin's Principle in the Optimal Control of State-Constrained Elliptic PDE**
Frederic Bonnans, INRIA, Rocquencourt, France and *Eduardo Casas*, Universidad de Cantabria, Spain

9:10 **A Minimax Control Problem for Elliptic PDEs**
Jiongmin Yong, Fudan University, Shanghai, People's Republic of China

CP7/Regents Room
Nondeterministic Processes
Chair: Mark H.A. Davis, Imperial College, United Kingdom

7:30 **Infinite Horizon Undiscounted Optimal Control of Finite Stochastic Automata**
Emmanuel Fernandez-Gaucherand, University of Arizona

7:50 **Steering Policies and Stochastic Approximations**
Armand M. Makowski, University of Maryland, College Park and Dye-Jyun Ma, Digital Equipment Corporation, Littleton, MA

8:10 **Asymptotic Analysis of Nonlinear Risk-Sensitive Control**
Matthew R. James, Australian National University, Australia

8:30 **Risk-Sensitive Optimal Control for Maximum Capture Probability**
Pierpaolo Soravia, Università di Padova, Italy and Brown University and *Hang Zhu*, Brown University

8:50 **Commitment as Irreversible Investment**
Joseph G. Haubrich, Federal Reserve Bank of Cleveland and Joseph A. Ritter, Yale University

9:10 **Directional Derivability for Parametrized MinMax Problems with Dependent Constraints**
Jacqueline Morgan, Università Degli Studi di Napoli, Italy

9:30 **The State and Parameter Estimation in Stochastic Financial Systems**
Jingshan Li, Academia Sinica, People's Republic of China and Zhonglian Li, China Institute of Finance, People's Republic of China

CP8/Presidents Room
Applications
Chair: Jonathan R. Bar-on, University of Oklahoma

7:30 **Progress in Active Control of Rotating Stall**
James D. Paduano and Christian Van Schalkwyk, Massachusetts Institute of Technology

7:50 **The Dynamics and Control of Axial-Flow Gas Compressors**
Raymond A. Adomaitis and Eyad Abed, University of Maryland College Park

8:10 **Intelligent Grasping/Regrasping Planning of Robotic Manipulators**
Nimish H. Soni, Amir Shirkhodaie and A.H. Soni, University of Cincinnati

8:30 **An Intelligent Knowledge Based System for 3D Feature Extraction of Objects from 2D Vision System Data**
Sunil Gupta, Amir Shirkhodaie and A.H. Soni, University of Cincinnati

8:50 **Application of Simulated Annealing to Porous Media Flow Inverse Problem**
Ahmed Ouenes, New Mexico Institute of Mining and Technology and Patrick Siarry, École Central de Paris, France

9:10 **Position Control of a Pneumatic Actuator using Sliding Modes**
Miguel Angel Flores-Rangel and *Rafael Castro-Linares*,Centro de Investigacion y de Estudios Avanzados del I.P.N., Mexico

9:30 **Adaptive Observer Design Using Theory of Variable Structure Systems: A Case Study of the Motor Generator Set**
Han-Long Yang, University of Kaiserslautern, Germany

9:50 **Traffic Control and Simulation**
Thomas Riedel and Urban Brunner, Swiss Federal Institute of Technology (ETH) Zurich, Switzerland

Conference Program

7:30/University Ballroom Foyer
Registration opens

8:00-8:50
Concurrent Invited Speakers

IC1/Ballroom A & B
Chair: J. William Helton, University of
California, San Diego

Control System Design Using H_∞ Methods

There are many ways of formulating control
system design problems as optimization exer-
cises of various types. Design methods should
be closely related to physical requirements, in-
teractive, and computationally cheap and reli-
able. The speaker will discuss how particular
H_∞ methods can be made to satisfy these require-
ments and will illustrate the current state of the
theory, solution, and applications. The methods
he will address are related to robust stabilization
of coprime factor models and variations that do
not give induced-norm problems.

Keith Glover
Department of Engineering
University of Cambridge, United Kingdom

IC2/Ballrooms C & D
Chair: Steven I. Marcus, University of
Maryland, College Park

Nonlinear Problems in Adaptive Linear Control Theory

Adaptive linear controllers are designed to tackle
systems whose linear dynamics depend linearly
on some unknown parameters. By considering
these parameters as components of the state
vector, we realize that we are, in fact, facing
nonlinear systems and expect that adaptive lin-
ear controllers will also be nonlinear.

By looking at an elementary case—a pro-
portional adaptive controller—the speaker will
point out the main general results available on
boundedness of all the closed loop solutions and
their properties. He will invoke techniques of
dynamical system theory—invariant manifold,
averaging, bifurcations—input-output l_p-stabil-
ity theory, and ad hoc techniques while sketch-
ing how these results are obtained.

Laurent Praly
Centre Automatique et Systemes
École des Mines de Paris, France

8:55-9:45
Concurrent Invited Speakers

IC3/Ballrooms A & B
Chair: J. William Helton, University of
California, San Diego

Nonlinear Control of Visual Feedback Systems

Visual feedback is essential for autonomous in-
telligent systems that carry out their tasks in an
unstructured environment. A typical problem in
visual feedback control aims to keep a manipu-
lator at a fixed distance and attitude relative to a
moving object, based on the feedback of the error
between the desired and the actual positions and
attitude estimated by the image processing. This
is a feedback system in the sense that it forms a
closed loop, but it has many different features

from conventional feedback systems due to the
high dimensionality of the feedback signal. The
speaker will present a nonlinear dynamic model
that relates the movement of the camera at-
tached to the tip of the manipulator hand and the
optical flow generated by it on the image surface.
He will discuss linearized model and a feedback
control law based on the LQG theory. The con-
trol law is actually implemented on the PUMA
560 and experiments are carried out which illus-
trate the theoretical results.

Hidenori Kimura
Department of Mechanical Engineering
Osaka University, Japan

IC4/Ballrooms C & D
Chair: Steven I. Marcus, University of
Maryland, College Park

Noninvertibility and the Dynamics of Adaptively Controlled Systems

Perturbations that drive discrete-time adaptively
controlled systems away from the set point can
be quantified by computing the boundaries sepa-
rating the basin of attraction of the set point from
those of other, undesirable attractors. The basins
are found to sometimes consist of complicated,
disconnected strucures in phase space. This re-
sults from the nonunique reverse-time dynamics
often exhibited by these systems. The speaker
will discuss the nonlinear dynamics of some
representative discrete-time adaptively con-
trolled systems in the presence of plant/model
mismatch, and focus on situations where the
desired operating point is locally but not glo-
bally stable. He will also discuss the effect of
noninvertibility on forward-time dynamical be-
havior.

Yannis G. Kevrekidis
Department of Chemical Engineering
Princeton University

9:45/Hubert Hemphrey Room
Coffee

10:30 AM-12:30 PM
Concurrent Sessions

MS11/Ballroom A
Computational Nonlinear Control

The theory of nonlinear control has advanced
dramatically over the past two decades, and the
time has come for more practical applications.
Between theory and applications stands compu-
tation and this minisymposium will address these
issues.
Organizer: Arthur J. Krener
University of California, Davis

**10:30 Adaptive Backlash Inverse: Numerical
Implementation for Control
Applications**
Gang Tao and Petar Kokotovic,
University of California, Santa Barbara

**11:00 Parallel Computation of Nonlinear
Feedback Method for Robot Arm Control**
A.K. Ramadori and *T.J. Tarn*,
Washington University

**11:30 Shock Waves for Riccati Partial
Differential Arising in Nonlinear
Optimal Control**
Christopher I. Byrnes, Washington
University

12:00 Nonlinear Systems Toolbox
Arthur J. Krener, Organizer

MS12/Ballroom B
Control, Chaos and Dynamical Systems (Part 1 of 2)

The methodology and techniques of dynamical
systems is playing an increasing role in answer-
ing questions related to controllability and stabi-
lization. The speakers in this minisymposium
will illustrate the elegant use of various dynami-
cal notions (e.g. rotation number, Lyapunov ex-
ponents, ergodicity, topological mixing) in the
study of control theoretic problems such as con-
trollability and feedback stabilization and dis-
cuss the problem of controlling chaotic trajecto-
ries of (nonlinear) dynamical systems by exploit-
ing their very chaotic nature. They will also
describe examples stemming from concrete prac-
tical problems.
Organizer: Mahesh G. Nerurkar
Rutgers University

**10:30 Rotation Number and Feedback
Control**
Russell Johnson, Università de Firenze,
Italy and Mahesh Nerurkar, Organizer

11:00 Invariant Manifolds for Control Flows
Wolfgang Kliemann, Iowa State
University

**11:30 Using Chaos to Direct Trajectories to
Targets**
James A. Yorke, University of
Maryland, College Park

**12:00 Using Time Series for Feedback
Control of Chaotic Systems**
Celso Grebogi, University of Maryland,
College Park

MS13/Ballroom C
Parameter Identification in Distributed Systems

The problems in the estimation of parameters of
distributed systems to be addressed in this
minisymposium arise from various areas of flow
in porous media, heat conduction and elastic
structures. The speakers will discuss the formu-
lation of estimation problems and their numeri-
cal solution by various algorithms. In addition,
some of the speakers will focus on basic model-
ling and validation as well as identification of
system parameters from various types of data.
Organizer: Luther W. White
University of Oklahoma, Norman

**10:30 Parameter Identification Problems for
Elliptic and Parabolic Equations**
Semion Gutman, University of
Oklahoma, Norman

**11:00 Identifiability of Semiconductor
Defects from Laser Beam Induced
Current Images**
Weifu Fang and *Kazufumi Ito*, University
of Southern California

**11:30 Spectral Identification in Narrow Plate
Models**
David L. Russell, Virginia Polytechnic
Institute and State University

**12:00 Identification of Parameters in a
Volterra Equation with Weakly
Singular Kernel**
Dennis Brewer, *Robert Powers*, and
Hyun Lee, University of Arkansas,
Fayetteville

MS14/Ballroom D
Convergence Analysis for Stochastic Systems

The analysis of controlled queueing systems is an important problem in stochastic control. Often these problems have too many variables to lend themselves to numerical analysis. So it is important to simplify these models by using appropriate scalings. One such approach is the so-called Brownian networks as formulated by Harrison. In Brownian networks, the original queueing network is replaced by a diffusion process reflected at the boundary of the positive cone. The coefficients of the diffusion model are formally obtained by using heavy-traffic limit theorems. From a theoretical point of view there are several important problems to analyze. Convergence is still an open problem and the nonsmooth character of the reflection boundary introduces challenging mathematical questions. The speakers will address these questions and discuss the formulation and analysis of the limiting control problem and numerical schemes for stochastic control problems.

Organizer: Halil M. Soner
Carnegie Mellon University

10:30 Convergence of Approximation Schemes for Hamilton-Jacobi-Bellman Equations
Panagiotis E. Souganidis, Brown University

11:00 Lyapunov Functions for Reflecting Brownian Motions
Paul Dupuis, Brown University and Ruth J. Williams, University of California, San Diego

11:30 Convergence for Controlled Martingale Problems
Thomas G. Kurtz, University of Wisconsin, Madison

12:00 Polling Systems in Heavy Traffic
E.G. Coffman, Jr., AT&T Bell Laboratories, A.A. Pukhalskii, Institute for Problems of Information Transmission, Moscow, Russia and *M.I. Reiman*, AT&T Bell Laboratories

MS15/Nolte Room
LFTs, LMIs, and μ: Real Parameters and Uncertain Nonlinearities

The purpose of this minisymposium is to present recent results in analysis of robust performance for uncertain systems with an emphasis on structured uncertainty arising from real parameters and nonlinearities. We will begin with a tutorial overview of Linear Fractional Transformations (LFT) and the role of the Structured Singular Value, μ, and Linear Matrix Inequalities (LMI) in solving LFT problems. LFTs and LMIs unify many concepts and generalize transfer functions and their state-space realizations to include uncertainty.

Organizer: John C. Doyle
California Insitute of Technology

10:30 Overview of LFTs, LMIs, and μ
John C. Doyle, Organizer

11:10 Robust Performance with Nonlinear, Time-varying Structured Uncertainty
Jeff Shamma, University of Texas, Austin

11:50 Robust Performance with Real Parametric Uncertainty
Peter Young, California Institute of Technology

CP9/Faculty Room
Linear Systems I

Chair: James A. Reneke, Clemson University

10:30 Output Restricted Linear Systems
Renée Schwarzschild, Rutgers University

10:50 Unifying State Feedback/LTR Observer and Constant Output Feedback Design by Dynamic Output Feedback
Chia-Chi Tsui, CUNY College of Staten Island

11:10 The Mapping Degree of the Pole Placement Map
Joachim Rosenthal, University of Notre Dame and Xiaochang Wang, Texas Tech University

11:30 Global Behavior of Closed-Loop Linear Systems with Bounded Inputs
Rodolfo Suárez, José Alvarez and Jesús Alvarez, Universidad Autonoma Metropolitana-Iztapalapa, Mexico

11:50 H_2 Optimal Sampled Data Control with Small Sampling Period
H.L. Trentelman, University of Groningen, The Netherlands

12:10 On the Existence of Solutions of the General Algebraic Riccati Equation
Shan-Ben Chen, Naval Aeronautical Engineering Academy, People's Republic of China and *Don Hong*, Texas A&M University, College Station

CP10/Regents Room
Nonlinear Systems II

Chair: Matthias Kawski, Arizona State University

10:30 Nonlinear Dynamics in Adaptive Control Systems
Shi Bai, Michigan State University

10:50 On Model Matching of Nonlinear Systems
Yanlin Li and E. Bruce Lee, University of Minnesota, Minneapolis

11:10 Sliding Modes: Tracking Problem in Nonlinear Dynamic Systems
Yuri B. Shtessel, University of South Carolina, Columbia

11:30 Motion Planning and Control of Non-Redundant Manipulators at Singularities
Sunil K. Singh, Dartmouth College

11:50 Nonlinear Observers Using Least Squares Solution of Nonlinear Operator Equations
Hannah Michalska, Imperial College of Science, Technology and Medicine, United Kingdom

12:10 Holonomically Constrained Robot Control via a Generalized State Observer
Amit Ailon, Ben-Gurion University of the Negev, Israel

12:30-1:50
Lunch

1:55-2:45
Concurrent Invited Speakers

IC5/Ballrooms A & B
Chair: Mark H.A. Davis, Imperial College, United Kingdom
Stochastic Control with Applications to Modeling of Financial Markets

The speaker will present recent work and current issues in mathematical finance in which the Itô calculus and the representation of martingales as stochastic integrals play a fundamental role. He will discuss two problems in finance, one microeconomic and the other macroeconomic. The first is the problem of determining a fair price for a contingent claim in the presence of a complete market. Its resolution leads to the celebrated Black-Scholes option pricing formula. The second problem is the determination of the equilibrium complete market prices for a set of agents with individual endowments and preferences. The speaker will indicate how these problems lead to questions in stochastic duality, singular stochastic control, and viscosity solutions for Hamilton-Jacobi-Bellman equations.

Steven E. Shreve
Department of Mathematics
Carnegie Mellon University

IC6/Ballroom C&D
Chair: Elijah Polak, University of California, Berkeley
Iterative Nonlinear Programming Algorithms for Optimal Control Problems

Optimal control problems are nonlinear programs with structured constraints and objective functions. Discrete-time problems are typically set in R^n, and are often large in scale, with several state and control variables at each of many time stages. Continuous-time problems are set in function spaces and their finite-dimensional approximations are again large in scale. General purpose iterative nonlinear programming algorithms can be applied to discrete-time problems, but at potentially great cost, since general algorithms do not exploit structure. On the other hand, certain special purpose nonlinear programming methods are readily tuned to discrete-time problems, and are very efficient in this setting. Several useful discrete-time algorithms have continuous-time counterparts that can be approximated on increasing sequences of finite-dimensional spaces to produce computable continuous-time algorithms. The iterates in such schemes are no harder to implement than their discrete-time antecedents and may even be easier to compute; however, surprising differences can emerge in asymptotic convergence properties since continuous-time problems are richer in bad and good solution types and accompanying algorithmic behavior. The scope of existing convergence theories for the formal continuous-time algorithms is limited by a lack of suitable infinite-dimensional extensions of the Kuhn-Tucker sufficient conditions; such theorems are only now beginning to appear.

Joseph C. Dunn
Department of Mathematics
North Carolina State University

2:45/Hubert Humphrey Room
Coffee

3:30 PM-6:00 PM
Concurrent Sessions

MS16/Ballroom A
Nonholonomic Control Systems

Systems with nonholonomic constraints are of great current interest in nonlinear control systems and are of practical importance, arising in such apparently different problems as controlling wheeled vehicles and stabilizing coupled satellites. Moreover these systems are intrinsically nonlinear and require some of the most recent developments in nonlinear systems theory for their solution, such as the theory of connections on fiber bundles and geometric phases, controllability on principal bundles, small time local controllability and higher order variational problems. The speakers will present an introduction and overview to many of these ideas.

Organizers: Anthony M. Bloch
Ohio State University and
Peter E. Crouch
Arizona State University

3:30 **Randomized Feedback Stabilization and Motion Planning for Nonholonomic Systems**
Roger W. Brockett, Harvard University

4:00 **Nonholonomic Mechanics and Optimal Control**
P.S. Krishnaprasad, University of Maryland, College Park

4:30 **Attitude Stabilization of a Rigid Spacecraft Using Gas Jet Actuators Operating in a Failure Mode**
Mahmut Reyhanoglu, *N. Harris McClamroch*, and Hariharan Krishnan, University of Michigan, Ann Arbor

5:00 **The Geometry of Nonholonomic Control Systems on Riemannian Manifolds**
Anthony M. Bloch and Peter E. Crouch, Organizers

MS17/Ballroom B
Control, Chaos and Dynamical Systems (Part 2 of 2)

(For Description, see MS 12, page 10)

Organizer: Mahesh G. Nerurkar
Rutgers University

3:30 **Controlling Chaotic Systems**
Wijaysurya Dayawansa, University of Maryland, College Park

4:00 **Lyapunov Exponents for Multidimensional Systems**
Sri Namachichivaya, University of Illinois, Urbana-Champaign

4:30 **Linear Infinite Dimensional Chaos with Applications to Diffusion Approximations**
Thomas J. Taylor, Arizona State University

5:00 **Title to be announced**
Fritz Colonius, Universitat Augsburg, Germany

MS18/Ballroom C
Numerical and Experimental Methods for Distributed Parameter Control Systems

The speakers in this minisymposium will discuss contemporary problems in deployment and design of feedback control law for Tethered Satellite Systems; computation, simulation and control of a mast-antenna system with stochatic disturbance; algorithms and computation for boundary control using the boundary element method; mechanical vibration analysis for plates with applications to identification of parameters.

Each speaker will address the difficulties in the research of the above areas, present the state-of-the-art methods, theory and techniques for resolving them, and indicate the advantages, practical and potential applications, and consequences in science and technology.

Organizer: Goong Chen
Texas A&M University, College Station

3:30 **Feedback Deployment and Retrieval of Satellites Using Elastic Tethers**
Srinivas R. Vadali and Euisok Kim, Texas A&M University, College Station

4:00 **Feedback Stabilization of Infinite Dimensional Stochastic Systems Applied to Shuttle Orbiter**
Nasir U. Ahmed, University of Ottawa, Canada

4:30 **Recent Progress in the Computation of Boundary Control of Distributed Systems Using the Boundary Element Method**
Goong Chen, Organizer and Jianxin Zhou, Texas A&M University, College Station

5:00 **Identification of Parameters in Narrow Plate Models Based on Frequency Data**
David L. Russell, Virginia Polytechnic and State University, and Luther White, University of Oklahoma, Norman

MS19/Ballroom D
HJB Equations and Viscosity Solutions: Theory and Applications

Hamilton-Jacobi-Bellman (HJB) equations arise naturally in control theory and differential games as the partial differential equations satisfied, at least heuristically, by the value functions. HJB equations do not admit, in general, global smooth solutions; the correct class of weak solutions known as viscosity solutions, was introduced by Crandall and Lions. One of the first and very fundamental uses of viscosity solutions in control theory was the observation that value functions (which in general may be even discontinuous) are the unique viscosity solutions of the associated (HJB) equations. This in turn led to direct and rigorous proofs of convergence of numerical schemes and to a plethora of applications including large deviations, finance theory, and front propagation. Another rather striking consequence of the theory is the strong compactness properties associated with the notion of solution, which in turn allow passage to the limit under very weak conditions. The speakers will discuss the theory and applications of viscosity solutions.

Organizer: Panagiotis E. Souganidis
Brown University

3:30 **Viscosity Solutions of Hamilton-Jacobi-Bellman Equations**
Michael G. Crandall, University of California, Santa Barbara

4:00 **Weak Limits for Hamilton-Jacobi-Bellman Equations - Applications to Control Theory and Large Deviations**
Benoit Perthame, Université d'Orleans, France

4:30 **Optimal Control of Exit Time Problems**
H. Mete Soner, Carnegie Mellon University

5:00 **The Maximum Principle for Viscosity Solutions of Bellman Equations and the Attainable Set of Controlled Diffusion Processes**
Robert Jensen, Loyola University

5:30 **Asset Pricing Models with Market Imperfections**
Thaleia Zariphopoulou, Worcester Polytechnic Institute, and University of Wisconsin, Madison

MS20/Nolte Room
Interpolation and Robust Control in Time Varying Systems

Robust control and signal processing applications of interpolation methods account for some of the major developments in linear systems. The recent removal of the limitation to LTI systems vastly increased the scope of applications, including the use of tighter uncertainty bounds in robust control, dealing effectively with issues of nonstationary signal processing, sample-data design, gain-scheduling, and adaptive control. The speakers in this minisymposium will present an overview of state-of-the-art results with attempt to balance the range of motivations and main technical approaches in the new and rapidly growing interpolation-related LTV System Theory.

Organizer: Gilead Tadmor
Northeastern University

3:30 **Nevanlinna-Pick Interpolation for Time-Varying Input-Output Maps: The Continuous Time Case**
Joseph A. Ball, Virginia Polytechnic Institute and State University, I. Gohberg, Tel Aviv University, Israel, and M.A. Kaashoek, Frije Universiteit, The Netherlands

4:00 **Model Reduction of Nonstationary Systems**
Patrick Dewilde, Technical University of Delft, The Netherlands

4:30 **Robust Sampled-Data Control Systems**
Pramod P. Khargonekar, University of Michigan, Ann Arbor

5:00 **The LTV One, Two and Four Block Model Matching Problems, Factorization Theory and Related State Space Analysis: A Variational Approach**
Gilead Tadmor, Organizer

MS21/Faculty Room
Numerical Methods in Optimal Control

The speakers will present some recent advances in the development of numerical methods for optimal control.

Organizer: William W. Hager
University of Florida, Gainesville

3:30 Sequences of Generalized Equations and Best Approximations in Optimal Control
Asen L. Dontchev, Mathematical Reviews, Ann Arbor, MI and William W. Hager, Organizer

4:00 Numerical Solution of Semilinear Parabolic Control Problems
Mathias Heinkenschloss and Ekkehard W. Sachs, Universität Trier, Germany

4:30 Interior Point Methods for Optimal Control with State and Control Constraints
Stephen J. Wright, Argonne National Laboratory

5:00 Multi-level Projected Newton-like Methods for Optimal Control Problems
C.T. Kelley, North Carolina State University, Raleigh and E.W. Sachs, Universitat Trier, Germany

5:30 Stability and Convergence Analysis in Nonlinear Optimal Control
Asen L. Dontchev, Mathematical Reviews, Ann Arbor, MI; *William W. Hager*, Organizer; Aubrey B. Poore, Colorado State University, Fort Collins; and Bing Yang, West Virginia Tech

CP11/Regents Room
Linear Systems II
Chair: Joachim Rosenthal, University of Notre Dame

3:30 Quadratic Stabilizability of a Linear System with Uncertainties Through Linear Feedback
Ning Hu and I. Norman Katz, Washington University

3:50 Robust Linear Quadratic State Feedback in the Presence of System Uncertainty
A.S. Arar and *M.E. Sawan*, Wichita State University

4:10 The Linear Regulator Problem with a Distribution of Parameters
H.Thomas Banks, North Carolina State University and *Ben G. Fitzpatrick*, University of Tennessee, Knoxville

4:30 Linear Quadratic Gaussian Control under Randomly Varying Distributed Delays
Asok Ray and Nan-Chyuan Tsai, Pennsylvania State University

4:50 Observer-Based Controller Design for Nonstandard Singularly Perturbed Sampled-Data Systems (SPSDS)
M.T. Beheshti and M.E. Sawan, Wichita State University

5:10 Zeros of Spectral Factors and the Geometry of Splitting Subspaces
Anders Lindquist, Royal Institute of Technology, Sweden; Gyorgy Michaletzky, Eotvos Lorand University, Hungary; and Giorgio Picci, University of Padova, Italy

5:30 Minimality and Observability of Reciprocal Realizations on the Circle
Jan-Åke Sand, Royal Institute of Technology, Sweden

5:50 Response Feedback Control for Stochastic Linear Hereditary Systems
James A. Reneke and Robert E. Fennell, Clemson University

CP12/Medical Room
Neural Nets and Control
Chair: Clark Jeffries, Clemson University

3:30 Control of Nonlinear Systems Using a Neural Network Approach
Hugh F. VanLandingham, Virginia Polytechnic Institute and State University

3:50 A Neural-Net Based Controller with Guaranteed Stability Margins
Mario Sznaier, University of Central Florida

4:10 Nonlinear Deadbeat Control Using Neural Networks
Asriel U. Levin, Yale University

4:30 Approximation of Control and Optimal Control Problems Using Neural Nets
M. Ermish and *M. Nouri-Moghadam*, Pennsylvania State University, Lehman

4:50 Expert System of Model Reduction Techniques Based on Artificial Neural Networks
Yuan Zeng-Ren, Jiang Li-Nan and Yuan Jun, Tsinghua University, Beijing, People's Republic of China

3:30-5:30/Foyer
Poster Session
Discretization Chaos of a Discrete Variable Structure System
Xinghuo Yu, University of Central Queensland, Australia

Factorizations of Rational Matrix Functions in Terms of Local Data
L. Rodman, College of William and Mary

Recent Results on Controlled Markov Processes with an Infinite Planning Horizon
Emmanuel Fernandez-Gaucherand, University of Arizona

A Sequential Approach to Nevanlinna Pick Interpolation Problem
Hossein M. Oloomi and Qing Xu, Purdue University, Ft. Wayne

Minimum Energy Optimal Control for Linear Time-Invariant Discrete-Time Systems
Ala Al-Humadi, Embry-Riddle Aeronautical University

On the Disturbance Decoupling with Stability Problem for Linear Repetitive Processes
E. Rogers, University of Southampton, United Kingdom and D.H. Owens, University of Exeter, United Kingdom

A Unified Approach in Analyzing Lyapunov Stability and Practical Stability of Delay Stochastic Systems
Zhao-Shu Feng, South China University of Technology, People's Republic of China

Nonlinear Controller for a Heat-Exchanger
M. Chidambaram, Indian Institute of Technology, India

Discrete-Time Loop Transfer Recovery under Induced Delays
Jenney (Hong) Shen and *Asok Ray*, Pennsylvania State University

On Differential Time-Domain and Frequency-Domain of Nonlinear Control Systems
Li Cao, East China Normal University, Shanghai, People's Republic of China and *Pin Liu*, Shanghai Jiao Tong University, Shanghai, People's Republic of China

On Stability Robustness Issues for MIMO Systems
Yanlin Li and E. Bruce Lee, University of Minnesota, Minneapolis

Relating Impedance to Reflection Coefficients for Mass Dampers
Jacob S. Glower, North Dakota State University

Robust Control of Discrete Time Systems Under Mixed Time/Frequency Domain Specifications
Mario Sznaier, University of Central Florida

Active Control of Flexible Structures with Piezo-Electric Sensoractuators
Farouza Pourki, Drexel University

5:30-7:30
Dinner Break

7:30-10:10
Concurrent Sessions

CP13/Nolte Room
Numerical Methods
Chair: William W. Hager, University of Florida, Gainesville

7:30 On the Use of Randomly Chosen Values for Control in Iterative Dynamic Programming
Bojan Bojkov and *Rein Luus*, University of Toronto, Canada

7:50 On Computing High Accuracy Solutions of a Class of Riccati Equations
Andras Varga, Ruhr-University Bochum, Germany

8:10 Numerical Treatment of Random Integrodifferential Equations
N.G. Medhin, Clark Atlanta University and M. Sambandham, Morehouse College and Clark Atlanta University

8:30 Numerical Aspects of Qualitative Control Theory for Time-Delay Retarded-Feedback Objects
Vladimir M. Marchenko, Byelorussian Institute of Technology, Russia

CP14/Faculty Room
Robust Control
Chair: Robert L. Wheeler, Virginia Polytechnic Institute and State University

7:30 Frequency-Dependent Multipliers, Parameter-Dependent Lyapunov Functions, and Constant Real Parameter Uncertainty in Robust Analysis and Synthesis
Dennis S. Bernstein, University of Michigan, Ann Arbor and Wassim M. Haddad, Florida Institute of Technology

7:50 Investigation of Robust Adaptive Control Laws for Flight Control System Implementation
Joe P. Hill and Quang M. Lam, Coleman Research Corporation, Fairfax, VA

8:10 Robust Stability and Optimality for Pole-Assignment of Discrete-Time System Using Feedback Methods
Chi-Ti Yen, Wichita State University

8:30 Robust Output Feedback to Reduce NOx Emissions in Diesel Engine Exhaust Gases
Alois Amstutz, Institut fur Energietechnik Laboratorium fur Verbrennungsmotoren and *L. del Re*, Eidgenossische Technische Hochschule Zurich, Switzerland

8:50 On the Schmidt Pairs of Multivariable Hankel Operators and Robust Control
Andrea Gombani, LADSEB-CNR, Italy and CWI, The Netherlands

9:10 An Approximate Solution for a Robust Fault Detection and Identification in Dynamic Systems
H. Ahmadi, University of British Columbia, Canada

9:30 Frequency-Shaped LQG/LTR Controller Design for Distributed Parameter Systems
Yee-Pien Yang and Min-Lang Lee, National Taiwan University, Republic of China

9:50 Robust Reduced-order Control of Multi-Area Power Systems
Abdulla Ismail, United Arab Emirates University, Al-Ain, United Arab Emirates

CP15/Regents Room
Estimation, Filtering, and Control

Chair: A.H. Tewfik, University of Minnesota

7:30 Differential Geometry and Measure Transformations Applied to Nonlinear Estimation and Control
Charalambos D. Charalambous and Joseph L. Hibey, Old Dominion University

7:50 Optimal Estimation of Dynamically Evolving Diffusivities
Kurt S. Riedel, Courant Institute of Mathematical Sciences, New York University

8:10 Using Black-Box Indentification Methods to Estimate and Augment a Continuous-Time Physical Model
Henry Tominaga, Ching Chung and Mark Ekblad, Integrated Systems, Inc., Santa Clara, CA

8:30 Performance Evaluation of Several Nonlinear Observers
David M. Reynard, S. Manchanda, M.T. Tham and A.J. Morris, University of Newcastle upon Tyne, United Kingdom

8:50 Upper Bounds on the Number of Linear Relations Identified from Noisy Data by the Frisch Scheme
Keith G. Woodgate, Imperial College of Science, Technology and Medicine, United Kingdom

9:10 Comparison Study of Image Reconstruction Using Higher Order Statistics Information
Jun Liu and Boon Hee Soong, Nanyang Technological University, Republic of Singapore

9:30 A New Failure Detection and Isolation Algorithm
Jelel Ezzine, King Fahd University of Petroleum and Minerals, Saudi Arabia

9:50 Sequential Nonlinear Least Squares Estimation for Control Applications
Vasile Sima, Research Institute for Informatics, Romania

CP16/Presidents Room
Distributed Parameter Systems II

Chair: Semion Gutman, University of Oklahoma

7:30 A Control Problem for Fluid Flow
Kazufumi Ito and *Sungkwon Kang*, University of Southern California

7:50 Sharp Regularity Results for Boundary Control of a Linear Thermoelastic Rod
Scott W. Hansen, Iowa State University

8:10 Flexible Truss Structures and the Homogenization of Von Karman's Equation
Ben G. Fitzpatrick, University of Tennessee, Knoxville and *David A. Rebnord*, Syracuse University

8:30 Computation of an LQR Control for a Multiple Component Structure
Belinda B. King, North Carolina State University and University of Southern California

8:50 Adaptive Linear Quadratic Control for Distributed Parameter Systems
I.G. Rosen and Michael Demetriou, University of Southern California

9:10 Optimization and Shape Control of Smart Structures
Farouza Pourki, Drexel University

9:30 Nonsmooth Analysis and Shape Optimization for Partial Differential Equations
Srdjan Stojanovic, University of Cincinnati

9:50 Mass Damper Design via Minimization of Reflections
Jacob S. Glower, North Dakota State University

7:30/University Ballroom Foyer
Registration opens

8:00-8:50
Concurrent Invited Speakers

IC7/Ballrooms A & B
Chair: Eduardo D. Sontag, Rutgers University
Computational Complexity and Control Problems

The theory of computational complexity provides tools and concepts that can be used to draw conclusions about on the difficulty of several problems arising in control theory. Furthermore, complexity theory can provide useful information pertaining to both discrete problems (NP-completeness theory), and to problems involving continuous variables (information-based complexity).

In this presentation, the speaker will introduce some complexity concepts and demonstrate their applicability to control theory through a review of several representative results. Some specific control problems that can be approached from a complexity point of view include Markov decision theory, stochastic control, discrete-event systems, team theory and decentralized control, the controllability problem for nonlinear systems, and the robustness problem in linear controller design.

John N. Tsitsiklis
Department of Electrical Engineering
Massachusetts Institute of Technology

IC8/Ballrooms C & D
Chair: Andre Manitius, George Mason
University
Supervisory Control of Discrete and Continuous Systems

The speaker will survey aspects of the modelling and supervisory control of both discrete and continuous systems. He will discuss recent work dealing with real-time extensions and applications of the supervisory control framework of automata and formal languages, and then consider mixed systems with both continuous and discrete variables. Several interesting phenomena can be observed in such systems including the reduction of the continuous model to a finite automaton and, at the other extreme, the display of chaotic behavior. The speaker will describe methods, including statistical methods, for analyzing these systems and give some simple examples.

Peter J. Ramadge
Department of Electrical Engineering
Princeton University

8:55-9:45
Concurrent Invited Speakers

IC9/Ballrooms A & B
Chair: Eduardo D. Sontag, Rutgers University
Theory and Practice of Process Control

Most control theory research is focussed on control law design, though this task requires only a small fraction of the effort necessary to control a system and may not be critical in making it successful. Other, often more important issues, are: the design of the system, so that it is easy to control, developing a model to serve as a basis for control law design, the proper placement and use of actuators and sensors, scheduling the control law to account for nonlinearities, and providing graceful performance degradation in the event of actuator saturation or actuator/sensor failure. The speaker will describe the successes and failures of modern control theory in addressing these issues and will attempt to define research goals for a practical theory.

Manfred Morari
Department of Chemical Engineering
California Institute of Technology

IC10/Ballrooms C & D
Chair: Andre Manitius, George Mason
University
Image and Signal Analysis as Dynamic Estimation Problems

A research area of considerable current interest is the development of statistically-based algorithms for signal and image analysis. Motivations for the use of such methods include the incorporation of prior knowledge, the use of statistical means for dealing with ill-posedness, and the development of computationally efficient algorithms. In this presentation, the speaker will argue that the particular statistical framework of estimation for dynamic systems has a considerable amount to offer in such investigations, leading not only to new image processing algorithms but also to new interpretations and generalizations of standard dynamic estimation algorithms such as the Kalman filter. He will use several signal and image processing problems to illustrate the point. He will show how standard regularization methods for computer vision problems such as motion estimation have natural statistical interpretations, leading to the development of new methods for space-time tracking in image sequences and to a new "fractal regularization" methodology that is related closely to multiresolution stochastic methods defined on trees which admit Kalman filter-like algorithms which are recursive in scale.

Alan S. Willsky
Laboratory for Information and Decision Systems
Massachusetts Institute of Technology

9:45/Faculty/Foyer
Coffee

10:30 AM-12:30 PM
Concurrent Sessions

MS22/Ballroom A
System Theoretic Models for the Analysis of Physical Systems

The purpose of this minisymposium is to illustrate the relevance of some ideas from systems theory in the analysis of physical systems. The speakers will address the behavioral framework in systems theory, Hamiltonian systems, dissipation, and symmetries.

Organizer: Jan C. Willems University of
Göningen, The Netherlands

10:30 **Geomteric Mechanics and Paradigms for Control Theory**
P.S. Krishnaprasad, University of Maryland, College Park

11:00 **The Behavioral Approach to Modelling Physical Systems**
Jan C. Willems, Organizer

11:30 **Internal and External Characterizations of Strictly Dissipative Systems**
Stefano Pinzoni, LADSEB-CNR, Italy

12:00 **Symmetries in Dynamical Systems**
Fabio Fagnani, Università di Pisa, Italy

MS23/Ballroom B
Modeling and Control of Flexible Robots

There has been tremendous progress made in the area of robot control in the past decade. Most of the advance is restricted to rigid robots. This case is relatively benign: the system is feedback linearizable, full state measurement can be reasonably assumed, and every degree of freedom is actuated.

However, most robots actually contain significant amount of flexibility. This may arise due to lumped joint flexibility (due to gear train) or distributed link flexibility. The properties that are exploited in the rigid robot case now no longer hold. The system may not always be feedback linearizable, full state is not always available (especially in the link flexibility case), and not every degree of freedom is actuated. There have been many approaches proposed in the past. Some of the most prominent ones are: feedback linearization for a simplified model, dynamic feedback linearization for a complete model, and passive feedback with inverse plant feedforward. The speakers in this minisymposium will provide an overview of the latest directions and results in control of flexible robots.

Organizer: John T. Wen
Rensselaer Polytechnic Institute

10:30 **The Use of Passivity in Elastic Joint Robots**
Patrizio Tomei, Seconda Università di Roma, Italy

11:00 **Control of Robots with Joint Elasticity via Regulation**
Alessandro De Luca, Università di Roma "La Sapienza", Italy

11:30 **Robust Versus Adaptive Control of Flexible Joint Robots**
Mark Spong, University of Illinois at Urbana-Champaign

12:00 **A Passivity/Inverse—Dynamics Approach to the Tracking Control of Flexible Robots**
John T. Wen, Organizer

MS24/Ballroom C
Computational Control of Distributed Parameter Systems

The speakers in this minisymposium will present a representative cross section of the interdisciplinary blend of analytic and numerical techniques that occur in advanced control design and practical numerical solution of distributed parameter systems. The speakers will discuss control and stabilization of distributed parameter systems models and address both linear and nonlinear aspects of computation and control. Whether for the efficient simulation of a boundary feedback control or for the computation of the control for nonlinear systems, a modification and enhancement of conventional numerical techniques is required. The speakers will describe various spectral methods that work well for these models.

Organizers: Kenneth L. Bowers and
John R. Lund
Montana State University, Bozeman

10:30 **Parameter Choice in Tikhonov Regularization**
Bernard A. Mair, University of Florida, Gainesville

11:00 **Boundary Feedback Stabilization of Nonlinear Distributed Parameter Systems**
David S. Gilliam, Texas Tech University, and Christopher I. Byrnes, Washington University

11:30 **Simulations of Stabilization via Boundary Feedback**
Timothy S. Carlson, Montana State University, Bozeman and Kenneth L. Bowers and John R. Lund, Organizers

12:00 **Active Noise Control in Acoustic/ Structure Interaction Models Via Piezoceramic Actuators**
H. Thomas Banks, North Carolina State University, Richard J. Silcox, and *Ralph C. Smith*, NASA Langley Research Center

MS25/Ballroom D
Applications of Nonsmooth Analysis to Optimal Control Theory (Part 1 of 2)

The minisymposium focuses on tools and methods of nonsmooth analysis as they apply to optimal control theory. In broad terms, nonsmooth analysis is a subject that seeks to unify and broaden the application of differentiable techniques to situations where the sets and functions under consideration are not necessarily differentiable. Such situations arise naturally in optimization theory because a "min" or "max" operation does not preserve differentiability. In optimal control theory, nonsmooth methods have developed beyond a mere generalization of hypotheses. The theory includes many useful and powerful tools for the study of a variety of issues including necessary and sufficient conditions, sensitivity, relation of controls, and solutions to Hamilton Jacobi equations. The speakers will discuss these issues and the tools that have been developed to address them.

Organizer: Peter R. Wolenski
Louisiana State University, Baton Rouge

10:30 **Risk Sensitive Optimal Control and Differential Games**
Wendell H. Fleming and William M. McEneaney, Brown University

11:00 **Viscosity Solutions for Boundary Control Problems**
P. Cannarsa, Seconda Università di Roma, Italy, F. Gozzi, Università di Pisa, Italy and *H. Mete Soner*, Carnegie Mellon University

11:30 **Cracks in Attainable Sets**
Jack Warga, Northeastern University

12:00 **Proper Relaxation of Delayed Controls**
Qiji Zhu, Northeastern University

MS26/Nolte Room
Fault Detection and Diagnosis (for Automobiles)

Technical diagnostics is one of the most important areas of systems science and engineering. If a mathematical model of the monitored plant is available, it may be utilized to check the consistency of controls and measurements which in turn can then be used to derive diagnostic information.

The automobile is a plant of which more than 12 million are placed into operation each year. Also it is a major air pollutant. With advanced diagnostics utilizing an on-board vehicle computer, the car's emission performance (and maintainability) can be significantly improved.

The speakers in this minisymposium will provide an overview of methods of model-based technical diagnostics and present application approaches to automotive powertrains.

Organizer: Janos J. Gertler
George Mason University

10:30 **Analytical Redundancy Methods in Fault Detection and Isolation**
Janos J. Gertler, Organizer

11:00 **The Need for FDI of Automotive Systems and a Robust Model-Based FDI of Power Train Sensors**
Dan Cho, Princeton University

11:30 **Fault Detection in Internal Combustion Engines: Decoupling the Effects of Load Disturbances**
Giorgio Rizzoni and Vasanth Krishnaswami, Ohio State University, Columbus

12:00 **On-Board Fault Diagnosis for Automotive Engines Using Structured Parity Equations**
Janos Gertler, Organizer; *Mark Costin*, General Motors Research Laboratories; Warren, MI; X. Fang, R. Hira, P. Kowalczuk and Q. Luo, George Mason University

MS27/Regents Room
Nonlinear Process Control

The speakers in this minisymposium will discuss problems of analysis and design of control systems arising in nonlinear processes. They will present an overview of current research activity, and discuss open problems of theoretical interest. The speakers will focus on the synthesis of control laws on the basis of state-space or input/output process models and on issues of sensitivity analysis and formulation of the control problem in a model predictive setting.

Organizers: Costas Kravaris
University of Michigan,
Ann Arbor and
Prodromos Daoutidis
University of Minnesota,
Minneapolis

10:30 **Motion Planning for Chemical Processes**
Jeffrey C. Kantor, University of Notre Dame

11:00 **Nonlinear Control Using Polynomial ARMA Models**
Evelio Hernandez and *Yaman Arkun*, Georgia Institute of Technology

11:30 **Sensitivity of Feedback Linearizing and Linear Controllers to Unmeasured Disturbances**
Francis J. Doyle III, E.I. Dupont de Nemours & Co., Inc., Wilmington, DE and *Manfred Morari*, California Institute of Technology

12:00 **Dynamic Compensation of Measurable Disturbances in Nonlinear Multivariable Processes**
Prodromos Daoutidis and Costas Kravaris, Organizers

CP17/Presidents Room
Control of Discrete-Event Systems

Chair: Emmanuel Fernandez-Gaucherand, Arizona State University

10:30 **Finite State Machines in a New Control Theoretic View**
Dieter Franke, Universität der Bundeswehr Hamburg, Germany

10:50 **Logical Analysis and Control of Time Petri Nets**
B.H. Krogh and *Archana Sathaye*, Carnegie Mellon University

11:10 **A Reconfigurable Discrete Event System for Process Control**
Humberto E. Garcia and Asok Ray, Pennsylvania State University University Park

11:30 **Discrete Event Model of a Token Ring Data-Link**
B. Familoni and S. Abuelyaman, Memphis State University

CP18/Medical Room
Stabilization and Stability of Nonlinear Systems

Chair: Andrea Bacciotti, Politecnico di Torino, Italy

10:30 **Global Stabilization of Nonlinear Systems: Some New Aspects**
Peter Seibert, Universidad Autonoma Metropolitana-Iztapalapa, Mexico

10:50 **Stabilization of Rotating Flexible Structures**
Rongze Zhao and Thomas A. Posbergh, University of Minnesota, Minneapolis

11:10 **Lyapunov Functions for Dynamical Systems with Competitive Controls**
Pierpaolo Soravia, Brown University

11:30 **A New Lyapunov Functional for a Stability Analysis in Delay-Differential Systems**
James Louisell, University of Southern Colorado

11:50 **Global Stabilization of Discrete-time Systems: A Passive System Approach**
Christopher I. Byrnes and *Wei Lin*, Washington University

12:10 **On Stabilization of Nonlinear Control Systems**
Oleg V. Anashkin, Simferopol State University, Ukraine

12:30-1:30
Lunch

1:30/University Ballroom
IP4/Chair: Avner Friedman, Institute for
Mathematics and Its Applications,
University of Minnesota,
Minneapolis

Control Systems on the Automobile: More Value for the Motorist

Continuing progress is being made in employing control systems on the automobile. This progress provides significant benefit to the motorist by facilitating a cleaner environment, better fuel economy, improved safety, and more confort and convenience. The powertrain and chassis systems have the most challenging and exciting control problems. The design goals are complex and sometimes conflicting. The system dynamics are multi-dimensional, nonlinear, time-varying, and include time delays. There is a strong need for describing the system behavior by mathematical models. The speaker will illustrate how the controls have been successfully implemented on the automobile.

Donald J. Dobner
Electrical and Electronics Engineering Department, General Motors Research Laboratories

2:30/Faculty/Foyer
Coffee

3:15-6:15
Concurrent Sessions

MS28/Ballroom A
Feedback Stabilization of Nonlinear Systems

Feedback stabilization of control systems is a classical problem. However, most of the the literature appearing in the last decades concerns linear system. The existence of stabilizing feedback for continuous-time, nonlinear systems cannot be reduced in general to the linear context. In fact, approximate linearization techniques give rise to very conservative results. Moreover, one has to consider many aspects of the problem which are not so relevant in the linear setting. The extent of the region of attraction (local versus global stabilizability), the smoothness of control functions, a static versus a dynamical approach, and robust and adaptive stabilization are some examples.

The speakers in this minisymposium will present an overview of current research on all these aspects of the problem and will stress typical applications, such as the rigid body attitude control and the robot arm.

Organizer: Andrea Bacciotti
Politecnico di Torino, Italy

3:15 A Discussion of Recent Results on Stabilization
Eduardo D. Sontag, Rutgers University

3:45 Robust Nonlinear Stabilization and Bifurcation Control Using Dynamic Feedback
Eyad H. Abed, University of Maryland, College Park

4:15 Robust Stabilization of Nonlinear Interval Plants
Petar V. Kokotovic and Randy A. Freeman, University of California, Santa Barbara and Laurent Praly, École de Mines de Paris, France

4:45 Self-Tuning Output Feedback Control of a Class of Nonlinear Systems
Riccardo Marino and *Patrizio Tomei*, Seconda Università di Roma, Italy

5:15 Stabilization Using LaSalle-Jurdjevic-Quinn Techniques
Gauthier Sallet, Université de Metz, and INRIA, Lorraine, France

5:45 Nonlinear Systems which are Stabilizable by Linear Feedback
Andrea Bacciotti, Organizer, P. Boieri, and L. Mazzi, Politecnico di Torino, Italy

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MS29/Ballroom B
Stochastic and Deterministic Adaptive Control of Distributed Parameter Systems

Some adaptive control problems for linear, stochastic and deterministic distributed parameter systems are described in this minsymposium. Since a solution of an adaptive control problem includes the identification of the unknown system and its control, the strong consistency of a family of least squares estimates of the unknown parameters under some verifiable conditions is given and a certainty equivalence adaptive control is constructed that is self-tuning and self-optimizing. For the self-tuning property some results are given on the continuity of differential and algebraic Riccati equations with respect to parameters. For practical applications computational results are important so some computational experiments are described for the deterministic adaptive control of and Euler Bernoulli beam.

Organizer: Bozenna J. Pasik-Duncan
University of Kansas, Lawrence

3:15 Adaptive Control and Observation of an Euler Bernoulli Beam
Andre Z. Manitius and Hongxing Xia, George Mason University

3:45 Riccati Equations Arising from Boundary and Point Control Problems
Irena Lasiecka, University of Virginia, Charlottesville

4:15 Adaptive Boundary Control of Linear Stochatic Distributed Parameter Systems
Tyrone E. Duncan, University of Kansas, Lawrence

4:45 On the Identification of Linear Stochastic Distributed Parameter Systems
Bozenna Pasik-Duncan, Organizer

MS30/Ballroom C
Applications of Nonsmooth Analysis to Optimal Control Theory (Part 2 of 2)

(For Description, See MS 25, page 16)
Organizer: Peter R. Wolenski
Louisiana State University, Baton Rouge

3:15 Synthesis of Optimal Strategies in Differential Games
Leonard D. Berkovitz, Purdue University

3:45 The Hamilton-Jacobi Equation in Convex Optimal Control
R.T. Rockafellar, University of Washington, Seattle

4:15 The Generalized Problem of Bolza
Philip D. Loewen, University of British Columbia, Canada and R.T. Rockafellar, University of Washington

4:45 Refined Euler-Lagrange Condition for Nonconvex Differential Inclusions
Boris S. Mordukhovich, Wayne State University

5:15 Regularity and Stability of Constrained Linear-Quadratic Problems
Asen L. Dontchev, Mathematical Reviews, Ann Arbor, MI

MS31/Ballroom D
Supervisory Control of Discrete-Event Dynamical Systems

Most man-made systems can be classified as discrete event dynamical systems (DEDS). These systems change their state at arbitrary time instants in response to external stimulus. The relationship between the state and the stimulus is highly irregular and cannot be characterized by simple differential or difference equations. The problems in modeling and control of such systems have become very important. In the recent past, there have been exciting new research efforts in this direction. These research efforts combine tools from computer science, operations research and control theory. The speakers in this minisymposium will concentrate on the logical aspects of supervisory control of DEDS.

Organizers: Vijay K. Garg
University of Texas, Austin, and
Steven I. Marcus
University of Maryland, College Park

3:15 Some Results in Supervisory Control of DES
W.M. Wonham, University of Toronto, Canada

3:45 Control of Discrete Event Systems Using Limited Lookahead Policies
Sheng-Luen Chung and *Stephane Lafortune*, University of Michigan, Ann Arbor and Feng Lin, Wayne State University, Detroit

4:15 On Some Algorithmic Questions in Discrete Event Control
Michael Heymann, Technion-Israel Institute of Technology, Israel

4:45 Fixed Points and their Applications to Supervisory Control of DEDS
Ratnesh Kumar, University of Kentucky, Lexington and Vijay K. Garg, Organizer

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MS32/Nolte Room
Advances in Signal Processing

This session will present a tutorial overview of some recent theoretical and practical developments in signal processing. Topics to be presented include vector quantization and its applications in signal coding and processing, paraunitary matrices and their role in the design of filter banks and wavelets, Markov random fields and their use in optical flow estimation, image restoration and segmentation and the role of signal processing techniques in the design and development of multi-media computers and communications machines.

Organizer: A.H. Tewfik
University of Minnesota, Minneapolis

3:15 Para-Unitary Matrices in Digital Signal Processing
P.P. Vaidyanathan, California Institute of Technology

3:45 Multiscale Markov Random Field Models and their Application to Image Processing
Bernard C. Levy, University of California, Davis

4:15 The Coming Multi-Media Revolution
James H. Snyder, AT&T Bell Laboratories

4:45 Vector Quantization and Signal Compression
Robert M. Gray, Stanford University

MS33/Regents Room
Numerical Linear Algebra and Control

The speakers will present some recent advances in numerical linear algebra applied to problems in control. They will present developments with singular value decompositions, algebraic Riccati equations, and robust stability arising from descriptor systems and will discuss numerical considerations including efficiency on serial and parallel machines and questions of numerical stability and conditioning.

Organizer: Ralph Byers
University of Kansas

3:15 Efficient Frequency Response Computation Using Rational Interpolation
Alan J. Laub and *Charles Kenney*, University of California, Santa Barbara

3:45 A Structure Preserving Method for Solving Algebraic Riccati Equations
Gregory S. Ammar, Northern Illinois University, and Volker Mehrmann, Universitat Bielefeld, Germany

4:15 Numerical Methods for the Regularization of Descriptor Systems by Output Feedback
A. Bunse-Gerstner, University of Bremen, Germany, V. Mehrmann, University of Bielefeld, Germany and *Nancy K. Nichols*, University of Reading, United Kingdom

CP19/Presidents Room
Process Control

Chair: Yaman Arkun, Georgia Institute of Technology

3:15 Frequency Domain Techniques for the Design of Decentralized Controllers
Jorg Raisch, University of Toronto, Canada

3:35 Modeling and Control of Fiber Pyrolysis in a Metal Matrix Composite Model Factory
C. Chung, M. Ekblad and *C. Elia*, Integrated Systems, Inc., Santa Clara, CA and C. Shelton, 3M Corporation, St. Paul, MN

3:55 A Stability Result for the Extended Kalman Filter Applications to Industrial Processes
E. Busvelle, F. Deza and F. Viel, Shell Recherche S.A., France

4:15 State-Space Description and Mathematical Model of a Tendam Cold Rolling System
Guofa Wu, University of Toledo; Zhe Xu and Bing Zhuo, Central Iron and Steel

Research Institute, People's Republic of China; Anxiang Xia, Jianwen Xiong, and Chengxiao Zeng, Wuhan Iron and Steel Company, People's Republic of China

4:35 Adaptive Control of a Multivariable Steam Gas Reforming System
Abderrazak M. Meziou, University of Louisville and Imad M. Alatiqi, Kuwait University, Kuwait

4:55 A New Kind of Generalized Predictive Control
Renmin-Den and Wang Li, Chongqing University, People's Republic of China

CP20/Medical Room
Distributed Parameter Systems III

Chair: Luther White, University of Oklahoma

3:15 Bounded-Input Bounded-Output Stability of Systems Represented by the Telegrapher's Equation
S.M. Shahruz, Berkeley Engineering Research Institute and A. Imam, University of California, Berkeley

3:35 Feedback Design by Extended Linearization for Burgers' Equation
Antoni S. Banach and William T. Baumann, Virginia Polytechnic Institute and State University

3:55 Asymptotic Behavior with Respect to Thickness of Stabilizing Feedback for the Kirchoff Plate
Mary Ann Horn and Irena Lasiecka, University of Virginia

4:15 Infinite Dimensional Continuous-time Linear Systems: Stability and Structure Analysis
Yuanyin Wu and Raimund Ober, University of Texas, Dallas

4:35 The Interlacing of Eigenvalues of Controlled Distributed Systems
C.R. MacCluer, Michigan State University

4:55 A Relaxation Approach for Eigenvalue Control Optimization
Raul B. Gonzalez de Paz, Universidad del Valle de Guatemala

5:15 Families of Vector Exponentials in Control Theory of Distributed Parameter Systems
Sergey A. Avdonin, St. Petersburg State University, Russia

6:15
Conference adjourns

6:30/Hubert Humphrey Room
Banquet
Control Theory: Future Outlook
Speaker: Avner Friedman,
Institute for Mathematics and Its Applications, University of Minnesota, Minneapolis

SIAM

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Avis Rent A Car has been selected as the offical car rental agency for this conference. The following rates will apply to cars rented at the airport subject to the conditions listed below:

Type of Car	Daily Rate	Weekly Rate	Weekend Rate
Economy	$33.00	$129.00	$24.00
Intermediate	$35.00	$135.00	$25.00
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Make sure to give the Avis Worldwide Discount (AWD) Number: **B133-303**, and mention that you are attending the SIAM Conference on Control, September 17-19, 1992.

Please make your car rental reservation in advance. On-site availability cannot be guaranteed.

Public Transportation from the Airport

The airport is approximately thirty minutes from the hotel. There is an airport shuttle called the *Airport Express*. It arrives every hour on the half hour outside the baggage claim area 5:30 AM - 11:00 PM, seven days a week. The cost for a one way ticket is $8.00. A round trip ticket is $12.25.

There are a number of cab companies that service the airport. The average one-way cost from the airport to the hotel is $18.00.

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Going South on 35 West
- Take the 4th Street Exit to the University of Minneapolis East Bank to University Avenue Exit #18
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- Go to Oak Street, turn right.
- Go to Washington Avenue, turn right.
- Go to Harvard Street, turn right.

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- Take 4th Street toward St. Paul
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Radisson Hotel Metrodome
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Minneapolis, MN 55414
612-379-8888

Reservations: SIAM is holding a block of rooms at the Radisson Hotel on a first come first served basis at the specially discounted rates of $75/single and $85/double. Please note that all rates are subject to an occupancy/sales tax of 12%. These rooms will be held for our exclusive use until **August 28, 1992**, after which date reservations will depend on availability. A deposit in the amount of one night's room rate is required to confirm reservations.

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The registration desk will be located in the University Ballroom Foyer and open as listed below:

Wednesday, September 16   7:00 PM - 9:00 PM

Thursday, September 17   7:30 AM - 4:30 PM

Friday, September 18   7:30 AM - 4:30 PM

Saturday, September 19   7:30 AM - 2:00 PM

Get-Togethers

SIAM Welcoming Reception
Wednesday, September 16, 1992
7:00 PM - 9:00 PM
University Ballroom D
Cash bar and assorted mini hors d'oeuvres.

Banquet Dinner
Saturday, September 19, 1992
6:30 PM
Radisson Hotel Metrodome, Hubert
Humphrey Room
Featured Speaker:
Avner Friedman,
Institute for Mathematics
and Its Applications,
University of Minnesota,
Minneapolis

The banquet will begin at 6:30 PM with a cash bar. Everyone will be seated at 7:00 PM for dinner. Dinner will consist of a choice of Sliced Smoked Tenderloins of Beef, Blackened Red Fish or Sliced Breast of Turkey. There will be vegetarian platters available for those with special needs. Wine will be served with dinner followed by dessert. Please be certain to mark your dinner selection on the reservation card. The cost is $25.00.

Please complete the Advance Registration Form on the inside back cover and return it in the envelope provided. We urge attendees to register in advance to take advantage of the lower registration fees. Advance registration form and payment must be received at the SIAM office by September 4, 1992 or you will have to pay the difference between the advance and the on-site fees at the conference.

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*Members of SIAM Activity Group on Control and Systems Theory.

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SIAM Conference on Control and Its Applications

September 17-19, 1992
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September 17-19, 1992
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On-Site	$150	$155	$185	$25
Conference	$___	$___	$___	$___
Banquet Dinner **($25)	$___	$___	$___	$___
Total	$___	$___	$___	$___

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