1999

IEEE INTERNATIONAL CONFERENCE

ON

CONTROL APPLICATIONS

and

IEEE INTERNATIONAL SYMPOSIUM

ON

COMPUTER AIDED CONTROL SYSTEM DESIGN

FINAL PROGRAM AND ABSTRACTS

August 22-27, 1999

Hapuna Beach Prince Hotel
Kohala Coast-Island of Hawaii, Hawaii, USA

Sponsored by IEEE Control Systems Society

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CSS Technical Committee on Computer Aided Control Systems Design

The American Society of Mechanical Engineers (ASME)

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WELCOME

On behalf of the Operating and Program Committees, we are pleased to welcome you to the 1999 International Conference on Control Applications (CCA) and the Symposium on Computer Aided Control Systems Design (CACSD), in the Big Island, Hawaii. This is the eighth CCA and the tenth CACSD symposium, and this is the second time that the CCA and CACSD have been held jointly. The conference is sponsored by the IEEE Control Systems Society (CSS), with co-sponsorship by the CSS Technical Committee on Computer Aided Control Systems Design, the American Society of Mechanical Engineers (ASME), and the Society of Instrument and Control Engineers (SICE), Japan. The composition of the organizing committee and the program committees reflect the importance of bringing together researchers in systems, control and automation who come from various disciplines and countries.

Since the time of the outstanding success of the 1990 Conference on Decision and Control that was held in Honolulu, Hawaii, many of us have looked forward to another CSS conference in Hawaii. The initial concept for the 1999 Conference on Control Applications was proposed by George Ianculescu; he developed a proposal and obtained approval from the CSS Board of Governors in 1997. Subsequently, George arranged for the Symposium on CACSD to be held in conjunction with the CCA. Since this initial start, George has continued to help with conference organization, in his role as "organizing chair". The program chairs Shinji Hara (CCA), Ioannis Kanellakopoulos (CCA), and Andras Varga (CACSD) have committed major time to the paper review process and to development of the technical program. Other members of the organizing committee and the program committees have made major contributions to the conference. We would like to recognize all of these individuals for their commitment to making the 1999 CCA/CACSD successful.

The conference highlights exciting multidisciplinary areas of control system applications that will help us respond to the technological challenges of the 21st century. The technical program is organized into six parallel tracks of invited and contributed paper sessions, consisting of nineteen CACSD sessions and fifty three CCA sessions with a total of 436 technical papers, during the four day period 23 August (Monday) to 26 August (Thursday). Four plenary lectures by distinguished control systems researchers are scheduled for each morning of these four days; abstracts of the plenary lectures and biographical sketches of each speaker are given in the following pages. In addition, a CACSD panel discussion will be held on 23 August (Monday). Three tutorial workshops are scheduled for 22 August (Sunday) and three tutorial workshops are scheduled for 27 August (Friday).

Finally, we again welcome you to the 1999 International Conference on Control Applications and the Symposium on Computer Aided Control Systems Design. We anticipate a stimulating week of technical activities, held in the splendor of an outstanding island location. We hope that you find much that is of technical interest and that you enjoy the many pleasures of Hawaii.

Mahalo,
Georg Gruebel (DLR Oberpfaffenhofen)
Harris McClamroch (The University of Michigan)
Akira Sano (Keio University)

CONFERENCE HIGHLIGHTS

Plenary Sessions

Plenary Lecture I   **Monday, August 23, 1999, 8:30 am - 9:30 am**

Hapuna Ballroom

Dr. Hilding Elmqvist, President Dynasim AB, Lund, Sweden

Modelica - A Language for Physical System Modeling, Visualization, and Interaction

Abstract:

Modelica is an object-oriented language for modeling of large, complex and heterogeneous physical systems. It is suited for multi-domain modeling, for example for modeling of mechatronics including cars, aircrafts and industrial robots which typically consist of mechanical, electrical and hydraulic subsystems as well as control systems. General equations are used for modeling of the physical phenomena. No particular variable needs to be solved for manually. A Modelica tool will have enough information to do that automatically. The language has been designed to allow tools to generate efficient code automatically. The modeling effort is thus reduced considerably since model components can be reused and tedious and error-prone manual manipulations are not needed. The principles of object-oriented modeling and the details of the Modelica language as well as several examples are presented.

Biographical Sketch:

Hilding Elmqvist attained his Ph.D. at the Department of Automatic Control, Lund Institute of Technology in 1978. In 1972-1975, he developed the first version of the simulation program Simnon which is sold world wide and has more than 2000 users. His Ph.D. thesis contains the design of a novel object-oriented modeling language called Dymola and algorithms for symbolic model manipulation.

Elmqvist spent one year in 1978-1979 at the Computer Science Department at Stanford University, California. He was in 1984-1990 the principal designer and project manager at a subsidiary to Alfa-Laval called SattControl in Malmo for developing SattGraph, a user interface system for process control and SattLine, a graphical, object-oriented and distributed control system. In 1992, he founded Dynasim AB in Lund, Sweden. The company develops software tools for modeling and simulation of large dynamical systems. The first product was Dymola for object-oriented modeling, which has been followed by Dymosim for simulation and Dymoview for 3D animation of dynamical and visual models. Finally, Dymodraw is a model diagram editor. These products have demonstrated the benefit of object-oriented modeling for both research and industrial applications.

Professor Hidenori Kimura, University of Tokyo

Uncertainty, Complexity and Learning: Control Perspective

Abstract:

   Control theory has produced a number of design methods ranging from Ziegler-Nichols ultimate sensitivity method to H_∞ method. We may add some "model-free" design strategies like fuzzy control and neural network, which recently emerged as, tools for intelligent control. Enormous variety of design methods gives wide range of options for practitioners of real control systems. The increase of options, however, sometimes gives a trouble to practitioners, if they do not know which design method is appropriate for achieving their control objectives. This is sometimes the case even for well-experienced practitioners and we must admit that control theory has not been helpful in this respect. The complexity of controllers is the central issue of the selection of design method. The simpler control configuration is desirable from the viewpoint of implementation and maintenance, but simpler controller is limited in its performance, which is most crucially measured by its ability of dealing with uncertainty. Thus, the uncertainty/complexity tradeoff is the most relevant feature of the issue of control configuration selection.

   In this talk, we discuss the limitation of LTI controllers, as the simplest scheme of feedback control, from the viewpoint of uncertainty management and establish the necessity of the switching control as the most complex control configuration. We shall show the switching control is a natural framework of active learning.

Biographical Sketch:

   Hidenori Kimura graduated from the University of Tokyo in 1965. He received the degrees of the Master and Doctor of Engineering from the University of Tokyo in 1967 and 1970, respectively. In 1970
he joined the Faculty of Engineering Science, Osaka University, where he engaged in research and education of control theory, signal processing and system theory for 17 years. In 1987, he moved to the Faculty of Engineering, Osaka University, where he was engaged in some applications of control theory in rolling control, robotics and automotive control. In 1995, he moved to the Faculty of Engineering, the University of Tokyo, where he is currently a professor of control engineering.

   He has written more than 100 papers and several books on multivariable control, signal processing and robust control including various application papers of control system design.
His current research interest lies in system identification of model set, learning and adaptation, control of complex systems and control of quantum mechanical systems. He received the Paper Award several times from the Society of Instrumentation and Control Engineers (SICE). He received paper awards from IFAC in 1984 and in 1990. He also received the George Axelby Award from IEEE Control Systems Society in 1984. He is a Fellow of SICE and IEEE and is a distinguished member of the IEEE Control Systems Society. He served as a member of the Board of Governors from 1989-1997. He was the General Chair of the 35th CDC in Kobe.

Plenary Lecture III   **Wednesday, August 25, 1999, 8:30 am - 9:30 am**
<div align="right">Hapuna Ballroom</div>

Professor Stephen Boyd, Stanford University

Convex Matrix Optimization Problems, with Applications in Control, Signal Processing, and Circuit Design

Abstract:

The recent development of efficient interior-point algorithms for convex optimization problems involving linear matrix inequalities (LMIs) has spurred research in a wide variety of application fields, including control system analysis and synthesis, combinatorial optimization, circuit design, structural optimization, experiment design, and geometrical problems involving ellipsoidal bounding and approximation.

In the first part of the talk, I will describe the basic problems, semidefinite programming (SDP) and determinant maximization, discuss their basic properties, and give a brief description of interior-point methods for their solution.

In the second half of the talk I will survey applications from several areas.

Biographical Sketch:

Stephen Boyd received the AB degree in Mathematics from Harvard University in 1980, and the PhD in EECS from the University of California, Berkeley, in 1985. In 1985 he joined the Electrical Engineering Department at Stanford University, where he is now Professor and Director of the Information Systems Laboratory. He has held visiting Professor positions at Katholieke University (Leuven), McGill University (Montreal), Ecole Polytechnique Federale (Lausanne), Qinghua University (Beijing), and Universite Paul Sabatier (Toulouse).

He was a member of the Board of Governors, IEEE Control Systems Society, from 1989 through 1992, is a Fellow of the IEEE, and has been a Distinguished Lecturer of the Control Systems Society since 1993. Awards and honors for his research in control systems engineering and optimization include the AACC Donald P. Eckman Award, an ONR Young Investigator Award, a Presidential Young Investigator Award, and an IBM faculty development award. He has given many plenary lectures in both optimization and control. He has received several awards for teaching and lecturing, including the 1994 Perrin award for outstanding undergraduate teaching in Stanford's School of Engineering, and the 1991 ASSU Graduate Teaching Award.

He is the author of two books: Linear Controller Design: Limits of Performance} (with Craig Barratt, 1991) and Linear Matrix Inequalities in System and Control Theory, (with L. El Ghaoui, E. Feron, and V. Balakrishnan, 1994). He is currently working (with Lieven Vandenberghe) on a book on convex optimization with engineering applications.

His interests include computer-aided control system design, and convex programming applications in control, signal processing, and circuits.

Dr. James Winkelman, Ford Motor Company

Control in the Automotive Industry: Accomplishments in the Twentieth Century, Challenges in the Twenty-First Century

Abstract:

The automotive industry is one of the most global industries in the world. It is an intensely competitive business, which affects the economies and environments of essentially every country in the world. World wide annual vehicle production reached 30 million around 1970, today it is about 50 million and by the end of the next decade it is projected to reach around 70 million. The impact of the automobile on the environment was recognized in the United States in the late 1960's and since then, vehicles are over ten times cleaner and have over twice the average fuel economy. Further, vehicles are significantly safer and offer the customer comfort and convenience levels untaught of in the 1970's. These advancements have been driven to a large part by the explosive development of low cost embedded micro processor control systems.

What does the future hold? There will be emission challenges, which could be more difficult than those faced in the past. A significant reduction in all emissions, including CO_2, must simultaneously be achieved. This may require the use of new powertrains and/or alternative fuels. The market will push for safer vehicles through electronically augmented control of vehicle dynamics under both normal and emergency conditions. All of this while providing greater comfort for the passengers. Development of control systems to allow the next generation vehicles to meet governmental regulations, customer expectations and be manufactured at an affordable cost will be key to successful product development.

Biographical Sketch:

Dr. Jim Winkelman obtained his B.S.E.E., M.S.E.E., and Ph.D. degrees from the University of Wisconsin in 1971, 1972 and 1976, respectively. Whereupon he spent the next ten years at General Electric working on the application of singular perturbation methods and adaptive control techniques to the area of power systems. From 1987 on, he has been at the Ford Motor Co. where he was involved in development electronic vehicle controls until 1993. He managed the Motorsports Electronics Department at Ford from 1993 to 1997 where they developed electronic controls for both chassis and powertrain systems. These included low bandwidth active suspension, four wheel steering, variable slip set point traction control, drive by wire throttle control and electronic brake proportioning controls. Since 1997 he has been with Visteon where he leads their advanced powertrain systems activities, which includes an in-house development of a gasoline direct injection system.

TUTORIAL WORKSHOPS

WORKSHOP 1. VARIABLE STRUCTURE CONTROL: BASIC THEORY AND APPLICATIONS
Raymond DeCarlo, Purdue University
Sergey Drakunov, Tulane University

Key design techniques in VSC for a broad class of linear and nonlinear systems. Includes practical examples: torque control of brushless DC motor, pneumatic servoactuator, antilock brake system, and automated steering of a moving vehicle.

WORKSHOP 2. CONTROL OF SYSTEMS WITH DYNAMIC FRICTION
C. Canudas de Wit, Laboratoire d'Automatique de Grenoble-France
H. Olsson, TAC AB, Sweden

Recent theoretical and practical achievements in modeling, analysis, and control of systems with dynamic friction. Topics include friction models, parameter identification, compensation methods, limit cycles,
and applications.

WORKSHOP 3. SAMPLED-DATA CONTROL SYSTEM DESIGN: MODERN APPROACH WITH APPLICATIONS
Yutaka Yamamoto, Kyoto University
Hisaya Fujioka, Kyoto University
Shinji Hara, Tokyo Institute of Technology

Comprehensive account of modern sampled-data control. Topics include intersample behavior, steady-state response, frequency response, H2 and H-Infinity control, computational issues, CAD programs, and design examples.

WORKSHOP 4. INTRODUCTION TO MODEL BASED METHODS FOR FAULT DETECTION AND FAULT ISOLATION
Jason L. Speyer, D. Lewis Mingori, University of California, Los Angeles

Background on the design of observer based fault detection filters. Develops and reviews current methodologies which extend the capabilities and robustness of "analytical redundancy" type fault detection/isolation filters.

WORKSHOP 5. PROCESS AND CONTROL SYSTEM PERFORMANCE MONITORING USING STATISTICAL TECHNIQUES
Michael J. Piovoso, Du Pont Company
Dale E. Seborg; University of California, Santa Barbara

Reviews traditional methods of process monitoring and statistical quality control as well as advanced methods which handle process dynamics and autocorrelated errors. Includes principal component analysis, projection to latent structures, and canonical variate analysis.

WORKSHOP 6. EVOLUTIONARY COMPUTATION AND ITS APPLICATION TO CONTROL ENGINEERING
Yun Li, University of Glasgow

Evolutionary algorithms interfaced with CAD simulators which "intelligently" search for globally optimal design structures and parameters in a computerized automatic trial-and-error process.

Perspectives of Computer Aided Control System Design

A discussion is planned with the following experts invited as panelists: Hilding Elmqvist, Dynasim AB, SE; Michael G. Safonov, University of Southern California, US; William S. Levine, University of Maryland, US; Sebastian Engell, Universitaet Dortmund, DE; Thomas Varsamidis, University of Wales, Bangor, UK; Daniel P. Schrage, Georgia Institute of Technology, US.

A pilot paper "Embedding the Control System Design Process into a Virtual Engineering Environment" by the Panel organizer Georg Gruebel, Chair IEEE Technical Committee on CACSD, is provided in the Proceedings. The view is that the high computation and visualization power that is now available at the control engineer's desk opens the perspective of embedding CACSD Technology into a Virtual Engineering environment. This enables concurrent interaction of control engineering with multidisciplinary high-fidelity system dynamics modeling, and supports a fundamental change of the conventional control design tuning process in a computation framework of fast nonlinear simulation, automatic search for feasible solutions, and interactive multiobjective optimization to trade-off conflicting design requirements. Such an environment links control design more closely to the realism of an engineering design process, and promotes active decision support to foster the control engineer's role as the prime decision maker in system dynamics design.

EXHIBITS

Outside Hapuna Ballroom

Several exhibitors will be present at the conference to showcase their products. Coffee and soft drinks will be available in the exhibit area twice a day for conference registrants.

CONFERENCE INFORMATION

REGISTRATION   **Sunday, August 22 - Friday, August 27**
On-Site Registration Desk   Outside Hapuna Ballroom

All conference attendees must register; personal badges will be provided to identify registered participants. There is a single registration fee for the CCA and the CACSD.   A registration packet is available for each registered participant at the Registration Desk during the following hours:

Registration Desk Hours:

Date	Time
Sunday, August 22	8:00 am – 12:00 noon, 6:00 pm – 8:00 pm
Monday, August 23	8:00 am – 12:00 noon, 2:00 pm – 4:00 pm
Tuesday, August 24	8:00 am – 12:00 noon
Wednesday, August 25	8:00 am – 12:00 noon
Thursday, August 26	8:00 am – 10:00 am
Friday, August 27	8:00 am – 10:00 am

Payment of fees must be made in US currency by check, money order, or credit card. Purchase orders, bon de commandes, bank transfers or promissory notes are not accepted. All questions concerning conference registration should be directed to one of the Registration Co-Chairs, Ragu Balakrishnan (ragu@ecn.purdue.edu) or Seiichi Shin (shin@axis.t.u-tokyo.ac.jp).

All registered participants will receive a CD-ROM containing the Conference Proceedings. Member and Non-Member regular registration also includes one ticket to the Banquet.

SPEAKERS' BREAKFAST   **Monday, August 23 - Thursday, August 26, 7:15am - 8:15 am**
                                                                              Hapuna Breezeway

Complimentary breakfast will be served for speakers, chairs and co-chairs on the day of their sessions. Speakers should attend the breakfast in order to facilitate session planning, and to provide biographical information to the session chairs or co-chairs. For papers with multiple authors, only the presenting author should attend the breakfast.

CONFERENCE PROCEEDINGS

The conference proceedings will be published in a CD-ROM version, with a printed version available to conference participants at an additional cost.

The CD-ROM proceedings will be distributed at the conference along with your registration package. There will be no printed proceedings at the conference. The printed hard copy Proceedings are not included in any registration, but can be ordered from the Registration Desk. The printed proceedings will be mailed after the conference using 4th class or book rate.

SOCIAL EVENTS

WELCOMING RECEPTION   **Sunday, August 22, 7:00 pm - 9:00 pm**

Open Courtyard

A Welcoming Reception (cash bar) for all conference attendees and their accompanying guests will be held on Sunday evening. A ticket for one complimentary drink is included with each regular registration packet. This is an excellent opportunity to meet old and new friends and to make plans for week of conference activities.

COMPANIONS' ORIENTATION   **Monday, August 23, 9:00 am - 10:00 am**

Mauna Kea Sexton Gallery

A brief orientation session will be held to provide an informal opportunity for accompanying guests to become better acquainted and to learn more about the hotel, local tours, shopping, and the surroundings.

CONFERENCE BANQUET   **Tuesday, August 24, 7:30 pm - 9:30 pm**

Hapuna Ballroom

The Conference Banquet will provide an opportunity for social interactions and a chance to enjoy a special Hawaiian meal. There will be a very short ceremony, highlighted by presentation of the Xerox best student paper award. Extra banquet tickets may be purchased at the Registration Desk until Monday, August 23, subject to availability. The price is $60 per person. If you plan to skip the Banquet, please return your ticket as early as possible to the Registration Desk; returned tickets will be made available to students or retirees who would like to attend.

FAREWELL RECEPTION   **Thursday, August 26, 6:00 pm - 8:00 pm**

Hapuna Pool Side

The Farewell Reception will be a special time to relax after the conference, to enjoy special refreshments, to say good-bye to friends, and to make plans for future conferences. All registrants and their accompanying guests are invited.

HAPUNA BEACH PRINCE HOTEL