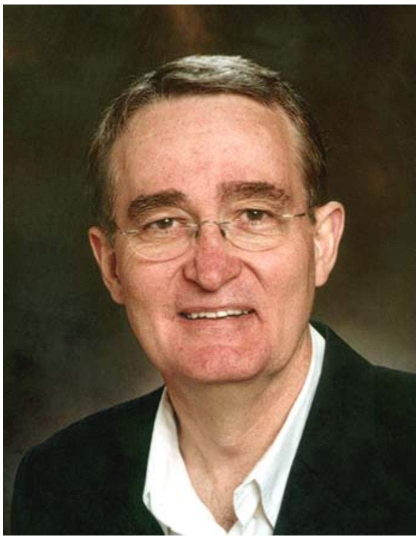
# Plenary Lectures at the 27th Chinese Control Conference

Speaker: Professor David Hill (The Australian National University)

Title: Advances in Stability Theory for Complex Systems and Networks

Abstract:

Throughout natural and engineered systems, questions about stability always arise. Will a power network avoid blackouts? Will the Internet avoid traffic congestion? Will a species population survive? Engineered systems now have features comparable to living systems, namely massive scale, high degrees of nonlinearity, uncertainty and heterogeneity. Such systems are summarized as being *complex*. An important class of such systems has a well-defined network structure where large numbers of nodes, typically described by nonlinear dynamical systems, are connected by links. Stability theory faces many challenges in providing tools to assess stability and instability for such complex systems. Often this assessment must allow for layers of feedback control which have been implemented to regulate local and global behavior. This talk will describe the advancement of stability theory to deal with complex systems with some emphasis on interconnected systems featuring feedback and network structures.



DAVID J HILL received the BE and BSc degrees from the University of Queensland, Australia, in 1972 and 1974, respectively. He received the PhD degree in Electrical Engineering from the University of Newcastle, Australia, in 1976. He is currently a Professor and Australian Research Council Federation Fellow in the Research School of Information Sciences and Engineering at The Australian National University. He has held academic and substantial visiting positions at the universities of Melbourne, California (Berkeley), Newcastle (Australia), Lund (Sweden), Sydney and Hong Kong (City University). He holds honorary professorships in engineering or mathematics departments at the University of Sydney, University of Queensland (Australia), South China University of Technology, City University of Hong Kong, Wuhan University and Northeastern University (China). His research interests are in network systems science, stability analysis, nonlinear control and applications. He is a Fellow of the Institution of Engineers, Australia, the Institute of Electrical and Electronics Engineers, USA and the Australian Academy of Science; he is also a Foreign Member of the Royal Swedish Academy of Engineering Sciences.

Speaker: 黄琳(北京大学工学院力学与空天技术系)

Title：运动体控制的几个科学问题

Abstract:

本文针对推动控制科学发展的重要背景之一——运动体控制所面临的科学问题作了介绍。除简单的前言外，全文分四部分：

1. 阐述运动体控制所受的物理学上的支配，包括由于坐标系之间相对运动引起的问题，运动体受有的单边约束和不可积的非完整约束等。
2. 讨论了由于运动复杂性的需求而提出的异类多作动器的动态配合问题和异类传感器在需经过信息融合的情况下由测量输出重构系统状态的问题。
3. 运动体系统本身存在的各种运动模式之间的耦合，例如姿态与轨道的耦合，飞行纵向运动的长短周期运动的耦合，刚体运动与弹性体变形运动之间的耦合，流体与固体之间的耦合，以及从设计要求上对气动与隐身所兼顾而引起的一体化考虑等。
4. 阐述了关于强时变、强非线性的问题，最后指出从运动体的实际需求出发提炼问题进行研究，将不仅对运动体本身十分重要而且将会有力地推动控制科学的发展

(Joint work with 段志生，杨莹)

黄琳 1957 年毕业于北京大学数学力学系，1961 年同系研究生毕业。1957 年 8 月至 2006 年 3 月先后在北京大学数学力学系、力学系工作，1984 年特批为教授。1985 年 9 月至 1986 年 9 月，1989 年 3 月至 1989 年 9 月和 1994 年 12 月至 1995 年 4 月三次在美国UMAS 等高校做访问学者进行合作研究，期间曾访问包括哈佛大学在内的多所大学进行学术交流。1990 年和 1996 年他还对日本与澳大利亚分别进行过短期的学术访向。2003 年当选为中国科学院信息技术科学部院士。现任北京大学工学院力学与空天技术系教授，兼任北京航空航天大学、浙江大学、东北大学、南京航空航天大学、华南理工大学、中南大学，南京理工大学等多所院校兼职教授或名誉教授，任中科院科学出版基金技术科学组组长。一直从事系统稳定性与控制理论方面的研究工作. 曾获包括国家自然科学三等奖在内的多项奖励.

Speaker: Hidenori Kimura(RIKEN(The Institute of Physical and Chemical Research), Japan)

Title: A New Neural Computation Scheme of Unsupervised Learning with Applications to Robot Biped Locomotion

Abstract: A new neural computational scheme of unsupervised learning is proposed to construct a machine intelligence that is capable of overcoming unpredictable uncertainties and unknowns through proper interactions with environment. Our scheme consists of homogeneous neuron distributions which form layered clusters of computational circuit. Each neuron is very simple and of classical McCulloch-Pitts type equipped with Hebb-type plasticity for their interconnections. The novelty of our neuron lies in its ability to change its threshold according to its firing situation, which makes our scheme stable and configurable. Each cluster of neurons represents the numerical values by the number of firing neurons just like enumerations by fingers. This non-symbolic nature of computations is shown to be very robust. It is shown that our configuration can act as a type of adaptive control which exhibits brain-like functions in its learning behaviors. Our scheme is shown to be successfully implemented to a biped robot that can walk under unstructured environment.

Hidenori Kimura was graduated from the University of Tokyo in 1965 and got the Ph.D Degree from there in 1970. Then, he joined the Department of Control Engineering, Osaka University where he engaged in research and education on control theory and its applications until 1994. Meantime, he stayed Imperial College of Science and Technology and Warwick University as a British Council Scholar for 15 months during the academic year of 1984-85. He joined the Faculty of Engineering, the University of Tokyo in 1995, where he engaged in research and education of biological control and intelligent robotics. He was a 1996 Springer Professor of University of California, Berkeley. In 2004, he retired from the University of Tokyo and joined the Research Institute of Physics and Chemistry (RIKEN) as a team leader of biological control systems laboratory. Since 2007, he is the Director of RIKEN BSI-Toyota Collaboration Center.

He is a recipient of many awards including IFAC Paper Prize Awards in 1981 and 1990, George Axelby Award and Distinguished Member Award from IEEE CSS, a Fellow of IEEE since 1990 and a Fellow of SICE since 1986. He is a Managing Editor of Asian Journal of Control.

Speaker: Tsu-Tian Lee (National Taipei University of Technology)

Title: Research on Intelligent Transportation Systems in Taiwan

Abstract: In the 21st century, the mainstream of technology development is the interdisciplinary integration, together with the human-centered technologies (HT) that emphasizes on friendly service

for human rather than the forced adaptation by human. Intelligent Transportation Systems (ITS), an integrated discipline of sensing, controls, information technology, electronics, communications and traffic management with transportation systems, represents a typical human-centered large-scale and highly complex dynamic system. It is aimed to provide the traveler information to increase safety, efficiency, and reduce traffic jam, therefore a more humanistic transportation system. Accordingly, new research topics emerge. Specifically, increasing machine intelligence(Machine IQ), human-in-the-loop control system technology (Human-centered Control), human-based intelligent dialogue interface technology (Human-based Interfacing), vision and communication supported and enhancement systems (Smart Vision, Smart Networking), human physical conditions detection and intelligent control technology (Intelligent Control), multi-agent for large-scale systems to support information analysis (Large-Scale System Analysis). Thus, fundamental research and technology development on ITS in Taiwan is devoted to following major studies;

1. Smart Vision – Biological-inspired Intelligent Vision Technology for ITS: Combining brain science and intelligent engineering to develop biological-inspired computer vision (e-Eye – electronic eye) techniques for ITS applications.
2. Smart Interfacing – Intelligent Dialogue System for ITS Information Access: Combining speech recognition and language processing to develop intelligent spoken dialogue system for accessing ITS information.
3. Smart Car – Intelligent Control and Intelligent Wheels (I-Wheels) for Next-Generation Smart Cars: Integrating intelligent control, power electronics and network control techniques to develop intelligent wheels (I-Wheels) and intelligent adaptive cruise control systems for ITS applications.
4. Smart Networking – High-Capacity Communication Networks for ITS: Developing and integrating the wireless communication networks and transportation networks technologies into the broadband wireless ITS network.
5. Smart Agent – Agent-based Software Engineering for ITS: Developing a systematic methodology for building multi-agent systems in an incremental manner based on the notion of trade-off analysis of agents' goals for ITS applications.

This lecture discusses some achievements of HT-ITS in Taiwan, including ITS information and communication platform, traffic dynamics simulation platform, driving safety assistance systems, and intelligent control technologies applied to next generation smart vehicles. Some real-life demonstrations of Advanced Traveler Information Systems (ATIS) and Advanced Vehicle Control and Safety Systems (AVCSS) on our experimental car are also shown in this lecture.

We believe that the proposed efforts will in turn enrich our research and teaching environment, reinforce our academic strength and open up new territory applications for each discipline. Equally importantly, the success of our efforts should bring social and economical benefits, in addition to academic values.

**Tsu-Tian Lee** (M'87-SM'89-F'97) was born in Taipei, in 1949. He received the B.S. degree in control engineering from the National Chiao-Tung University (NCTU), in 1970, and the M.S., and Ph.D. degrees in electrical engineering from the University of Oklahoma, Norman, Oklahoma, U.S.A. in 1972 and 1975, respectively. In 1975, he was appointed Associate Professor and in 1978 Professor and Chairman of the Department of Control Engineering at NCTU. In 1981, he became Professor and Director of the Institute of Control Engineering, NCTU. In 1986, he was a Visiting Professor and in 1987, a Full Professor of Electrical Engineering at the University of Kentucky, Lexington, Kentucky, U.S.A. In 1990, he was a Professor and Chairman of the Department of Electrical Engineering, National Taiwan University of Science and Technology (NTUST). In 1998, he became the Professor and Dean of the Office of Research and Development, NTUST. In 2000, he was appointed a Chair Professor, the Department of Electrical and Control Engineering, NCTU. Since 2004, he has been with the National Taipei University of Technology (NTUT), where he is now the President. Prof. Lee received the Distinguished Research Award from the National Science Council, Taiwan, China, in 1991–1998, and the Academic Achievement Award in Engineering and Applied Science from the Ministry of Education, Taiwan, China, in 1997, the National Endow Chair from the Ministry of Education, Taiwan, China, in 2003 and 2006, respectively, and the TECO Science and Technology Award from TECO Technology Foundation in 2003. He was elected to the grade of IEEE Fellow in 1997 .He was elected as a Fellow of IEE in 2000. He became a Fellow of New York Academy of Sciences (NYAS) in 2002. He has served as General Chair, Program Chair, Member of Technical Program Committee and Member of Advisory Committee for many IEEE sponsored international conferences. He is now the Vice President for Membership for the IEEE Systems, Man, and Cybernetics Society.

Speaker: Manfred Morari (ETH Zurich)

Title: Control of Hybrid Systems: Theory, Computation and Applications

Abstract: Theory, computation and applications define the evolution of the field of control. This premise is illustrated with the emerging area of hybrid systems, which can be viewed, loosely speaking, as dynamical systems with switches. Many practical problems can be formulated in the hybrid system framework. Power electronics are hybrid systems by their very nature, systems with hard bounds and/or friction can be described in this manner and problems from other domains, as diverse as driver assistance systems, anesthesia and active vibration control can be put in this form.

I will describe the theoretical basis of some of the tools that have been proposed to synthesize the controllers for hybrid systems. Parametric programming has received a lot of attention in the control literature in the past few years because model predictive controllers (MPC) can be posed in a parametric framework and hence pre-solved offline, resulting in a significant decrease in on-line computation effort. I will describe recent work on parametric linear programming (pLP) from the point of view of the control engineer. I will survey various types of algorithms, and identify a new standard convex hull approach that offers significant potential for approximation of pLPs for the purpose of control. The resulting algorithm, based on the beneath/beyond paradigm, computes low-complexity approximate controllers that guarantee stability and feasibility.

Many industrial applications will serve to highlight the theoretical developments and the extensive software that helps to bring the theory to bear on the practical examples.

(joint work with Colin Jones, Miroslav Baric and Melanie Zeilinger)

Manfred Morari was appointed head of the Automatic Control Laboratory at ETH Zurich in 1994. Before that he was the McCollum-Corcoran Professor of Chemical Engineering and Executive Officer for Control and Dynamical Systems at the California Institute of Technology. He obtained the diploma from ETH Zurich and the Ph.D. from the University of Minnesota, both in chemical engineering. His interests are in hybrid systems and the control of biomedical systems. In recognition of his research contributions, he received numerous awards, among them the Donald P. Eckman Award and the John Ragazzini Award of the Automatic Control Council, the Allan P. Colburn Award and the Professional Progress Award of the AIChE, the Curtis W. McGraw Research Award of the ASEE, Doctor Honoris Causa from Babes-Bolyai University, Fellow of IEEE, the IEEE Control Systems (Technical Field) Award, and was elected to the National Academy of Engineering (U.S.). Professor Morari has held appointments with Exxon and ICI plc and serves on the technical advisory boards of several major corporations.