Kyoto University and IEEE SMC Japan Chapter
The Joint International Workshop on Applied Analysis and Synthesis of Complex Systems

The 21st Century COE Program for Research and Education on Complex Functional Mechanical Systems, Kyoto University
and
IEEE Systems, Man, and Cybernetics (IEEE SMC), Japan Chapter.

November 11, 2004.

Kougakubu Sougou Kousya Room 111, Yoshida Campus
Kyoto University, Japan.
http://www.kyoto-u.ac.jp/access/kmap/map6r_y.htm

Agenda

MORNING SESSION: Introduction of the COE of Kyoto University	
9:30 – 9:40	An Overview of the COE Program, *Kazuo Tsuchiya* (Kyoto University, Jp., Project Leader of the COE)
9:40 – 10:10	Locomotion Control System for a Quadruped Robot, *Katsuyoshi Tsujita and Kazuo Tsuchiya* (Kyoto University, Jp.)
10:10 – 10:40	Dynamical and Complex Behaviors in Control Systems and Human-Machine Co-Adaptive Systems, *Tetsuo Sawaragi* (Kyoto University, Jp.)
10:40 – 11:00	Coffee break
11:00 – 11:25	Multi-fingered Grasping and Manipulation in Virtual Environment and Telepresence Systems, *Yasuyoshi Yokokohji* (Kyoto University, Jp.)
11:25 – 11:50	From "Function Designing" to "Bio-Environment Designing", *Naohide Tomita* (Kyoto University, Jp.)
11:50 – 12:15	Design of an Adaptive Control System by Modular Learning: Flight Control of an Autonomous Unmanned Helicopter, *Hiroaki Nakanishi* (Kyoto University, Jp.)
12:15 – 13:30	Lunch
AFTERNOON SESSION: Invited Lectures and Discussions	
13:30 – 15:00	Control in Dynamic Systems, *Professor Erik Hollnagel* (University of Linköping, Sweden.)
15:00 – 15:30	Coffee break
15:30 – 16:00	Learning about the Functions of Living Organisms and Assimilating Robots into Human Life, *Dr. Zhi-Wei Luo* (RIKEN, Jp.)
16:00 – 16:30	General Discussions
16:30 – 16:45	Concluding Remarks, *Tetsuo Sawaragi* (Kyoto University, Jp., Chair of IEEE SMC Japan Chapter)

Abstract

Program Overview

Kazuo Tsuchiya
(Project Leader of the COE,
Kyoto University, Jp.)

Locomotion Control System for a Quadruped Robot

Katsuyoshi Tsujita and Kazuo Tsuchiya
(Kyoto University, Jp.)

We have proposed a dynamic turning control system of a quadruped robot by using nonlinear oscillators. It is composed of a spontaneous locomotion controller and a voluntary motion controller. The proposed control system consists of a motion plan system and a motion control system. The motion control system consists of motor controllers which are installed at joints and control the joints by local PD feedback control. The motion plan system consists of nonlinear oscillators each of which has a stable limit cycle and generates the commanded angles of the joints as functions of the phase of the oscillator. The oscillators tune the phases through the mutual interactions and the feedback signals from the touch sensors at the tips of the legs. As a result, the robot with the controller walks stably by changing the locomotion period adaptively in a changing environment. In this talk, capability of dynamic turning motion of the proposed control system is verified through numerical simulations and hardware experiments: Various turning speed and orientation make the motion of the robot asymmetry in terms of duty ratio, stride and center of pressure. The proposed controller actively and adaptively controls redundant DOF to cancel the dynamic asymmetry and established stable turning motion at various locomotion speed and turning orientation.

Dynamical and Complex Behaviors in Control Systems and Human-Machine Co-Adaptive Systems

Tetsuo Sawaragi
(Complex System Control and Design Group Leader,
Kyoto University, Jp.)

Human and computer subsystems should be structured and designed to work in mutually cooperating ways guaranteeing a user's usability. For this purpose, progressive system redesigns are needed with respect to human computer interactions to increase system reliability and transparency by increasing human-system interactions and especially a human user's proactive participation, rather than by eliminating the human out of the loop. Such a *socially-centered view* on the human-machine system design regards a human and an automated agent as equivalent partners, and through their mixed-initiative interactions some novel relations of mutual dependency and reciprocity would emerge as well as flexible changes of role-taking are expected. To realize such a kind of new style of human-machine relationships, we develop a new idea called co-adaptive design principle, which means that both a human user and a machine should be able to adapt to the other through experiencing the interactions occurring between them. We applied this idea to an artifacts design; interface agent of robot tele-operation and human-agent collaborative systems.

Multi-fingered Grasping and Manipulation in Virtual Environment and Telepresence Systems

Yasuyoshi Yokokohji (Kyoto University, Jp.)

For the purpose of realizing the functions of human hand on mechanical systems, fundamental understanding of human hand is necessary through intensive observations of manipulation tasks by humans. We developed two research platforms, i.e., VR platform and telepresence platform, to investigate human grasping behaviors in virtual environment and remote environment through a slave robot. Before designing a haptic device, we intensively observed actual human grasping behaviors. Based on this observation, the basic mechanism of the haptic device was determined. We also observed human reaching behaviors to establish motion planning algorithm for this haptic device.

From "Function Designing" to "Bio-Environment Designing"

Naohide Tomita (Kyoto University, Jp.)

As living tissue maintains its shape and function by adaptive self-remodeling, it is difficult to design an artificial shape and a function in the body. Our theme is the "in-vivo environment designing" which is the key factor for successful tissue-engineering treatment. Several biological, clinical and mathematical approaches to the "in-vivo environment designing" will be introduced in the presentation. We want to discuss how to design the proper environments and how to control the shape and the function of living tissues, especially with respect to the following issues;
1.Effect of mechanical environment on differentiation of embryonic stem cells, and
2.Total Joint Regeneration system as an environment-designing treatment.

Design of an Adaptive Control System by Modular Learning: Flight Control of an Autonomous Unmanned Helicopter

Hiroaki Nakanishi (Kyoto University, Jp.)

Designing control system for complicated mechanical systems by training of intelligent system is developed. We propose a method to design robust control systems against stochastic uncertainties by use of off-line training of neural networks. On-line training is also important for control system because it enables to compensate undesirable effects which are not modeled or sudden changes of the controlled object and the environment. Therefore, a method to design an adaptive control system by modular learning is developed. Numerical simulations and experimental results of flight control of an autonomous unmanned helicopter demonstrate the effectiveness of proposed methods.
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Control in Dynamic Systems

Professor Erik Hollnagel
Cognitive Systems Engineering Laboratory (CSELAB)
Department of Computer and Information Science
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In Cognitive Systems Engineering (CSE), a cognitive system is defined as a system that can modify its behaviour on the basis of experience so as to achieve specific anti-entropic ends. In order to do this effectively it is necessary to use a mixture of feedback and feedforward control, and to develop strategies and heuristics that can counteract the detrimental effects of insufficient time. The presentation will describe the main characteristics that joint cognitive systems (humans and machines) use to cope with the complexity of a dynamic environment. Human performance can be described as

multi-layered control functions where the general coping strategy is dominated by a continuous trade-off between efficiency and thoroughness.

Learning about the Functions of Living Organisms and Assimilating Robots into Human Life

Dr. Zhi-Wei Luo
RIKEN Bio-Mimetic Control Research Center
Environment Adaptive Robotic Systems Laboratory
Laboratory Head

Recently, as is marked by the rapid spread of computers, internet and mobile communication, the development of information science provides us human being with enormous information realm. Meanwhile, the systems around us are becoming larger and more complex. It comes to be more and more important for the systems to have high flexibility, diversity, reliability and affinity. System control theory, which forms the core foundation for understanding, designing and operating of systems, has shown remarkable progress in, especially the robust control and adaptive control from last 1980th. In addition, information theories and technologies have also seen great development, which make it possible for us to process higher capacity of information much faster and more intelligently. However, these theories and technologies are still limited and are insufficient to handle complex large-scale systems as well as real time processing of spatial- temporal information. Under this background, bio-mimetic control research, which aims to mimic biological systems at system level the flexible and real time information processing functions as well as sophisticated high degrees of freedom nonlinear motor control functions, is becoming most important subject. The research taking place at the BMC is not only creating new "human-friendly" robots, but at the same time is providing clues that will aid in the understanding of human themselves, and is certain to bring breakthroughs in a variety of scientific fields related to robotics research.

Biographies of the Invited Lecturers

Professor Erik Hollnagel
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1962-1968	Computer programmer at 'I/S Datacentralen af 1959', part time from 1967.
1971	M.Sc. (cand. psych.) from University of Copenhagen, Denmark.
1971-1981	Associate professor at Institute of Psychology, University of Aarhus, Denmark.
1981	Ph.D., (lic. psych.) from University of Aarhus, Denmark.
1978-1982	Research fellow at Risø National Laboratory, Electronics Department.
1982-1985	Head of Man-Machine Interaction Research Division, OECD Halden Reactor Project (Norway).
1985-1986	Associate professor at the Psychological Laboratory, University of Copenhagen. Teaching and research on man-machine systems.
1985-1986	Senior researcher at Advanced Information Processing Division (AIP) of Computer Resources International (CRI), Copenhagen, Denmark
1986-1987	Manager for the Research & Development Department of the AIP Division of CRI.
1987-1989	Manager for the Production & Development Department of the AIP Division of CRI.
1989-1991	Senior consultant, Business Development, Space Division, CRI
1990-1992	External lecturer (Artificial Intelligence), University of Copenhagen.
1991-1993	Principal scientist, Space Division, CRI
1992-1993	Scientific consultant, European Institute of Engineering and Cognitive Science (EURISCO), France
1993-1995	Technical Director, Human Reliability Associates Ltd., (UK)
1995-1999	Principal Advisor, Man-Machine Systems Division, OECD Halden Reactor Project (Norway)

1997-1999	Adjunct Professor (Human-Machine Interaction), Department of Industrial Engineering,University of Linköping (Sweden)
1999-	Full professor (Human-Computer Interaction), Department of Computer and Information Science, University of Linköping (Sweden)

Journal boards

Joint Editor-in-Chief of the International Journal of Cognition, Technology & Work (Springer Verlag, London).
Member of the International Consultant Board of 'Le Travail humain'
Member of the Advisory Board of Cognitive Science Quarterly
Member of the Editorial Board of Theoretical Issues in Ergonomics Science
Member of the Editorial Board of International Journal of Cognitive Ergonomics
Member of the Editorial Board of the IEA Journal of Ergonomics Research

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1980-1984	Department of Automatic Control and Computer Engineering Huazhong University of Science and Technology, China
1984-1986	Teacher of Suzhou University, China
1986-1988	Visiting Researcher of Aichi Institute of Technology
1991	M.S. in information engineering from Nagoya University, Japan
1992	Dr.Eng. in information engineering from Nagoya University, Japan
1993-1994	Assistant professor at Toyohashi University
1994-1998	Frontier Researcher at Bio-Mimetic Control Research Center, RIKEN
1998-	Guest researcher of Shanghai Jiaotong University, China
1999-2001	Associate professor at Department of Applied Biological System Engineering, Yamagata University
2001-	Head of Environment Adaptive Robotic Systems Laboratory The Institute of Physical and Chemical Research (RIKEN) Bio-Mimetic Control Research Center

Membership: IEEE, SICE, RSJ