The 21st Century COE Program
Mechanical Systems Innovation
The University of Tokyo

Newsletter

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The 21st Century COE Program
Mechanical Systems Innovation, The University of Tokyo

International Symposium Series are held

International Symposium Series on Mechanical Systems Innovation

"Opening address by Prof. Hiroshi Komiyama, the vice-president of the University of Tokyo"

The International Symposium Series on Mechanical Systems Innovation was held for six full days at the end of 2004, from Monday, December 6 to Saturday, December 11, at the Takeda Conference Hall of the University of Tokyo. There were, in fact, three international symposia, centered on three different topics: micro/nano thermal and fluids systems, biomedical systems innovation, and innovative aerial/space flyer systems. Each symposium lasted two days.

Professor Hiroshi Komiyama, the vice-president of the University of Tokyo, presided over the opening of these series and our project leader, Professor Nobuhide Kasagi, introduced the 21st Century COE Program, "Mechanical Systems Innovation." We invited famous researchers from home and abroad, and provided them multiple opportunities to exchange information about frontier research in their various fields. Poster sessions in each symposium invited presentations from numerous graduate students and young faculty members in the COE. This marked a great opportunity for them to inform the scientific community of their research.

International Symposium on Micro/Nano Thermal and Fluids Systems


"Question from Prof. Sebastian Volz"

This symposium was held for two full days on Monday, December 6 and Tuesday, December 7. About 150 researchers from home and abroad gathered to exchange information and thus expand their understandings of micro/nano thermal and fluids systems in the field of biotechnology and energy.

The first day featured lectures on micro/nano thermal and fluids systems by Professor F. Jensen (Massachusetts Institute of Technology, USA) and Professor Stish G. Kandlikar (Rochester Institute of Technology, USA).

On the second day, Dr. Sebastian Volz (Ecole Central Parl, France) posted new information about near-field heat transfer between nanoparticles. There were 13 additional speakers this day, including 6 speakers from overseas. Their presentations were followed by active discussion.

About 40 graduate and post-doc students displayed poster presentations throughout the two days, and they had a wonderful opportunity to develop a sense of the international research through active information exchange with the invited researchers.

International Symposium on Biomedical Systems Innovation

This symposium was held for two full days on Wednesday, December 8 and Thursday, December 9. It was kicked off with an opening address by Professor Kimihiko Hirao, Dean of the School of Engineering. This symposium consisted of four sessions: biomedical systems simulation, surgical and welfare robotic systems, noninvasive or minimally invasive medical therapy and nano/micro bioengineering. About 110 researchers from home and abroad gathered and exchanged information. Leading researchers in their various fields delivered lectures. Professor Paolo Dario (Scuola Superiore Sant'Anna, Italy) and Professor Charles A. Taylor (Stanford University, USA) posted new information about medical therapy and biotechnology research. There were 16 speakers including 5 speakers from overseas. There was an active discussion after each lecture.


"Presentaion by Prof. Paolo Dario"

International Symposium on Innovative Aerial/Space Flyer Systems

This symposium was held for two full days on Friday, December 10 and Saturday, December 11. The opening address was delivered by Professor Kimihiko Hirao, Dean of the School of Engineering. The latest research developments concerning dynamics and the design of micro /unmanned air vehicles were presented. There were 19 speakers including 10 speakers from overseas. About 190 researchers from home and abroad gathered and exchanged information.

Perhaps the most impressive lecture was a demonstration flight of the world's smallest autonomous vehicle, developed by Dr. Osamu Miyazawa (Seiko Epson Co. Ltd.). He demonstrated three minutes of continuous flight by the vehicle onstage. The participants burst into applause. An active question-and-answer period was held after the session.


"Flight demonstration by Dr. Osamu Miyazawa"

About 20 graduate students had short presentations in the poster session on the second day. There was an active discussion between researchers and young faculty members. This was of great value to the developing young researchers.

Voices from young researchers

Effects of Mechanical Forces on Cells

Shunsuke Iwayoshi, Ph.D. course student, Department of Mechanical Engineering

In physiological conditions, the movement of blood through blood vessels generates physical forces on the blood vessels such as shear stress due to tangential dragging by flow and circumferential strain due to pulsatile pressure changes. These mechanical forces cause blood vessel remodeling, in vivo, and also cell shape changes, in vitro. For example, when cyclic uniaxial stretch is applied to cultured endothelial cells (ECs), which consist of blood vessel inner lumen, ECs change their shapes within several hours to become more oriented and more elongated perpendicular to the direction of stretch. It has been suggested that cytoskeleton and Rho family GTPase signaling are involved in this cell shape remodeling, but the roles of these molecules are still unclear. In my research, I am trying to reveal the mechanisms of endothelial morphological changes in response to cyclic stretch by visualization of actin cytoskeleton remodeling via the Green Fluorescent Protein (GFP) technique and of Rho GTPase signaling via the Fluorescent Energy Transfer (FRET) technique.

Since mechanical forces effect tissue remodeling, they are expected to be powerful tools in constructing tissue-engineered organs with the desired mechanical properties for regenerative medicine. In addition, mechanical forces can cause pathological conditions such as arteriosclerosis. Elucidation of the mechanisms by which cells respond to mechanical forces would be a great help in advanced medicine. As research in this field needs the contributions of mechanical engineers as well as biologists, I hope to do creative work as a research assistant of the 21st century COE Program, Mechanical System Innovation.

Micro- and Meso-scale analyses of lipid membranes

Taisuke Sugii, Ph.D. course student, Department of Mechanical Engineering

My research is related to multi-scale analysis of microcirculation systems, and belongs to the project of “Hyper Modeling / Simulation” within this COE program. Blood is a multi-component fluid, containing dispersed components such as red blood cells (RBCs). In microcirculation systems, blood flows through capillaries, which are often narrower than the size of the RBCs, leading to deformation of the RBCs. Therefore, the dynamics of blood flow with deformable components plays an important role in maintaining a normal distribution of nutrients and gases such as oxygen throughout the body, and in keeping tissues in a healthy state. Moreover, many applications of artificially dispersed components as carriers have been recently proposed; one prominent example is Drug Delivery System (DDS), in which medical agents are enclosed in vesicles (closed components made of amphiphilic molecules just as RBCs are) and delivered to the affected area of the body. For these and other reasons, investigations of the behavior of vesicles in blood capillaries have become important. In our laboratory, we are attacking this problem on various scales: those of the membrane molecules (the micro-scale), the vesicle (the meso-scale) and the blood flow containing many vesicles (the macro-scale). My research involves micro- and meso-scale computer simulations of lipid membranes. For example, I have analyzed the responses of molecules and membranes to mechanical stimulations such as membrane dilation or shear flow, and have investigated the relationships of my findings to macroscopic theories of membrane deformation. Many macroscopic phenomena are closely related to microscopic behaviors of membrane molecules when vesicle dynamics is accompanied by deformations and molecular transport across membranes. I am also considering a systematic analysis from the micro-scale to the meso- or the macro-scale. Meanwhile, through the many activities of this COE project, I have had opportunities to meet students and researchers from various laboratories. It is very beneficial to have the chance to extend my understanding in this way, because I need a broad frame of reference to deal with these multi-scale phenomena. I deeply value this opportunity to develop working relationships with other researchers.

Report of MICCAI 2004

7th Medical Image Computing and Computer-Assisted Intervention

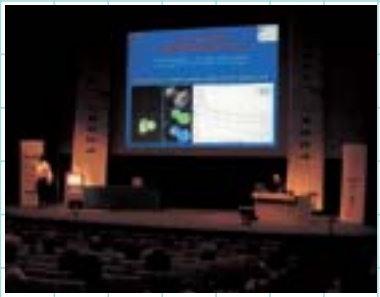
Naohiko Sugita, Research Associate, Department of Engineering Synthesis

From September 26 to September 30 in 2004, I participated in the 7th Symposium on Medical Image Computing and Computer-Assisted Intervention (MICCAI2004) held at St. Malo in France.

International conferences in computer graphics, image analysis, robotics (VBC, CVRMed, MRCAS) were unified in 1998, and this international conference was born as a gathering of the highest authorities in the respective fields. Cooperation between specialists of various disciples like medicine and engineering, image engineering and robotics, image analysis and graphics is especially important in an environment of rapidly evolving technology.

Presentations consisted of lectures and poster displays, and there were separate sessions in "Registration," "Segmentation," "Medical image analysis / visualization" and "Medical robot engineering."

I presented a poster with the title, "Development of a Novel Robot-Assisted Orthopaedic System designed for Total Knee Arthroplasty." This study was related to a medical robot-surgery system that aids in bone-cutting during total knee arthroplasty (TKA). I received valuable advice on my project from those who discussed it with me.



Hall for lectures

I also participated in a plenary session and feel that it was very useful because I was able to debate with many researchers about issues in medical imaging / robotics.

Cross-department doctoral course

Shinsuke Sakai, Professor, Department of Mechanical Engineering

A cross-department doctoral course is being carried out as one of the main objectives of the 21st century program, "Mechanical System Innovation (MSI)." The target students are mainly doctoral course students in 6 COE-related departments who have been selected as research assistants (RA). The main activity of this educational program is three classes in the School of Engineering entitled, "Mechanical System Innovation I, II and III". These classes are managed by Prof. Sakai (Dept. Mechanical Engineering), Prof. Washizu (Dept. Mechanical Engineering) and Prof. Nakasuka (Dept. Aeronautics and Astronautics) together with research associates and PDs. The classes correspond to the three main fields in MSI, energy, biomedical engineering and hyper modeling. Several teams of 4 to 5 students from different departments are formed in each class. At the beginning, the team subject is developed and the team members discuss the subject. In addition to the student discussion, related persons are invited to the class and a seminar with discussion is held. Each team member is allocated an assignment. The interim open workshop for the team activities is held at the end of the summer semester, and the final workshop is held at the end of the year-long sequence, in January. In the final workshop, an outline of each group's activities is presented in English, and the details are shown at poster session afterwards. In addition, the RA students are supposed to join the COE-related research seminars and international symposiums. It is expected that these diverse experiences and interactions will lend students a new perspective of mechanical engineering.

A Specially Appointed Professor is Employed

Toshiki Iino, Specially appointed professor, Department of Mechanical Engineering

My name is Toshiki Iino. I started working as a professor for the 21st century COE program "Mechanical Systems Innovation" in January of this year (2005).

Graduating from Department of Mechanical Engineering, the University of Toyko in 1969, I started my career as a researcher in the field of fluids engineering at the Mechanical Engineering Research Laboratory of Hitachi, Ltd. Over several decades, I have been engaged mainly in R & D management for that firm, as well as being an active participant in various societies of engineers. I resigned from Hitachi last December.

My mission in the COE program "Mechanical Systems Innovation" is to develop a unique education system for the University of Tokyo based on a reasonable projection of what society's needs will be in the middle of the 21st century. We are also striving to create a better flow of human resources between industry and academe, by which some doctoral course graduates will enter industries and lead R & D activities there and some of these will return to the university to pursue research and teaching there. I believe this kind of human resource circulation will lead to a more attractive and relevant doctoral course education and will thus spearhead a revival in Japanese industries.

Participating as a member of the COE program will broaden my connections with leaders in various applied research fields, and will thus contribute enormously to the innovations I seek to implement.

Specially Appointed Research Associates are Employed

Yosuke Hasegawa, Specially Appointed Research Associate, Department of Mechanical Engineering

I am Yosuke Hasegawa. I earned a Ph.D. in Engineering in September, 2004, and started working as a specially appointed research associate of the 21st century COE program in October 1st, 2004.

In my doctoral course, I was involved in the development of a high Schmidt number turbulent mass transfer model for CO_2 absorption into free liquid interfaces. Research on how to predict the gas transfer rate from observable information such as wind velocity, surface slope, etc. is quite challenging work, since it involves many hydrodynamic factors such as turbulent transport, multi-phase flow, interfacial waves, etc. Furthermore, recent experimental results suggest the critical roles of surface-chemical factors such as surface contamination and the presence of electrolytes. My own experience with this research has indicated the need for multi-physics and multi-scale analyses for better prediction of gas exchange in the future.

Establishment of hyper-modeling and high-performance simulation is one of the key issues in this COE program. I would like to take this opportunity to consider how these simulation techniques can support the creation of innovative mechanical systems. I very much appreciate the valuable advice from advanced colleagues and active discussion with them I have experienced thus far in this program.

Kensuke Tsuchiya, Specially Appointed Research Associate, Department of Engineering Synthesis

My name is Kensuke Tsuchiya. I have been a specially appointed research associate in this 21st COE program since October 20, 2004.

I worked as a research associate for two and a half years at the Institute of Engineering Innovation in the University of Tokyo, after receiving a Ph.D. in the Department of Engineering Synthesis.

My specialty is micro-/nano- fabrication and assembly. When I was a student, I developed a 3-dimensional handling system for use under a Scanning Electron Microscope that featured end effectors installed with manipulators. I applied the system to Intracytoplasmic Sperm Injection and DNA surgery.

Initially, I constructed micro-structures to demonstrate the system; however, the actual operation showed it to have low performance. Thus, I targeted high-value operations in refining the system.

Recently, I have been involved in developing various micro-devices for biomedical, chemical and production technologies. I would like to make further contributions by collaborating with researchers in other fields.

Program Executive Organization

Project Promoters

Program leader

Nobuhide Kasagi
Professor, Department of Mechanical Engineering, School of Engineering

Energy innovation

Toshio Nagashima
Professor, Department of Aeronautics and Astronautics, School of Engineering
Chisachi Kato
Professor, Department of Human and Society, Institute of Industrial Science
Takayuki Terai
Professor, Department of Quantum Engineering and System Science, School of Engineering
Kazuo Kageyama
Professor, Department of Environmental and Ocean Engineering, School of Engineering
Nobuo Takeda
Professor, Department of Advanced Energy, School of Frontier Sciences
Tamaki Ura
Professor, Department of Environmental and Ocean Engineering, Institute of Industrial Science
Shinichi Nakasuka
Professor, Department of Aeronautics and Astronautics, School of Engineering
Toyoshisa Fujita
Professor, Department of Geosystem Engineering, School of Engineering

Biomedical innovation

Mamoru Mitsuishi
Professor, Department of Engineering Synthesis, School of Engineering
Masao Washizu
Professor, Department of Mechanical Engineering, School of Engineering
Masayuki Nakao
Professor, Department of Engineering Synthesis, School of Engineering
Teruo Fujii
Associate Professor, Department of Environmental and Ocean Engieering, Institute of Industrial Science

Hyper modeling / simulation

Masahiro Shoji
Professor emeritus, Department of Mechanical Engineering, School of Engineering
Yoichiro Matsumoto
Professor, Department of Mechanical Engineering, School of Engineering
Takafumi Fujita
Professor, Department of Information and System, Institute of Industrial Science
Hideaki Miyata
Professor, Department of Environmental and Ocean Engineering, School of Engineering
Shinsuke Sakai
Professor, Department of Mechanical Engineering, School of Engineering

Specially appointed members

Toshiki Iino
Specially Appointed Professor, International Research and Education Center for Mechanical Systems Innovation, School of Engineering
Kensuke Tsuchiya
Specially Appointed Research Associate, International Research and Education Center for Mechanical Systems Innovation, School of Engineering
Yosuke Hasegawa
Specially Appointed Research Associate, International Research and Education Center for Mechanical Systems Innovation, School of Engineering

Advisory Committee

Advisory Committeemen

Koutaro Inoue	Senior Fellow, Japan Science and Technology Agency	Yoshitsugu Kimura	Chair, President, Kagawa University
Noboru Kikuchi	Professor, The University of Michigan	Tetsuya Tateishi	Professor, Tokyo Denki University

Activities of Mechanical Systems Innovation Program (scheduled)

〈Open Seminars〉

◎FY2004-15th Seminar
Date : December 15, 2004
Venue : Conference Room No.1, Institute of Industrial Science, Komaba Campus
Speaker : Dr. Peigang Deng (Department of Mechanical Engineering, The Hong Kong University of Science and Technology)
Subject : Micro Bubble Actuator for DNA Hybridization Enhancement

◎FY2004-16th Seminar
Date : January 28, 2005
Venue : Lecture Room No.226, Faculty of Engineering Bldg.8, Hongo Campus
Speaker : Prof. Rodney S. Ruoff (Department of Mechanical Engineering, Northwestern University)
Subject : Mechanics of Nanostructures and Nanocomposites

◎FY2004-17th Seminar
Date : March 9, 2005
Venue : Seminar Room No.2, Faculty of Engineering Bldg.2, Hongo Campus
Speaker : Prof. Yu-Chong Tai (Department of Electrical Engineering and Bioengineering, Calfornia Institute of Technology)
Subject : MEMS for Biomedical Applications: Emphasizing Blood Count On-a-Chip and Flexible Retinal Implant

〈Special Lecture〉

◎Cape Horn Expedition 2004
Date : June 28, 2004
Venue : Takeda Hall, Takeda Building, Asano Campus
Speaker : Prof. Yoshio Tsukio (Department of Mechanical Engineering, The University of Tokyo)
Subject : Cape Horn Expedition 2004

〈International Symposia〉

◎International Sympsium on Micro/Nano Thermal and Fluids Systems
Date : December 6-7, 2004
Venue : Takeda Hall, Takeda Building, Asano Campus

◎International Sympsium on Biomedical Systems Innovation
Date : December 8-9, 2004
Venue : Takeda Hall, Takeda Building, Asano Campus

◎International Sympsium on Innovative Aerial Robotics
Date : December 10-11, 2004
Venue : Takeda Hall, Takeda Building, Asano Campus

〈Cross-Department Doctoral Course〉

◎Research Assistant Final Debrief Session
Date : January 28, 2005
Venue : Takeda Hall, Takeda Building, Asano Campus

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