Daily Schedule

Tohoku University Engineering Summer Program 2017 – Robotics

Week 1

◇ **CH: Center Hall (C01)** ◇ **#611: Research Building M.A.E. (A15) Room #611** ◇ **AMH: Aoba Memorial Hall (C03)**

	July 23 (Sun)	July 24 (Mon)	July 25 (Tue)	July 26 (Wed)	July 27 (Thu)	July 28 (Fri)	July 29 (Sat)
8:50 10:20	Arrival Hotel Check-In (14:00-)	9:30 【CH2F】 Opening Ceremony	【#611】 Cameras and Image Sensors (Kagami)	【#611】 Robotics as Systems Integration, an overview I (Kosuge)	【#611】 Robotics for Human Assistance (Hirata)	【#611】 Molecular Robotics I (Murata)	Field Trip
10:30 12:00		【CH2F】 Space Robotics I (Yoshida)	【#611】 Visual Servo and Its Application in Robotics (Hashimoto)	【#611】 Robotics as Systems Integration, an overview II (Kosuge)	【#611】 Neuro-Robotics (Hayashibe)	【#611】 Molecular Robotics II (Murata)	
12:00 13:00		【CH1F "DOCK"】 Welcome Lunch	Lunch	Lunch	Lunch	Lunch	
13:00 14:30		13:45 【CH2F】 Introduction of Robotics Hands-On Activity (Yoshida)	Open Campus Lab Visit and Japanese Culture 【AMH】	Open Campus Lab Visit and Japanese Culture 【AMH】	Laboratory Hands-On Activity @ each lab.	Laboratory Hands-On Activity @ each lab.	
14:40 16:10		Laboratory Hands-On Activity @ each lab.					

Week 2

◇ **CH: Center Hall (C01)** ◇ **#611: Research Building M.A.E. (A15) Room #611** ◇ **AMH: Aoba Memorial Hall (C03)**

	July 30 (Sun)	July 31 (Mon)	August 1 (Tue)	August 2 (Wed)	August 3 (Thu)	August 4 (Fri)	August 5 (Sat)
8:50 10:20		【#611】 Space Robotics II (Yoshida)	【#611】 Computer Vision I (Okatani)	【#611】 Haptic Interfaces (Konyo)	【#611】 Medical and Health Care Applications of Microsystem Technologies (Haga)	Hands-On Activity (Preparation for Final Presentation) @ each lab	Hotel Check-Out (-11:00)
10:30 12:00		【#611】 Space Robotics III (Yoshida)	【#611】 Computer Vision II (Okatani)	【#611】 Disaster Robotics (Tadokoro)	【#611】 Field Robotics (Nagatani)		
12:00 13:00		Lunch	Lunch	Lunch	Lunch	Lunch	
13:00 14:30		Laboratory Hands-On Activity @ each lab.	Laboratory Hands-On Activity @ each lab.	Laboratory Hands-On Activity @ each lab.	13:30- Bio-inspired Robotics and Robot-inspired Biology (Ishiguro) 【Katahira】	13:00-16:30 【CH2F】 Final Presentation	
14:40 16:10					Laboratory Hands-On Activity @ each lab.		
						16:30 【CH2F】 Closing Ceremony	
						19:00 - 21:00 【Downtown】 Farwell Party	

: Ceremony, Student Activity

: Lecture

: Laboratory

Lecture Titles

Tohoku University Engineering Summer Program 2017 – Robotics

	Time	Title	Place	Professors
1	July 24,Mon 10:30-12:00	**Space Robotics I**	Center Hall 2F Conf. Room	Prof. Kazuya Yoshida
2	July 25,Tue 8:50-10:20	**Cameras and Image Sensors**	Room #611	Assoc. Prof. Shingo Kagami
3	July 25,Tue 10:30-12:00	**Visual Servo and Its Application in Robotics Space Robotics II**	Room #611	Prof. Koichi Hashimoto
4	July 26,Wed 8:50-10:20	**Robotics as Systems Integration, an Overview I**	Room #611	Prof. Kazuhiro Kosuge
5	July 26, Wed 10:30-12:00	**Robotics as Systems Integration, an Overview II**	Room #611	Prof. Kazuhiro Kosuge
6	July 27,Thu 8:50-10:20	**Robotics for Human Assistance I**	Room #611	Prof. Yasuhisa HIrata
7	July 27, Thu 10:30-12:00	**Neuro-Robotics**	Room #611	Prof. Mitsuhiro Hayashibe
8	July 28, Fri 8:50-10:20	**Molecular Robotics I**	Room #611	Prof. Satoshi. Murata
9	July 28, Fri 10:30-12:00	**Molecular Robotics II**	Room #611	Prof. Satoshi. Murata
10	July 31, Mon 8:50-10:20	**Space Robotics II**	Room #611	Prof. Kazuya Yoshida
11	July 31, Mon 10:30-12:00	**Space Robotics III**	Room #611	Prof. Kazuya Yoshida
12	August 1, Tue 8:50-10:20	**Computer Vision I**	Room #611	Prof. Takayuki Okatani
13	August 1, Tue 10:30-12:00	**Computer Vision II**	Room #611	Prof. Takayuki Okatani
14	August 2, Wed 8:50-10:20	**Haptic Interfaces**	Room #611	Assoc. Prof. Masashi Konyo
15	August 2, Wed 10:30-12:00	**Disaster Robotics**	Room #611	Prof. Satoshi Tadokoro
16	August 3, Thu 8:50-10:20	**Medical and Health Care Applications of Microsystem Technologies**	Room #611	Prof. Yoichi Haga
17	August 3,Thu 10:30-12:00	**Field Robotics**	Room #611	Assoc. Prof. Keiji Nagatani
18	August 3,Thu 13:30-14:00	**Bio-inspired Robotics and Robot-inspired Biology**	Katahira Campus	Prof. Akio Ishiguro

Lecturer Profile and Outline of Classes

(in the alphabetic order of lecturer's family name)

Yoichi HAGA, Professor, Graduate School of Biomedical Engineering

"Medical and Health Care Applications of Microsystem Technologies"

Abstract

Using microfabrication technologies called micromachining and nanotechnology, small medical devices with several functions for use in the human body have been developed. Several new technologies, for example, MEMS (Micro Electro Mechanical Systems) technologies, ultra-precision machining, laser machining are used for fabrication. Minimally invasive examinations and therapies with endoscopes and catheters are already widely performed, and new more precise examinations and diagnoses which have been impossible to date can now be realized by installing microsensors in these medical devices. Furthermore, more precise and safe surgical treatment can be realized by installing microactuators (shape memory alloy, piezoelectric elements, etc.) in the minimally invasive therapeutic devices. Thin, soft and small wearable health care devices which is mounted on human body surface enable new useful measurement item in daily life, for example fatigue and stress level.

Research Interests

(1) Active Catheter and Endoscope Using Shape Memory Alloy Actuators
(2) Ultra Miniature Fiber-Optic Pressure Sensor
(3) Intravascular Forward-looking Ultrasonic Probe
(4) Wearable-type Healthcare Devices

Honors and Awards

2014 Best Paper Award (Engineering), Japan Society of Computer Aided Surgery
2012 IEEJ Technical Development Award, The Institute of Electrical Engineers of Japan
2007 Best Paper Award, Japanese Society for Medical and Biological Engineering
2004 Best Presentation Award, Welfare Engineering Symposium, The Japan Society of Mechanical Engineers
2004 Best Paper Award, Japan Society of Computer Aided Surgery
2002 JSAO-Grant, Japanese Society for Artificial Organs

Koichi HASHIMOTO, Professor, Graduate School of Information Sciences

"Visual Servo and Its Application in Robotics"

Abstract

Visual servo is a feedback control framework useful for robot motion generation. It can also be used for robust image processing. Using with high-speed cameras image processing algorithms with feedback structure presents outstanding robustness. A parallel processing algorithm suitable for GPU architecture will be introduced. In this lecture, many visual servo applications of robot manipulation systems including robotic manufacturing, visual inspection and microscope robots are presented.

Research Interests

(1) Theoretical issues in visual servo
(2) High-speed vision systems and high-speed image processing algorithms
(3) GPU programming
(4) Visual servo microscope
(5) Optgenetic motion control of micro bio-systems
(6) Fluorescent 3D measurement of neural activity from freely moving animals.

Honors and Awards

2013 Vice-Dean of GSIS
2013 Fellow, SICE
2011 Assistant for University President
2011 Best Contribution Award, Society of Instrument and Control Engineers (SICE)
2010 Best Paper Award, Journal of Institute of Systems, Control and Information Engineering
2009 Best Paper, IEEE Int. Conf. Mechatronics and Automation
2006 Best Biomimetics Paper, IEEE Int. Conf. Robotics and Biomimetics
2005 Best Mechatronics Paper, IEEE Int. Conf. Mechatronics and Information Technology
2004 Best Vision Paper Finalist, IEEE Int. Conf. Robotics and Automation
1994 Young Investigator Excellence Award, Robotics Society of Japan

Mitsuhiro HAYASHIBE, Professor, Graduate School of Engineering

“Neuro-Robotics”

Abstract

The current era is recently referred as a century of robotics and AI. However, there are still a lot of things we need to deeply learn from advanced and robust human motor control and sensory functions which humans only own. Under the known rule and predefined environment, robot and AI can outperform the capability of human thanks to its computation and memory performance. But it is obvious human can revenge once the unknown or new rule is applied or the new dynamics environment is introduced.

Robotics is effective as a computational tool to understand human motor learning mechanism. Then, it can be used to understand human sensory motor system, and it can be also used as an augmenting technology for neuro-rehabilitation. Neuroscience is useful to provide new insights to improve the current robotics function. In our lab, we study on neuroscience for robotics and robotics for neuroscience as “Neuro-Robotics”. In this lecture, relevant topics regarding Neuro-Robotics and Neuroprosthetics will be introduced.

[reference article]

E. Demircan, D. Kulic, D. Oetomo, M. Hayashibe, "Human Movement Understanding", IEEE Robotics and Automation Magazine, vol.22, no.3, pp.22-24, 2015.

Research Interests

Human motor control

Learning mechanism

Neuroprosthetics

Neurorehabilitation

Honors and Awards

2016 Swiss National Science Foundation fellowship for Short Visits. (EPFL)

2015 Habilitation degree (Professor qualification) at University of Montpellier, France.

2008 Academic Tenure with INRIA (Institut National de Recherche en Informatique et en Automatique), France.

2005 CAS Young Investigator Award, Gold Prize from Hitachi Medical Systems

2005 Best Paper Award, Journal of Japanese Society for Computer-Aided Surgery

2003 MMVR (Medicine Meets Virtual Reality) Best Poster Presentation Award

Yasuhisa HIRATA, Professor, Graduate School of Engineering

“Robotics for Human Assistance”

Abstract

Most of robots have been used as industrial robots in factories to replace humans doing tasks, which humans do not want to do or could not do, and have been isolated from humans. Recently, however, we expect to utilize robot systems not only the industrial fields but also the fields such as home, office and hospital in cooperation with human. For realizing the physical supports for human being by using the robot systems, we have to consider two main points: achieving high performance and user safety. In this lecture, the human-robot cooperation systems for augmenting the human performance will be given. In addition, the passive robotics concept, which can realize the high-safety robot, will be introduced, and the motion control methods of several passive robots will be lectured.

Research Interests

Human-Robot Cooperation

Assistive Robot

Passive Robot

Multiple Robots Coordination

Honors and Awards

Young Investigator Excellence Award, Robotics Society of Japan in 2001

Best Paper in Robotics Award of ROBIO in 2004

JSME Award for best paper, Japan Society of Mechanical Engineers in 2005

Best Paper Award, Robotics Society of Japan in 2005

Original Paper Award, FANUC FA and Robot Foundation in 2006

Young Scientists’ Prize, The Commendation for Science and Technology, Minister of Education, Culture, Sports, Science and Technology in 2014

Akio Ishiguro, Professor, Research Institute of Electrical Communication

"Bio-inspired Robotics and Robot-inspired Biology"

Abstract

Animals are able to exhibit surprisingly adaptive and resilient behavior in real time under real world constraints. Such movements are achieved via spatiotemporal coordination of a large number of bodily degrees of freedom in response to the environment. Clarifying the control principle underlying this remarkable ability of animals allow us to understand biological systems more deeply as well as to construct truly adaptive robot that could not be realized solely by the conventional robotics technology.

In the lecture of "Bio-inspired Robotics and Robot-inspired Biology," our current activities are introduced. We also show demonstration of some of our robots developed in our lab.

Research Interests

(1) Bio-inspired robotics

(2) Robotics-inspired biology

(3) Synthetic paleontology

Honors and Awards

2016 WIRED Audi Innovation Award

2014 CLAWAR Association Best Technical Paper Award

2012 IEEE/RSJ International Conference on Intelligent Robots and Systems JCTF Novel Technology Paper Award for Amusement Culture Finalist

2012 The International Conference on Biomimetic & Biohybrid Systems Best Paper Award

2011 IEEE/RSJ International Conference on Intelligent Robots and Systems NTF Award Finalist for Entertainment Robots and Systems

2009 IEEE/RSJ International Conference on Intelligent Robots and Systems Best Paper Award Nomination Finalist

2008 Ig Nobel Prize (Cognitive Science Prize)

2004 IEEE/RSJ International Conference on Intelligent Robots and Systems Best Paper Award

2003 IEEE/RSJ International Conference on Intelligent Robots and Systems Best Paper Award Nomination Finalist

Shingo KAGAMI, Associate Professor, Graduate School of Information Sciences

"Cameras and Image Sensors"

Abstract

In order to investigate and develop advanced technologies for robot vision, image-based control and vision-based intelligent systems, it is important to understand how cameras acquire images, and how obtained images are affected by sensor structures and dynamic aspects of sensor operations. This lecture describes the principles, structures and operations of CCD/CMOS image sensors and camera systems. It also mentions related advanced topics such as high-speed imaging and exposure control as well as their applications.

Research Interests

(1) High-speed vision systems and real-time vision processing

(2) Vision application in robotics and human interfaces

(3) Real-time sensory information processing

Honors and Awards

2011 Research Incentive Award, M. Ishida Foundation

2010 Frontier Paper Award, Meeting on Image Recognition and Understanding

2009 Best Conference Paper Award, IEEE International Conference on Mechatronics and Automation

2004 Young Investigator Excellence Award, Robotics Society of Japan

2000 Incentive Award, IEEE Solid-State Circuits Society Japan Chapter

Masashi KONYO, Associate Professor, Graduate School of Information Sciences

“Haptic Interfaces”

Abstract

Haptics is all things related to our sense of touch. Creating haptic feedback for human interfaces contributes to enhancing our communication and physical capabilities. In this lecture, the recent topics and the state-of-art on haptic interfaces are introduced, especially from the aspect of cutaneous sensations. Advanced vibration feedback technologies, which produce force-like sensations, such as friction, inertia, and viscosity sensations for mobile information devices and motion support system are also introduced.

Research Interests

Haptics, Tactile Display, Tactile Sensor, New Actuators, Virtual Reality

Honors and Awards

Best Paper Award, Journal of Robotics and Mechatronics, 2010

Best Paper Award, Transaction of Virtual Reality Society of Japan, 2002 and 2007

Best Poster Award of IEEE World Haptics Conference 2007 and 2013

Best Hands on Demo Award at the EuroHaptics 2008

Best Demo Award of IEEE Haptics Symposium 2014

ROBOMEC Award, JSME Robotics and Mechatronics Division, 2001, 2007, 2008, 2009, and 2012

Kazuhiro KOSUGE, Professor, Graduate School of Engineering

"Robotics as Systems Integration, an Overview I, II"

Abstract

First, two issues for robot systems integration are discussed. One is related to how to integrated devices and unit technologies into robot systems and the other is related to how the robotic systems are integrated into society. Both issues are very important for bringing the robotics into the real world. Then, the systems integration issues are discussed using examples of robots and RT systems having physical interactions with humans which include robot helpers, passive robotic systems, and walking helpers. The dance partner robot, PBDR, is also discussed as a research platform for the future robot and RT systems for quality of life.

Research Interests

Robotics
New Robots Design
Intelligent Systems Design
Control Engineering

Honors and Awards

Director & Delegate, Division X, IEEE (2015-2016)
Member, Board of Directors, IEEE (2015-2016)
President, IEEE Robotics and Automation Society (2010-2011)
IEEE Fellow
RSJ Fellow
JSME Fellow
SICE Fellow
JSAE Fellow
JSME Awards for the best papers, Japan Society of Mechanical Engineers in 2002 and 2005
RSJ Award for the best papers from the Robotics Society of Japan in 2005
Original Paper Award, FANUC FA and Robot Foundation in 2004 and 2006
Best Paper Award of IROS'97

Satoshi MURATA, Professor, Graduate School of Engineering

“Molecular Robotics I, II”

Abstract

The concept of nanometer scale mechanical systems first appeared in the famous lecture “There is plenty of room at the bottom” by Feynman (1959). Inspired by this idea, Drexler claimed that it is possible to build innovative artificial molecular machines such as gears and bearings by using a universal assembler that assembles atoms. Although his idea was met with much skepticism, it led to the establishment of a research field called *molecular nanotechnology.* In this lecture, DNA nanotechnology which is one of those emerging molecular nanotechnologies will be depicted. By the DNA nanotechnology, it becomes possible to make various mechanical and/or information processing devices out of DNA molecules. Accordingly, current efforts focus on creation of nanoscale molecular robots. Some topics on the frontline research will be reported.

Research Interests

(1) DNA Nanoengineering and its application to create Molecular Robots

(2) Distributed Autonomous Systems

(3) Sciences on Form

Honors and Awards

1992 IEEE Industrial Electronics Society, Outstanding Transaction Paper Award

1996 Outstanding Paper Award J.SICE 1996

1998, 2002, 2006 International Symposium on Distributed Autonomous Robotic Systems, Best Paper Award

2004 ROBOMEC Award, JSME

2007 Good Design Award, METI, Development of M-TRAN III (as a chief designer)

Keiji NAGATANI, Associate Professor, New Industry Creation Hatchery Center (NICHe)

“Field Robotics”

Abstract

Field robots are expected to work in irregular outdoor terrains and hostile environments, instead of human. Therefore, the field robotics research includes the following topics: high-performance mobility, environment mapping and localization, path planning and navigation, and supervisory teleoperation. In the lecture of “Field Robotics”, some technical issues relating to the field robotics will be introduced, and mobility mechanism topics will be discussed in detail.

Research Interests

(1) Locomotion mechanism

(2) Teleoperation

(3) Mapping and path planning for mobile robots on rough terrain

(4) Autonomous navigation

Honors and Awards

1. Kisoi Motohiro Award (academic achievement): Keiji Nagatani, 2012, International Rescue System Institute.

2. IROS RoboCup Best Paper Award ：Yoshito Okada, Keiji Nagatani, Kazuya Yoshida, ``Semi-autonomous Operation of Tracked Vehicles on Rough Terrain using Autonomous Control of Active Flippers'', 2009 IEEE/RSJ International Conf. on Intelligent Robots and Systems.

3. Best Paper Award： Kenjiro Tadakuma, Riichiro Tadakuma, Hiroaki Kinoshita, Keiji Nagatani, Kazuya Yoshida, Martin Udengaard, Karl Iagnemma, ``Mechanical Design of Cylindrical Track for Sideways Motion'', 2008 IEEE International Conference on Mechatronics and Automation.

Takayuki OKATANI, Professor, Graduate School of Information Sciences

"Computer Vision I, II"

Abstract

It is said that more than eighty percent of sensory information humans receive is through vision. Computer vision is a research area that studies how to make a computer perform the high-level visual information processing that humans do. Its application covers a wide range including robot vision, video/film production, medical applications, computational photography etc. This lecture describes two key problems in computer vision, 3D reconstruction from multi-view images and visual object recognition, from their theoretical bases to practical applications.

Research Interests

(1) Statistical methods and optimization in computer vision

(2) Multi-view geometry and its applications, e.g., large-scale city modeling

(3) Image-based recognition of objects, materials, and others that humans can visually recognize.

Satoshi Tadokoro, Professor, Graduate School of Information Sciences

"Disaster Robotics"

Abstract

The Great Eastern Japan Earthquake was the first disaster where many robotic systems were used for disaster response and recovery. It is predicted that robotic systems become essential solutions in the near future. In this lecture, special topics related to rescue robots and systems will be introduced.

Research Interests

Rescue robotics, Actuators, Virtual Reality

Honors and Awards

President, IEEE Robotics and Automation Society 2016-2017
President, International Rescue System Institute
Program Manager, Japan Cabinet Office ImPACT Tough Robotics Challenge Program
IEEE Fellow, JSME Fellow, RSJ Fellow, SICE Fellow
RSJ Best Achievement Award
JSME RMD Best Achievement Award
SICE SI Best Achievement Award
RSJ Social Contribution Award
METI Robot of This Year
FDMA Commissioner Award

Kazuya Yoshida, Professor, Graduate School of Engineering

“Space Robotics I, II, III”

Abstract

Space robots have two distinct application fields: One is orbits around the earth. Manipulator arms mounted on Space Shuttle or International Space Station are in this category and dynamics and control in free-floating environment are of interest. The other is the surface of the moon or planets. Locomotion and remote/autonomous navigation are of interest. After a general introduction of current achievements in space robotics, specific focuses are placed on *Hayabusa*, a Japanese asteroid probe and the sensing and navigation of a wheeled mobile robot (rover) for lunar/planetary exploration.

In the lecture of “Micro-satellites and Micro-rovers,” our current activities on micro-satellites and micro-rovers are introduced. As for the micro-satellites, a university-made “RISING-2” satellite was launched on May 24, 2014 and it is now making top-of-the-world level achievements. As for the micro-rovers, lunar rovers for the GLXP challenge are elaborated.

[reference article]

"Achievements in Space Robotics" Kazuya Yoshida, IEEE Robotics & Automation Magazine, Volume: 16, Issue: 4, pp.20-28, 2009.

Research Interests

(1) Dynamics and control of space robotic systems ranging from orbital free-flying robots to planetary exploration rovers

(2) Development of university-based micro-satellites

(3) Terrestrial applications of space technology, such as robotics remote exploration for search and rescue missions.

Honors and Awards

2015 Terrestrial Milestone Prize in Google Lunar XPRIZE (for team HAKUTO)

2014 Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, Japan

2008 Award for Excellence in Physical Science & Mathematics for Springer Handbook of Robotics, Association of American Publishers, Inc.

2008 Best Paper Award in IEEE 2008 International Conference on Mechatronics and Automation

2001 Best Conference Paper Award in IEEE 2001 International Conference on Robotics and Automation

1998-Now Visiting Faculty of International Space University

JSME Fellow, JSASS Fellow, RSJ Fellow