TESP 2018-Robotics

Tohoku University Engineering Summer Program in 2018

for graduate students

Daily Schedule

Week 1

◇ CH: Center Hall (C01)　◇ #A07: Laboratory Building M.A.E. (A07)　◇ AMH: Aoba Memorial Hall (C03)

	July 29 (Sun)	July 30 (Mon)	July 31 (Tue)	August 1 (Wed)	August 2 (Thu)	August 3 (Fri)	August 4 (Sat)
8:50 10:20	Arrival Hotel Check-In (14:00-)	9:30 【CH2F】 Opening Ceremony	【#A07】 Space Robotics II (Yoshida)	【#A07】 Robotics as Systems Integration, an overview (Kosuge)	【#A07】 Disaster Robotics (Tadokoro)	【#A07】 Computer Vision (Okatani)	Field Trip
10:30 12:00		【CH2F】 Space Robotics I (Yoshida)	【#A07】 Space Robotics III (Yoshida)	【#A07】 Vision-based Robot Control (Arai)	【#A07】 Haptic Interfaces (Konyo)	【#A07】 Field Robotics (Nagatani)	
12:00 13:00		【CH1F "DOCK"】 Welcome Lunch	Lunch	Lunch	Lunch	Lunch	
13:00 14:30		【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.					

: Ceremony, Student Activity　: Lecture　: Laboratory

Week 2

◇ CH: Center Hall (C01)　◇ #A07: Laboratory Building M.A.E. (A07)　◇ AMH: Aoba Memorial Hall (C03)

	August 5 (Sun)	August 6 (Mon)	August 7 (Tue)	August 8 (Wed)	August 9 (Thu)	August 10 (Fri)	August 11 (Sat)
8:50 10:20		【#A07】 Molecular Robotics I (Murata)	【#A07】 Visual Servo and Its Application in Robotics (Hashimoto)	【#A07】 Robotics for Human Assistance I (Hirata)	【#A07】 Neuro-Robotics (Hayashibe)	Hands-On Activity (Preparation for Final Presentation) @ each lab	Hotel Check-Out (-11:00)
10:30 12:00		【#A07】 Molecular Robotics II (Murata)	【#A07】 Cameras and Image Sensors (Kagami)	【#A07】 Robotics for Human Assistance II (Hirata)	【#A07】 Medical and Health Care Applications of Microsystem Technologies (Haga)		
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 2018 – Robotics

	Time	Title	Place	Professors
1	July 30,Mon 10:30-12:00	**Space Robotics I**	Center Hall 2F Conf. Room	Prof. Kazuya Yoshida
2	July 31,Tue 8:50-10:20	**Space Robotics II**	Building #A07	Prof. Kazuya Yoshida
3	July 31,Tue 10:30-12:00	**Space Robotics III**	Building #A07	Prof. Kazuya Yoshida
4	August 1,Wed 8:50-10:20	**Robotics as Systems Integration, an Overview**	Building #A07	Prof. Kazuhiro Kosuge
5	August 1, Wed 10:30-12:00	**Vision-based Robot Control**	Building #A07	Assoc. Prof. Shogo Arai
6	August 2,Thu 8:50-10:20	**Disaster Robotics**	Building #A07	Prof. Satoshi Tadokoro
7	August 2, Thu 10:30-12:00	**Haptic Interfaces**	Building #A07	Assoc. Prof. Masashi Konyo
8	August 3, Fri 8:50-10:20	**Computer Vision**	Building #A07	Prof. Takayuki Okatani
9	August 3, Fri 10:30-12:00	**Field Robotics**	Building #A07	Assoc. Prof. Keiji Nabgatani
10	August 6, Mon 8:50-10:20	**Molecular Robotics I**	Building #A07	Prof. Satoshi Murata
11	August 6, Mon 10:30-12:00	**Molecular Robotics II**	Building #A07	Prof. Satoshi Murata
12	August 7, Tue 8:50-10:20	**Visual Servo and Its Application in Robotics**	Building #A07	Prof. Koichi Hashimoto
13	August 7, Tue 10:30-12:00	**Cameras and Image Sensors**	Building #A07	Assoc. Prof. Shingo Kagami
14	August 8, Wed 8:50-10:20	**Robotics for Human Assistance I**	Building #A07	Prof. Yasuhisa HIrata
15	August 8, Wed 10:30-12:00	**Robotics for Human Assistance II**	Building #A07	Prof. Yasuhisa HIrata
16	August 9, Thu 8:50-10:20	**Neuro-Robotics**	Building #A07	Prof. Mitsuhiro Hayashibe
17	August 9,Thu 10:30-12:00	**Medical and Health Care Applications of Microsystem Technologies**	Building #A07	Prof. Yoichi Haga

Lecturer Profile and Outline of Classes

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

Shogo ARAI, Associate Professor, Graduate School of Engineering

"Vision-based Robot Control"

Abstract

With the price reduction of optical instruments such as cameras, projectors and three-dimensional measurement sensors, various type of robots are controlled based on vision. This lecture describes vision-based robot control schemes. The field of vision-based robot control includes the following technical topics; control theory, image processing, 3D measurement, visual servoing, 3D point cloud processing.

Research Interests

(1) Control Theory in Networked Control Systems
(2) Robot vision application in robotics
(3) Real-time sensory information processing

Honors and Awards

2010 Best Paper Award, Institute of Systems, Control and Information Engineers
2012 Best Paper Award Finalist in IEEE International Conference on Mechatronics and Automation 2012

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

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