

# Mechanical Systems and Urban Innovation Science

## Course of Intelligent Mechanical Systems

### Intelligent Systems Optimization



Since various kinds of radioactive wastes generate from nuclear-related facilities, medical-related facilities, etc., these must be safely disposed. The Fukushima Daiichi Nuclear Power Station accident occurred by the Great East Japan Earthquake in March 2011, and surrounding environment was contaminated by radioactive materials. Our laboratory is doing research and development (R & D) for improvement of the reliability of engineering technologies and advancement of safety assessment technologies, environmental dynamics such as behaviour of radioactive materials in

the environment contaminated by the Fukushima Daiichi Nuclear Power Station accident, radiation safety such as shielding and dose analyses, and their systems for design and analysis evaluation.

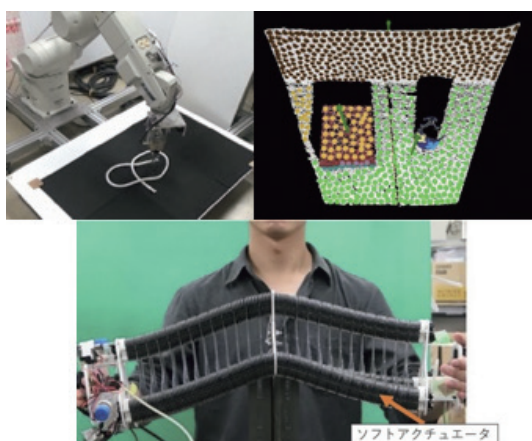


**Assoc. Prof. SATO Haruo**

■ Research Themes

Nuclear engineering/Radioactive waste (Backend engineering)/Environmental dynamics/Radiation safety (Radiation engineering)

### Intelligent Adaptive and Learning System



In our research field, our aim is to achieve robots capable of performing complex tasks, and we conduct fundamental research on advanced cognitive capabilities such as problem-solving, decision-making, and environment perception. Additionally, we strive for the social implementation of robots and engage in applied research in areas such as healthcare and rehabilitation.

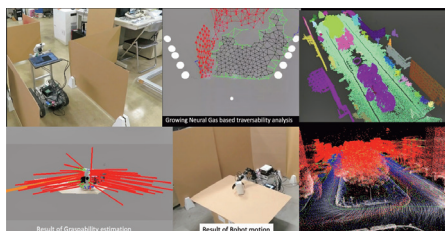


**Prof. MATSUNO Takayuki**

■ Research Themes

Surgical assistive robot/Manipulator robot

### Adaptive Autonomous Systems



We are conducting research on space perception and recognition to realize robots capable of executing autonomously in various environments. As a methodological foundation for these technologies, we are engaged in fundamental research on computational intelligence, represented by neural networks and evolutionary computation. Furthermore, by applying the developed methods to autonomous mobile robots and verifying their effectiveness, we aim to establish autonomous systems that function effectively in real-world environments.

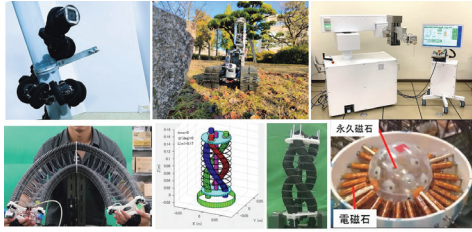


**Assoc. Prof. TODA Yuuichirou**

■ Research Themes

Soft computing

# Biorobotics



We research and develop robots that are highly adaptable to the environment like living organisms, robots that cooperate with humans, and robots that can be applied to humans. For example, we are researching and developing a snake-like robot that can move through various environments like a biological snake, and a rescue robot for disaster response. We are also developing a remote-controlled needle-puncturing medical robot and a rehabilitation device using soft actuators.

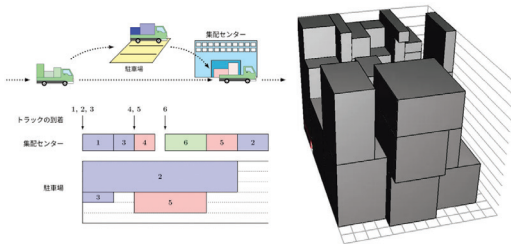


**Prof. KAMEGAWA Tetsushi**  
 ■ Research Themes  
 Robotics/Snake robots/Rescue robots/ Medical robots



**Asst. Prof. SHIMOOKA So**  
 ■ Research Themes  
 Soft robotics/Mechatronics/Actuator/ Medical and welfare engineering

# Mathematical Systems Optimization



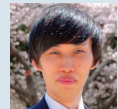
Operations research is a mathematical and scientific method for making better decisions on practical issues. In particular, we use mathematical system optimization to solve various problems in production, logistics, and transportation. Specifically, we deal with production scheduling problems, such as creating work schedules in factories, cargo loading and sorting problems in warehouses and transportation companies, optimal elevator operation management, and the development of algorithms to improve the efficiency of EC site operations.

**Prof. TANAKA Shunji**  
 ■ Research Themes  
 Operations research/Mathematical systems optimization/Scheduling/Logistics



**Assoc. Prof. YANAGAWA Yoshinari**  
 ■ Research Themes  
 Industrial Engineering/Production Management/Social Systems Engineering

**Asst. Prof. KAWAMOTO Takaki**  
 ■ Research Themes  
 Operations Research/Combinatorial Optimization/Assignment Algorithms



# Intelligent Mechanical Control



System control technology helps machines, electronics, and even chemicals work smoothly and safely in our everyday lives. In our lab, we try to make more intelligent systems that combine real life and computers, creating a better, more convenient society. We mainly focus on advanced ideas such as nonlinear control theory and data-driven control methods to achieve this. Our research covers everything from fundamental theories to practical uses in society. We aim to help people live more comfortably, safely, and sustainably by better controlling the technologies around us.

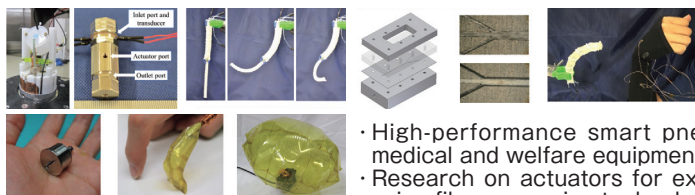


**Prof. NISHIMURA Yuki**  
 ■ Research Themes  
 System Control Theory/Nonlinear Control/Stochastic Control



**Asst. Prof. IKEZAKI Taichi**  
 ■ Research Themes  
 System Control Theory/Data-Driven Control/Cyber-security

## System Integration



Our research is about actuators and device for mechatronics and their system applications.

- Application of micro actuators and special environmental mechanisms
- Microreactors and microfluidic devices
- High-performance smart pneumatic artificial muscles, soft mechanisms, and medical and welfare equipment applications
- Research on actuators for extreme environments and devices for space probes using film processing technology



**Prof. KANDA Takefumi**

### ■ Research Themes

Actuator/Sensor/Mechatronics/Softmechanism/Welfare device/Microsystem/Microreactor/Specific environment/Ultrasonics/Piezoelectricity/Microchannel

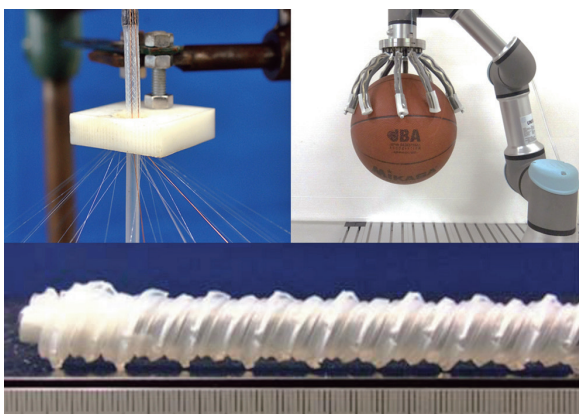


**Asst. Prof. YAMAGUCHI Daisuke**

### ■ Research Themes

Actuator/Sensor/Mechatronics/Softactuator/Softmechanism/Microsystem/Specific environment/Extreme environment/Spacecraft/Lunar exploration/Pneumatics/Ultrasonics/Piezoelectricity

## Soft Mechanical Systems



Our laboratory conducts research on the design, fabrication, and control of novel soft actuators, artificial muscles, and soft sensors using flexible materials. We are also engaged in the development of soft robots that integrate these components, aiming to create next-generation robots that are safe, gentle, and capable of smooth, human-friendly motion.

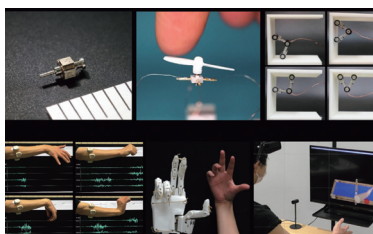


**Assoc. Prof. WAKIMOTO Shuichi**

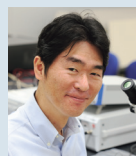
### ■ Research Themes

Actuator/Sensor/Mechatronics/Softactuator/Softmechanism/Medical device/Welfare device

## Mechatronic Systems



The Mechatronics Systems Laboratory is engaged in creative and fundamental research and development of new sensors and actuators, applied research and development of robot hands and medical diagnosis and measurement devices using these technologies, and research and development of peripheral technologies. In particular, we focus on sensors and actuators based on the piezoelectric effect as a driving principle, and our research ranges from basic research such as driving theory to design, development, and evaluation of new devices, as well as applied research such as robot control using these devices.



**Prof. MASHIMO Tomoaki**

### ■ Research Themes

Microrobotics/Actuators/Sensors/Ultrasonic motors

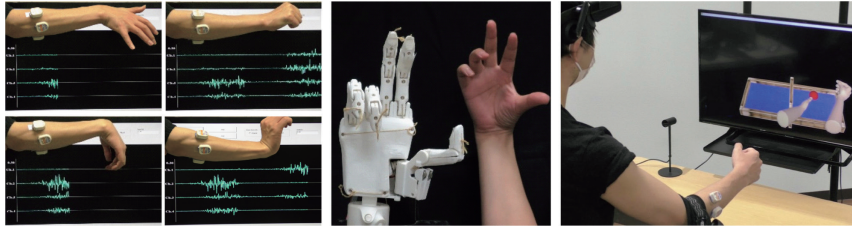


**Asst. Prof. IZUHARA Shunsuke**

### ■ Research Themes

Microrobotics/Actuators/Sensors/Ultrasonic motors

# Biomechatronics



Our research group focuses on the mechanisms of biological systems, and conducts research on biological signal processing/analysis as well as their application to human-machine interfaces. In particular, we aim to support independent living for people with physical disabilities through the development of robots that can be controlled by biological signals.



**Assoc. Prof. SHIBANOKI Taro**

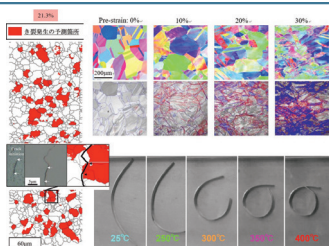
■ **Research Themes**

Robotics, Mechatronics, Medical and Welfare Engineering

# Mechanical Systems and Urban Innovation Science

Course of Advanced Mechanics

## Structural Materials



Our research focuses on metallic materials, composite materials, and functional materials to create the required material properties by controlling their microstructures. With the motto "Seeing is believing," we emphasize the importance of observing, thinking about, and modeling phenomena by ourselves. Laboratory students have access to a variety of state-of-the-art electron microscopy systems and are able to learn micro-sampling techniques, as well as observation and analysis techniques at the atomic level.



Prof. OKAYASU Mitsuhiro

■ Research Themes

Structural Materials/Composites/  
Functional Materials/Microstructures

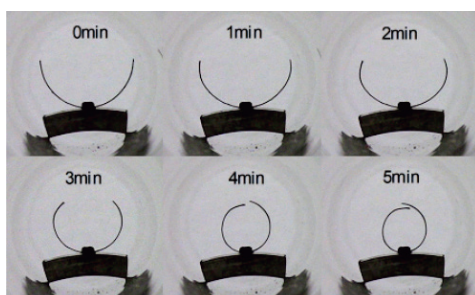


Asst. Prof. ARAKAWA Junta

■ Research Themes

Structural Materials/Composites/  
Functional Materials/Microstructures

## Functional Materials



Shape memory alloys are materials that return to their original shape when heated after deformation. However, our laboratory has developed alloys that, contrary to shape memory alloys, deform more and more when heated. This phenomenon can be applied to the manufacture of high-strength, thin-walled tubes, which has been difficult. We are also developing materials with opposite coefficients of thermal expansion, which shrink when heated and expand when cooled, and novel alloys that allow bimetallic motion with a single type of alloy.

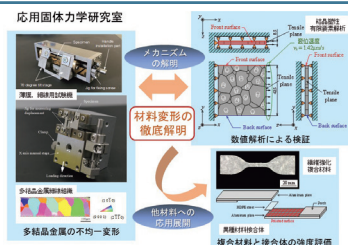


Assoc. Prof. TAKEMOTO Yoshito

■ Research Themes

Structural Materials/Composites/  
Functional Materials/Microstructures

## Applied Solid Mechanics



The target of our research is deformation, damage and fracture of various practical materials, including metallic and polymeric materials. We conduct experimental observations of nonuniform deformations for the materials and the corresponding numerical simulations in various levels.

Prof. TADA Naoya

■ Research Themes

Fracture /  
Damage / Deformation /  
Solid mechanics



Assoc. Prof. UEMORI Takeshi

■ Research Themes

Constitutive equation /  
Deformation / Numerical analysis /  
Mechanics of plasticity



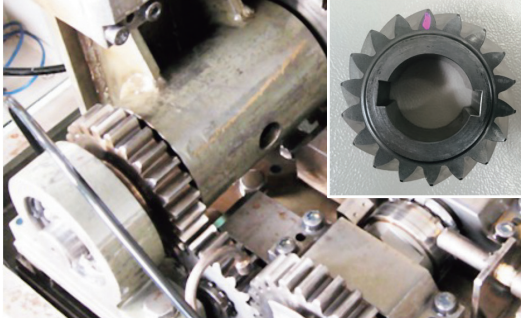
Asst. Prof. SAKAMOTO Junji

■ Research Themes

Fracture / Fatigue /  
Vibration / Fracture mechanics



# Machine Design and Tribology



In order to realize a carbon-neutral or decarbonized society, mechanical systems are required to be highly efficient, lightweight, and have a low environmental impact. At the mechanical design laboratory, we apply cutting-edge surface modification methods, coating methods and analysis methods to study technologies that dramatically improve the life, efficiency, and functionality of power transmission elements for EVs and various tribo-elements.

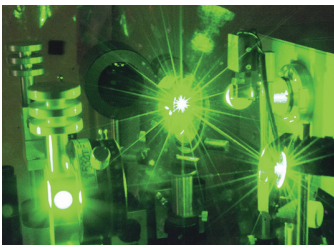


**Assoc. Prof. SHIOTA Tadashi**

■ **Research Themes**

Mechanical element/Tribology/Gear/  
Fatigue strength/Low friction and wear/Surface modification/Coating

# Nontraditional Machining



Along with the rapid progress of industrial technology, various new materials with excellent properties have been developed. Most of these materials are difficult to machine by the conventional mechanical methods, and the demand for machining of fine complicated shapes has been increased. Our laboratory is researching on high-performance and high-functional nontraditional machining methods, such as Electron Discharge Machining (EDM), Electron Beam Machining (EBM), and Laser Beam Machining (LBM) with using electric, electronic, optical energies. In addition, we are developing novel machining methods for the next generation.



**Prof. OKADA Akira**

■ **Research Themes**

Nontraditional machining technology

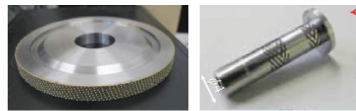


**Asst. Prof. SHINONAGA Togo**

■ **Research Themes**

Electron beam machining/Laser beam machining

# Manufacturing Engineering



Studies on high efficiency, high precision, high quality, optimization, and intelligent automation of machining, which is the basic technology of manufacturing, and its peripheral technologies are carried out. In particular, advanced manufacturing technology for both machine tool users and builders is being developed through studies on not only grinding, cutting and abrasive finishing or their evaluation technology, but also further development of AI / IoT technology specialized in the field of manufacturing.

**Prof. OHASHI Kazuhito**

■ **Research Themes**

Manufacturing Engineering/  
Grinding/Machining (Cutting)/Abrasive  
Machining



**Senior Asst. Prof. KODAMA Hiroyuki**

■ **Research Themes**

Manufacturing Engineering/  
Machining (Cutting)/Grinding/Abrasive  
Machining/Data Mining



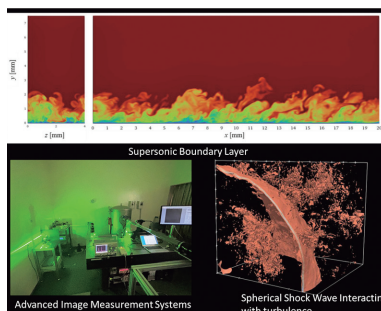
**Asst. Prof. KANEKO Kazuki**

■ **Research Themes**

Mechanical Engineering/  
Manufacturing Engineering/Grinding/  
Machining (Cutting)/Abrasive Machining



## Aerodynamics



Our laboratory mainly studies the aerodynamics of high-speed flows related to the field of aerospace engineering. In particular, for the development of the next generation of passenger aircraft that will fly at speeds faster than the speed of sound, we are taking on the challenge of reducing frictional resistance on the aircraft and noise caused by shock waves generated by the aircraft, by making full use of advanced image measurement technology, large-scale numerical simulations, and data analysis based on AI technology. We are working on a wide range of topics, from elucidating fundamental physics to applied research.

Prof.  
KOUCHI Toshinori



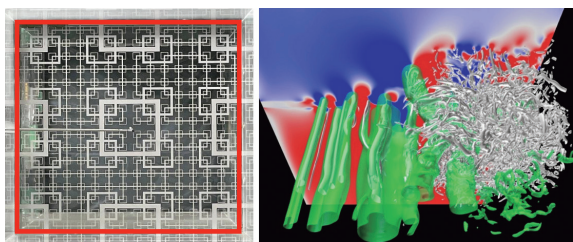
■ Research Themes  
Aerodynamics/Aerospace Engineering/  
Mechanical engineering

Asst. Prof.  
TANAKA Kento



■ Research Themes  
Aerodynamics/Aerospace Engineering/  
Mechanical engineering

## Fluid Dynamics



The Fluid Dynamics Laboratory studies the motion of fluids, such as air and water, from a mechanical perspective in order to elucidate flow phenomena, build models and improve the efficiency with which flow energy is utilised. Specifically, our work covers: (i) elucidating and modelling flow fluctuations known as turbulence; (ii) creating high-fidelity flow simulations and verifying their reliability; (iii) developing and enhancing the reliability of experimental flow-field measurement techniques using wind-tunnel facilities; and (iv) developing component devices that harness fluid energy.



Assoc. Prof.  
SUZUKI Hiroki

■ Research Themes  
Fluid Dynamics/Turbulence Engineering/  
Mechanical Engineering

## Heat Transfer Engineering



The Heat Transfer Engineering Laboratory conducts research on understanding the basic phenomena of heat and mass transfer for the effective use of thermal energy and developing products with industrial needs. Specifically, we are conducting a wide range of research such as thermal energy transport and storage using latent heat, development of a new desiccant air conditioning system, investigations of droplet condensation, evaporation and freezing behavior with controlling the surface properties of an object, microcapsules containing latent heat storage materials, and numerical analysis of absorption and reflection by generation and functional thermal radiation films.

Prof.  
HORIBE Akihiko

■ Research Themes  
Latent heat storage/  
Heat transport/Polymer  
sorberent/Microcapsule/Droplet/  
Surface properties/Thermal radiation



Assoc. Prof.  
YAMADA Yutaka

■ Research Themes  
Latent heat storage/  
Heat transport/Polymer  
sorberent/Microcapsule/Droplet/  
Surface properties/Thermal radiation

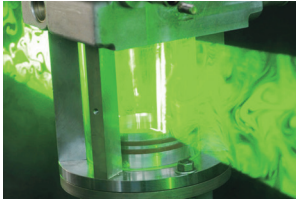


Asst. Prof.  
ISOBE Kazuma

■ Research Themes  
Latent heat storage/  
Heat transport/Polymer  
sorberent/Microcapsule/Droplet/  
Surface properties/Thermal radiation



# Heat Power Engineering



Heat Power Engineering Laboratory focuses on combustion research for improving thermal efficiency and reducing harmful exhaust emissions. In-cylinder gas flow, spray and combustion processes are measured with ultra high-speed imaging, spectroscopy of emissions from chemical reactions, and lasers. Furthermore, CFD simulations are performed to predict and to elucidate those processes. Effective use of hydrogen, e-fuels and bio-fuels that contribute to carbon neutrality are also targeted.

**Prof. KAWAHARA  
Nobuyuki**

■ **Research Themes**  
Thermal Engineering  
/Internal Combustion  
Engine/Combustion/Laser  
Diagnostic/Numerical Simulation



**Assoc. Prof.  
KOBASHI Yoshimitsu**

■ **Research Themes**  
Thermal Engineering/  
Internal Combustion  
Engine/Combustion/Fuel/  
Compression Ignition

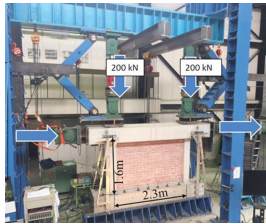


**Asst. Prof.  
TSUBOI Kazuya**

■ **Research Themes**  
Thermal Engineering/  
Combustion Engineering  
& Science/Computational Fluid  
Dynamics



### Aseismic Design of Structures



#### Wind Resistance Group

Wind and tidal power generation are being developed by applying flow-induced oscillations in structures such as bridges caused by wind and water currents.

#### Earthquake Resistance Group

Our research is a combination of analytical simulation, earthquake damage surveys, and structural experiments in order to evaluate and improve the seismic performance of buildings for disaster mitigation and earthquake-resistant cities. Focusing on sustainability, we explore innovative earthquake-resistant structural systems, such as hybrid designs featuring CLT timber walls and reinforced concrete.



**Prof. HIEJIMA Shinji**

#### Research Themes

Wind engineering/Vibration engineering/  
Wind power generation/Tidal current  
power generation



**Assoc. Prof.  
ALWASHALI Hamood**

#### Research Themes

Seismic evaluation of buildings/seismic  
retrofit/performance assessment design/  
building structure/seismic disaster mitigation

### Design of Steel Structures



Research and education are conducted on the advanced methods of construction and maintenance of civil infrastructures. The types of infrastructures of our interest include railway, road, river, port, and soil structures such as tunnels, bridges, dams, banks. In terms of research topics, particular focuses are placed on the development of the state-of-the-art structural monitoring and nondestructive inspection techniques for the infrastructures under operation. To this end, we are developing physio-chemical models of structures, materials, and measurements, and validate the models and the monitoring/testing techniques built on them through computer simulations and experiments.



**Prof. NISHIYAMA Satoshi**

#### Research Themes

infrastructure/construction/maintenance/  
steel structure/monitoring/nondestructive  
inspection

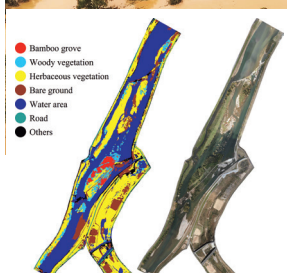


**Assoc. Prof. KIMOTO Kazushi**

#### Research Themes

infrastructure/construction/maintenance/  
steel structure/monitoring/nondestructive  
inspection

### Hydraulic Engineering



We have conducted education and research on water flow analysis and hydraulic design methods for various hydraulic structures in rivers and coastal areas, which are related to the creation of diverse aquatic environments that can coexist with nature.



**Assoc. Prof.  
YOSHIDA Keisuke**

#### Research Themes

Hydraulic Engineering



**Assoc. Prof.  
AKOH Ryosuke**

#### Research Themes

Social Infrastructure(Civil  
Engineering/Architecture/  
Disaster Prevention)/  
Hydroengineering

## Geotechnical and Groundwater Engineering



Study on Prediction of Slope Failure during Heavy Rainfall  
Development of Monitoring and Numerical Modeling Methods for Safety Assessment of River Levees against Seepage



**Prof. KOMATSU Mitsuru**

■ **Research Themes**

Unsaturated soils/Analysis of seepage flow/Soil moisture



**Assoc. Prof. FURUKAWA Zentaro**

■ **Research Themes**

Geodisaser Prevention Engineering/ Geoenvironmental Engineering/ Vegetation

## Architectural Design and Theory



Development and Design Technical Practices of Design for Environmental Sustainability



**Assoc. Prof. KAWANISHI Atsushi**

■ **Research Themes**

Architectural Design/ Architectural Theory/Design/ Architectural Planning/Urban Planning

## Wood-Based Materials



Although wood is a natural material with excellent mechanical properties, it has some weaknesses due to its biological origin. To overcome these weaknesses, previous researchers have developed various timber composite members and wood-based materials manufactured by gluing or connecting timber and small elements of wood. Now, to promote large-scale timber structure with a view to decarbonization, we will use the latest analytical and measurement techniques to provide theoretical support for fracture phenomena of existing wood-based materials and timber composite member; additionally, we will propose new combinations and forms of them on the basis of this analysis.



**Asst. Prof. SUDO Ryutarō**

■ **Research Themes**

Wood-Based Material/ Timber Engineering

## Wood Resource Utilization



Wood is significantly different from other agricultural and marine products in that, with proper management, it can store carbon over the long term. Maximizing this capability could potentially help mitigate global warming. Our laboratory is working toward further mitigating global warming by recycling wood. Additionally, we are conducting research on the effective use of wood resources by combining recycled wood with adhesive technologies.



**Prof. KORAI Hideaki**

■ **Research Themes**  
Wood resources/Wood-based materials/Wood adhesion/ Recycled wood/ Carbon storage

## Urban and Building Environmental Engineering



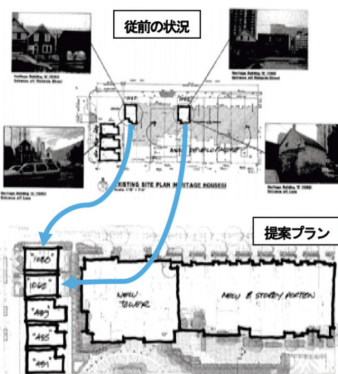
Energy is essential for maintaining human activity. However, consuming energy not only causes global environmental issues such as global warming and energy resource depletion, but also causes local (urban) environmental issues such as heat island phenomenon and air pollution. We have been researching in our laboratory to clarify the way urban structures and the related energy systems should be built in the near future in order to realize a comfortable urban environment while maintaining a sustainable earth.



**Prof. NARUMI Daisuke**

■ **Research Themes**  
Sustainable Urban and Architectural Design/Carbon Neutral/Energy System/Heat Island

## Architecture and Urban Spatial Planning



A mechanism for inheriting a housing as a good stock from a previous generation as a living housing for future generations, handing down the culture and the community or the characteristics in the district, and how to use them, how to control new development, We are proceeding with research, keeping in mind these ideas. So far, We are doing research on from the design control method of individual architecture to architectural planning / planning history and urban spatial planning, history related to architecture and planning / legal system and its implementation, in both Japan and overseas cities.



**Assoc. Prof. HORI Hirofumi**

■ **Research Themes**  
Architecture and urban spatial planning/Architecture and urban design policies/Architecture and urban landscape/Area based management/ Business improvement district



**Senior Asst. Prof. HASHIDA Ryohei**

■ **Research Themes**  
Architectural plan/ Housing theory / Modern history

# Design of Concrete Structures



address the goals of a sustainable society from the concrete perspective.

Concrete is the foundation of social infrastructure that supports this substance civilization. However, the act of building a structure with concrete, or the act of building concrete itself is an act that destroys the natural environment. I want to own a car, I want to travel abroad, I want to live with a flush toilet, a TV, a cooler, but I also want to protect the natural environment. Developing a sustainable society may be the answer to this contradiction of humanity. In this laboratory, we



**Prof. AYANO Toshiki**  
 ■ Research Themes  
 Construction material/  
 Concrete engineering



**Assoc. Prof. FUJII Takashi**  
 ■ Research Themes  
 Construction material/  
 Concrete engineering

# Urban and Transport Planning



Realizing Sustainable Cities: In Japan, Sustainable cities are required in a declining birthrate and aging society. To realize safe, secure, and vibrant cities and transportation, we are researching efficient urban and transportation planning that takes into consideration the environment and people's lives.

Specifically, We are conducting research on the following topics.

- 1) traffic safety
- 2) public transportation planning
- 3) barrier-free transportation planning
- 4) clarification of the actual situation of the spongification phenomenon that occurs in the process of population decline
- 5) compact city planning
- 6) landscape-oriented city planning
- 7) measures for city planning in line with the history of historical and cultural civil engineering heritage that take advantage of the uniqueness of the region.

**Prof. HASHIMOTO Seiji**  
 ■ Research Themes  
 Urban Transportation  
 Planning/Community Development  
 by Transportation Policy/Traffic  
 Calming



**Assoc. Prof. HIGUCHI Teruhisa**  
 ■ Research Themes  
 Civil Engineering  
 History/Historical  
 Structures Preservation  
 and Utilization/Visual Town  
 Planning/Disaster Prevention



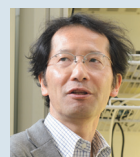
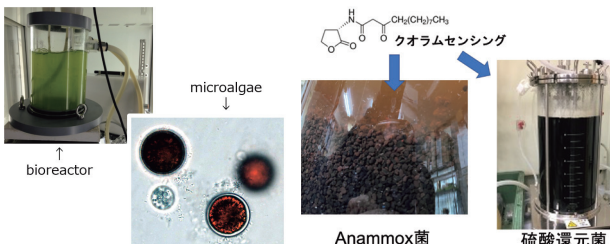
**Assoc. Prof. UJIHARA Takehito**  
 ■ Research Themes  
 Urban Planning/  
 Urban Environment  
 /Urban Transportation



# Water Environment and Sanitation



"Water" is essential for our lives and livelihoods, and also works as a medium of transporting substances on both local and global scales. Therefore, the sustainability of our life and ecosystem can be easily threatened by the excess usage and pollution of water resources. We are doing education and researches on "water quality control technology (water treatment)" and "relationship between material transport and aquatic ecosystems" to solve or prevent such issues for water resources. We hope to make our society safe, comfortable, and sustainable.



**Prof. NAGARE Hideaki**  
 ■ Research Themes  
 Water environment/Water treatment/  
 Resource recovery/Chemical substances