Faculty and Laboratories of Department of Mechano-Informatics

※: Professors denoted by this symbol do not accept new graduate students for the applicable academic year.

[RCAST]

denotes the professors of Research Center for Advanced Science and Technology holding adjunct professorship at School of Information Science and Technology.

[AI center]

denotes the professors of AI Center (*1) holding adjunct professorship at School of Information Science and Technology.

*1 Next Generation Artificial Intelligence Research Division, Center for Education and Research in Information Science and Technology (CERIST), and Next Generation Artificial Intelligence Research Center, The University of Tokyo.

[VR center]

denotes the professors of VR Center (*2) holding adjunct professorship at School of Information Science and Technology.

*2 Virtual Reality Educational Research Division, Center for Education and Research in Information Science and Technology (CERIST), and Virtual Reality Educational Research Center, The University of Tokyo.

JSK Robotics Laboratory
(Jouhou System Kougaku Laboratory)

URL: http://www.jsk.t.u-tokyo.ac.jp/

Research in this laboratory is focusing on the fundamental functions and systems necessary for future intelligent robots that will live and work in the daily life field and human society. The members are challenging something new through their own integrated robot systems and learning how to build sustainable systems for the future with each other.

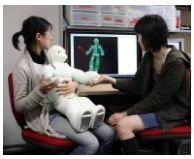
(1) Daily life support humanoid platform : recognition of situations in human life environments, using tools, dishes, tablewares, and appliances, learning from humans, conversation with humans, etc.
(2) Musculoskeletal tendon-driven humanoid : humanlike musculoskeletal body with very many joints and numerous redundant sensors aiming at powerful and supple motions like human, design principle of humanoid body structure, autonomous development of complex sensory-motor system, etc.
(3) Embedded robotics devices: soft flesh or deformable tactile sensor devices, integrated IMU sensors, perception devices, embedded CPU for flying robots, onbody communication LAN system, power system for intelligent robots. etc.
(4) Dynamics whole body control humanoid : integrating high-torque, high-speed motor drive circuit, high-speed 3D recognition system, dynamics whole-body.
(5) IRT (Information and Robot Technology) to support human and aging society: through fusing IT and RT systems, personal mobility robots, affectionate watching appliance are conducted for supporting the future life society
(6) Robot Open Software System : design and development of open-source type intelligent robot for mobile manipulation robot.

Daily Assisteive HRP2-JSK humanoids

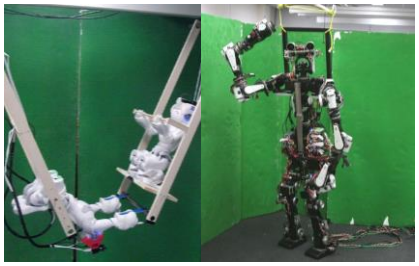
Musculoskeletal humanoids

Flying Robots

IRT Robots



Soft exterior and interaction



Dynamic whole-body control humanoid

Open software robot : PR2

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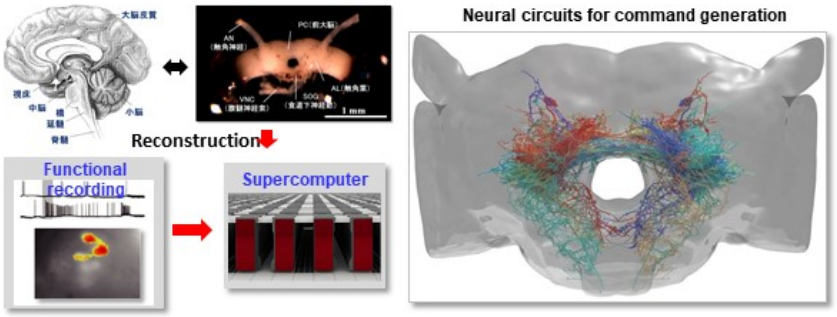
Kanzaki & Takahashi Lab

Research field: The aim of our research is to clarify the basic neural mechanisms for generating adaptive behaviors (or intelligence) using interdisciplinary approaches combining informatics, engineering and biology. As model systems, we use cultured neurons, insect brains and rat brains. Our research deals with investigating bio-machine hybrid systems, and also establishes basic technologies for controlling behavior by external commands to brain functions.

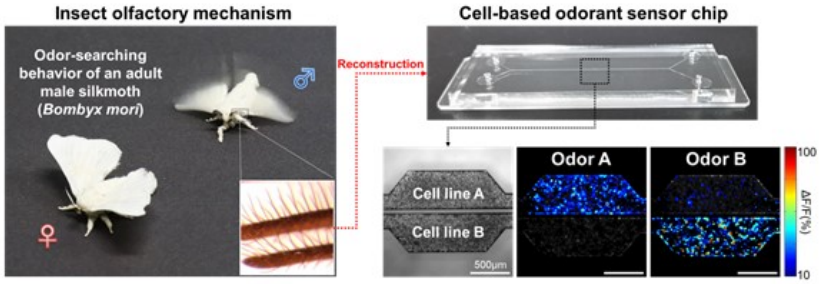
Kanzaki Group (RCAST, Komaba Research Campus)

http://www.brain.rcast.u-tokyo.ac.jp/

(1) Understanding elementary intelligence of insect brains



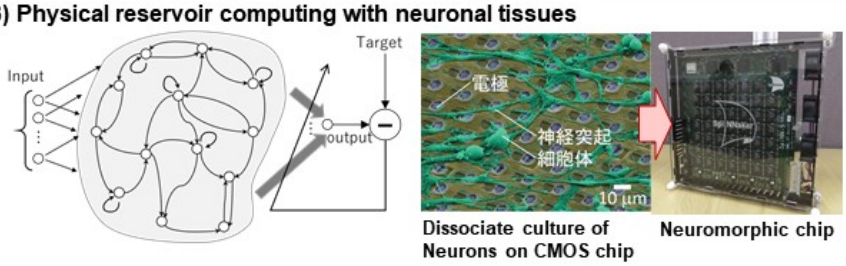
(2) Odorant sensors based on insect odorant receptors



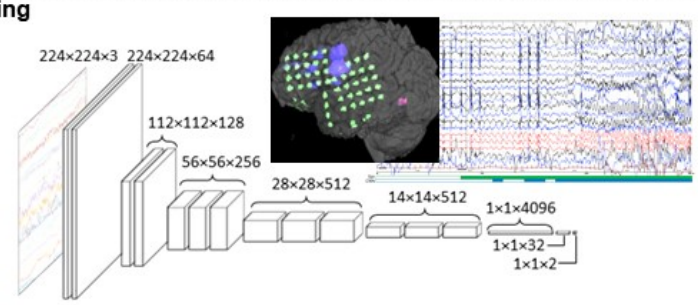
Takahashi Group (Hongo Camupus)

http://www.ne.t.u-tokyo.ac.jp/

(3) Physical reservoir computing with neuronal tissues



(4) Neural consciousness of consciousness and learning based on functional imaging



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Laboratory for Intelligent Systems and Informatics (ISI)

http://www.isi.imi.i.u-tokyo.ac.jp/

A Breakthrough Towards Truly Intelligent Systems in the Real World:

Towards truly effective and human beneficial intelligent systems in the complex and uncertain real world, we are trying to develop next generation AI methods based on new understanding of the principles of human intelligence, with application to real world tasks.

1. **Origin of Intelligence: Constructive Study of Emergence and Development of Embodied Cognition and Behavior**

Body-Brain Model and Simulated Development of Human Fetus/Infant, Baby Robot, Emergent/Instant Adaptative Behavior, Motor Development, Intrinsically Motivated Autonomous Learning, Imitation, Concept / Language Acquisition, Emergence of Consciousness, Developmen of Self-Other / Social Cognition.

2. **Elucidating/Modeling Human Intelligence, Next Generation AI**

Whole Brain Simulation, Nature/Application of Spiking Neurons, Emotion-Body-Cognition Interaction Model, Brain Science and Mathematical Modeling of Self-Esteem / Value System / Decision making / Motivation. Free Energy Principle, Advanced Deep Reinforcement Learning and Its Integration with Imitation. Acqusition of Affordances, Multi-Modal Measurement and Robot Learning of Dexterous Human Skills.

3. **Muculo-Skeletal Bodies and Motor Skills**

Artificial Muscles, Human/Animal Type Musculo-Skeltal Robots, Thin & Flexible Tactile Sensors, Biomechanics, Jumping & Running, Sport Motion, "Knacks" and "Focuses", Motor Learning

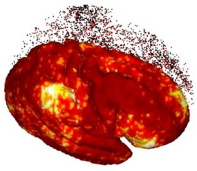
4. **Soft Robotics**

Soft Actuators, Printable Robots, Inflatable Robots, Soft User Interface. Bio-Inspired Robots, Continuum Arms, Co-evolution of Body & Behavior

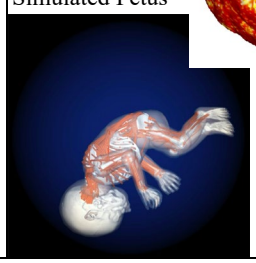
5. **Science & Technology of Monitoring / Nursing, Elderly Care, Assistive Technology for Peple with Developmental Disorders**

Monitoring & Risk Prediction of Humans Behavior/Health by Sensing & Machine Learning, Clinical Application of AI, Interactive Elderly Care Robots, Characterization of Developmental Disorders and Alleviative Technology for their Sufferings.

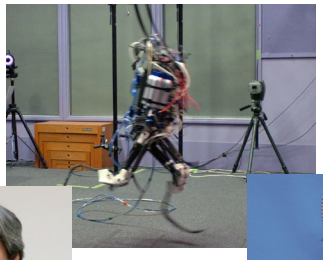
Whole Brain Simulation



Simulated Fetus



Baby Robot



Athlete Robot

High Density Thin Tactile Sensor

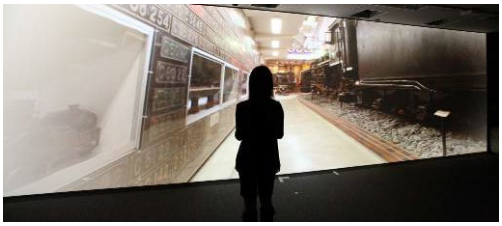
Cyber Interface Laboratory

http://www.cyber.t.u-tokyo.ac.jp

Research on Cybernetic Interface aims to study interfaces that unite human and computer seamlessly. Our particular interest is in exploring Cybernetic Interface on the basis of Virtual Reality (VR) and Computer Supported Cooperative Work (CSCW) technologies. We focus not only on system development, but also on exploring innovative contents in application areas, and studying the impact of human-computer interaction on psychological and social science research. Specifically, we are conducting research on multi-modal/cross-modal interfaces including tactile, olfactory, and gustatory senses, human augmentation technologies to enhance human physical and cognitive abilities, social robots, and educational systems using virtual and augmented reality.

Virtual Reality / Mixed Reality

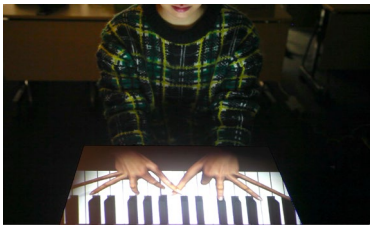
Redirected Walking techniques
Multi-modal and Cross-modal Interfaces
Human Augmentation with Virtual and Augmented reality
Ghost Engineering
(Embodiment toward Avatars and Its Effect on Perception/Cognition)
Virtual and Augmented Reality-Based Education



3D World Reconstruction from 2D Images

Territorial Virtual Time Machine

Redirected Walking using Visuo-haptic Interaction



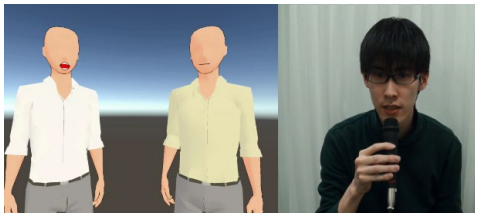
Ownership toward Augmented Body

Computer Supported Cooperative Work (CSCW) / Human-Computer Interaction

Telepresence Systems for Enhancing Remote Communication
Human-Robot Interaction and Social Robot
Behavior Elicitation & Emotion Evacuation Interfaces
Lifelog Visualization and Analysis, and Lifelog-based Future Prediction

Social robots in museum

Gustatory / Olfactory displays



"Cloning" technique for mediated group work

Emotion evocation via pseudo-bodily reactions

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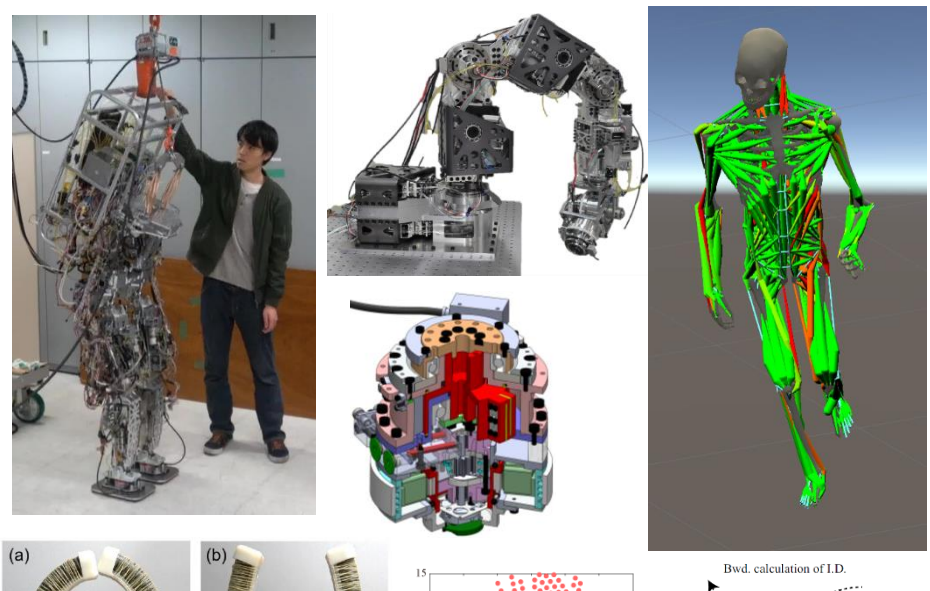
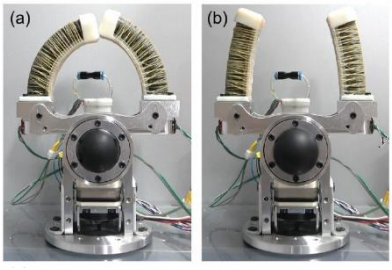
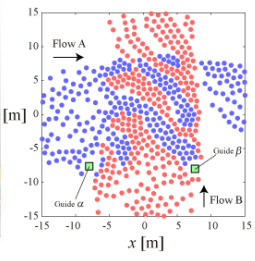
Dynamics and Control Systems Laboratory

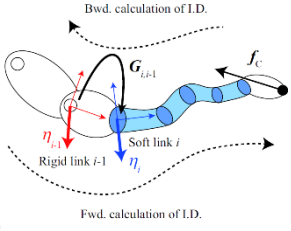
http://www.ynl.t.u-tokyo.ac.jp/

(1) Highly Robust Autonomous Driving Systems of Cars and Trucks
(2) AI-based Autonomous Harvest/Transport Systems for Vegetables and Fruits
(3) Dynamics & Control Theory of Humanoid, Human Musculo-skeleton, Human Flow & Soft Robot
(4) Development of Hydraulic Actuators & Hydraulically-driven Soft Robotics
(5) Advanced Optical Sensing and Image Understanding









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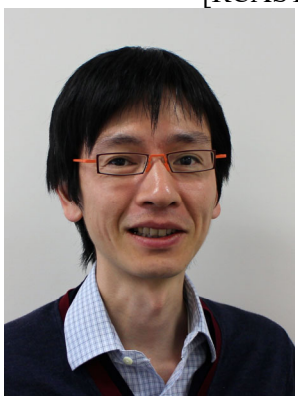
[RCAST]



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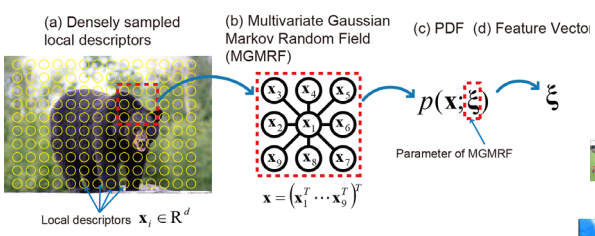
Machine Intelligence Laboratory

http://www.mi.t.u-tokyo.ac.jp/

Advanced Intelligent System for
Recognition in Real-world, Contents Generation and Knowledge Discovery

Our goal is to invent advanced intelligent systems for real-world recognition, contents generation and knowledge discovery by combining useful but infinite information in the physical space with a massive amount of data and powerful computational resources in cyberspace. To tackle this challenging problem, we utilize all resources in the area of computer science, including the mathematical basis and robotics.

1. **Mathematical Basis**
   Information theory, machine learning, deep learning, data mining, pattern recognition, stochastic/statistical theory, time series analysis, causality analysis, learning theory, feature extraction
2. **Recognition, Understanding and Thinking**
   Computer vision, image recognition and retrieval, 3D vision, behavior recognition, multimodal recognition, emotion understanding, natural language processing, speech and music information processing, medical information processing, big data
3. **Contents Creation**
   Sentence generation and summarization of image and video, image generation from sentences, dialog system, automatic article generation system



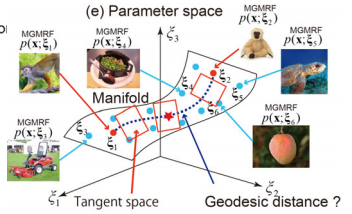
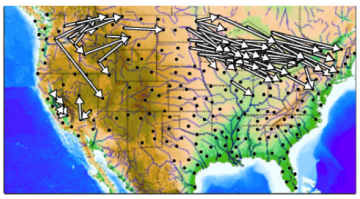


Image feature extraction based on information theory and machine learning

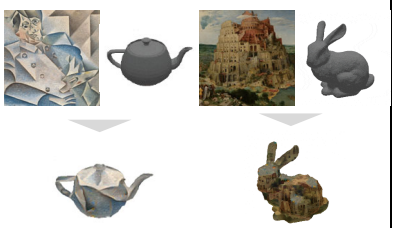


Causal analysis for meteorological data

A silver car parked in a residential street.

A brown horse standing in a lush green field.

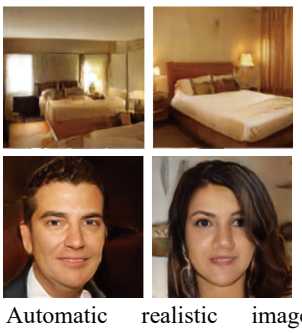
Automatic sentence generation system



Integration of computer vision, computer graphics, and machine learning

oboe Siamese cat diaper

Large-scale image recognition system



Automatic realistic image generation of unseen object

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Biohybrid System Lab.

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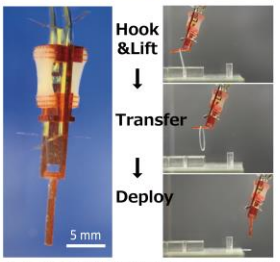
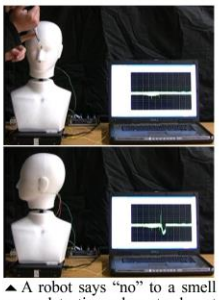
Our group focuses on creating bio-hybrid systems that combine bio-functional materials with micro/nano devices. As one example, biohybrid robots powered with skeletal muscle tissues allow to engineer dynamic systems of living organisms. As another example, biohybrid sensors with recombinant cells can detect target materials with high sensitivity and selectivity. We aim to realize such hybrid systems by combining various disciplines, such as mechanics, informatics, biophysics, cell biology, and material sciences. Personnel interested in multidisciplinary research, with any of these abovementioned backgrounds, are warmly welcomed to join us.

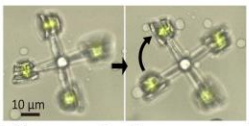
Cyborg technology *Enhance robots with living tissue, or upgrade living body by implanting artificial materials.*



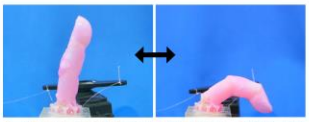
▲ A biohybrid robot with an antagonistic pair of skeletal muscle tissues reconstructed in-vitro. Contractions of the skeletal muscle tissues can be controlled via electrical stimulation.



▲ A robot says "no" to a smell upon detecting relevant odorant molecules using a cell-based sensor chip.

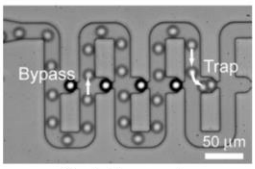


▲ Gears spun by the movement of Chlamydomonas, a moving green alga.

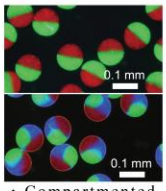


▲ Robot covered by skin tissue, which can heal its damage like what the living systems do.

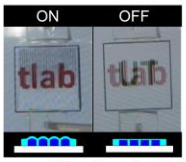
MEMS *Fabricate microdevices with refined structures and unique functions using microfabrication techniques.*



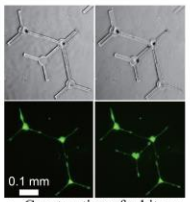
▲ Manipulate and arrange biomolecules or cells effectively using microfluidics, and achieve biological assays with unprecedented accuracy.



▲ Compartmented, uniform-sized hydrogel beads can be fabricated en masse using microfluidics.

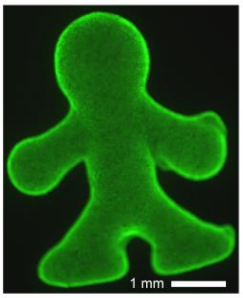


▲ Micro lens for the dynamic ON/OFF control of 3D displays. The lens consists of deformable microchannels actuated by hydraulic pressures.

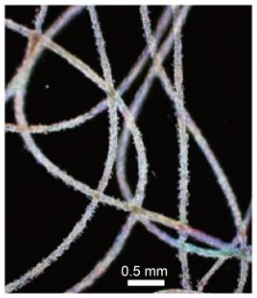


▲ Construction of arbitrary neuron networks by arranging cell-laden micro-plates.

Biofabrication *Fabricate biological "gears" and "wheels" using molecules or cells, assemble three-dimensional "machines", i.e. tissues/organs, for regenerative medicine or drug-testing models.*



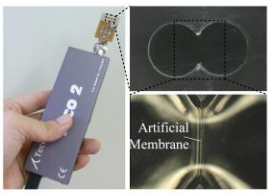
▲ Process living cells into micro beads, accumulate the beads to fabricate millimeter scale 3D tissues.



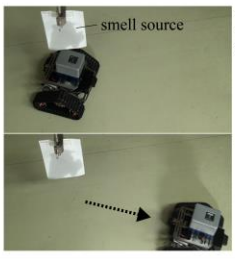
▲ Cell fiber: a thin, long, fibrous tissue fabricated using microfluidic techniques.

▲ A mini beef steak fabricated using cells isolated from bovine muscles.

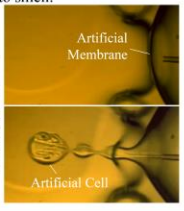
Artificial cell membranes *Manufacture cell membranes and eventually cells from scratch for biosensing.*



▲ Portable senor powered by an artificial cell membrane. The membrane consists of proteins derived from olfactory cells to detect smells.



◀ A robot mounted with an artificial cell membrane based odorant sensor, which can move in response to smell.



▶ Inspired by the principle of bubble guns, artificial cells can be fabricated by jetting a flow onto an artificial cell membrane.