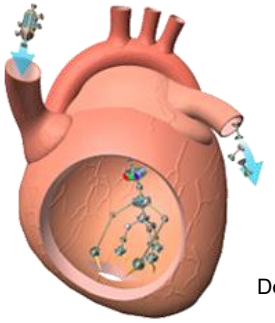
MHS2020

Program

The 31st 2020 International Symposium on
Micro-NanoMechatronics and Human Science

-From Micro & Nano Scale Systems to Robotics & Mechatronics Systems-

Symposium on “Science of Soft Robots”
Grant-in-Aid for Scientific Research on Innovative Areas, MEXT, Japan
Symposium on “Hyper-adaptability for overcoming body-brain dysfunction: Integrated empirical and system theoretical approaches”
Grant-in-Aid for Scientific Research on Innovative Areas, MEXT, Japan



Designed by Hitoshi Sakauchi

Dec. 7, 2020, Online Conference

Financial Supporter
Tokyo Electron Limited.

Science of Soft Robots
JSPS KAKENHI Grant-in-Aid for Scientific Research on Innovative Areas (2018-2022)

科研費 Grant-in-Aid for Scientific Research on Innovative Areas (Research in a Proposed Research Area, FY 2019-2023)
HYPER-ADAPTABILITY

TEL
TOKYO ELECTRON

Welcome Remarks

The **31st 2020 International Symposium on Micro-Nano Mechatronics and Human Science (MHS)** is held jointly with Symposium on "**Science of Soft Robots**" Grant-in-Aid for Scientific Research on Innovative Areas, MEXT, Japan, and Symposium on "**Hyper-Adaptability**" Grant-in-Aid for Scientific Research on Innovative Areas, MEXT, Japan. In this year, the symposium is supported by Institute of Nano-Life-Systems, Institutes of Innovation for Future Society, Nagoya University, and is financially supported by Tokyo Electron Limited.

As a strategic technology highlighting the 21st century, micro-nano mechatronics technology is currently used in broader spectra, ranging from basic applications in robots, actuators, sensors, semiconductors, automobiles, and machine tools to new applications in bio-medical systems and life science, construction machines, and aerospace equipments. Applications in welfare engineering, human life supporting engineering, medical engineering and other brand-new scopes are also expected, with related R&D now under way. Symposium on Micro-Nano Mechatronics and Human Science (MHS) was inaugurated in 1990 by Professor Toshio Fukuda, at Nagoya University. This is the 31st of MHS.

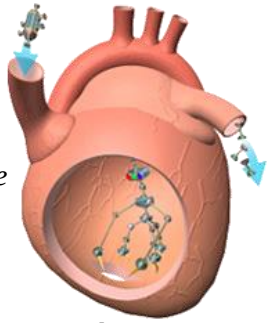
This year, we are jointly holding the 31st International Symposium on Micro-Nano Mechatronics and Human Science and the Symposia of the Scientific Research on Innovative Areas, MEXT, Japan. MHS 2020 will be held online with all invited plenary talks. The safety and well-being of our participants is our priority. With the continued resurgence of COVID-19, it makes it an impossibility to hold the in-person event. MHS 2020 is free with access to all events including 8 plenary talks. This offering is made possible thanks to the support and leadership of the supporting organizations.

It is our sincere hope that this joint symposia will provide great opportunities for information exchange and interaction, and it will provide related industries with new technologies, and explore the potential of creating new industries. We also hope that we can hold lively discussions involving all participants to develop viable scenarios for advancing micro-nano mechatronics technology and human science.

As General Co-chairs, we would like to express our sincere gratitude to all committee members involved in planning and operating these symposia. To all participants, we extend our heartfelt welcome and thanks for attending this event.

Fumihito Arai	Koichi Suzumori	Jun Ota
The University of Tokyo	Tokyo Institute of Technology	The University of Tokyo

MHS2020 General Co-Chairs



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Dec. 7, 2020, Online Conference

9:00-9:15(JST) ***Opening Remarks Part I***
19:00-19:15(EST) Chairperson: *Fumihito Arai, The University of Tokyo*
Prof. Toshio Fukuda, Meijo University, Japan (Honorary Chair)
Prof. Fumihito Arai, The University of Tokyo, Japan (General Co-Chair)
Prof. Koichi Suzumori, Tokyo Institute of Technology (General Co-Chair)

9:15-9:45 (JST) ***Plenary Talk 1***
19:15-19:45 (EST) Chairperson: *Shingo Maeda, Shibaura Institute of Technology, Japan*
Optoelectronic Sensing of the Deformation of Soft Robots, and their Electrohydraulic Power
Robert F. Shepherd
Cornell University, USA

9:45-10:15 (JST) ***Plenary Talk 2***
19:45-20:15 (EST) Chairperson: *Shingo Maeda, Shibaura Institute of Technology, Japan*
Multifunctional Microscale Robots Powered by Soft Artificial Muscles
Yufeng (Kevin) Chen
Massachusetts Institute of Technology, USA

10:15-10:30(JST) ***Break***
20:15-20:30 (EST)

10:30-11:00(JST) ***Plenary Talk 3***
20:30-21:00 (EST) Chairperson: *Seiichi Hata, Nagoya University, Japan*
Bio-manufacture and Use of Extracellular Matrix Derived Hydrogels in Regenerative Medicine
Donald O. Freytes
NC State University and Univ. of North Carolina at Chapel Hill, USA

11:00-11:30(JST) ***Plenary Talk 4***
21:00-21:30 (EST) Chairperson: *Seiichi Hata, Nagoya University, Japan*
Respiration Sensor Sewn Inside Belly Band Measuring Capacitance Built Across Skin Allowing Walking Activity
Minoru Sasaki
Toyota Technological Institute, Japan

15:00-15:05(JST) ***Opening Remarks Part II***
01:00-01:05 (EST) Chairperson: *Yasuhisa Hasegawa, Nagoya University, Japan*
Prof. Jun Ota, The University of Tokyo, Japan (General Co-Chair)

15:05-15:35(JST) ***Plenary Talk 5***
01:05-01:35 (EST) Chairperson: *Yasuhisa Hasegawa, Nagoya University, Japan*
Human Robotics for Augmenting and Empowering People
Kenji Suzuki
University of Tsukuba, Japan

15:35-16:05(JST) ***Plenary Talk 6***
01:35-02:05 (EST) Chairperson: *Yasuhisa Hasegawa, Nagoya University, Japan*
The Role of Sense of Agency in Human Motor Control
Wen Wen
The University of Tokyo, Japan

16:05-16:20(JST) ***Break***
02:05-02:20 (EST)

16:20-16:50(JST) ***Plenary Talk 7***
02:20-02:50 (EST) Chairperson: *Masahiro Ohka, Nagoya University, Japan*
Highly-viscous Microjet Generator: Theory and Applications
Yoshiyuki Tagawa
Tokyo Univ. of Agriculture and Technology, Japan

16:50-17:20(JST) ***Plenary Talk 8***
02:50-03:20 (EST) Chairperson: *Masahiro Ohka, Nagoya University, Japan*
Soft Actuators Based on Electrostatic Forces for Wearable Haptics and Soft Robotics
Herbert Shea
EPFL, Switzerland

17:20-17:30(JST) ***Closing***
03:20-03:30 (EST)

Science of Soft Robots
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Plenary Talk 1　9:15-9:45 (JST), 19:15-19:45 (EST)

Optoelectronic Sensing of the Deformation of Soft Robots, and their Electrohydraulic Power

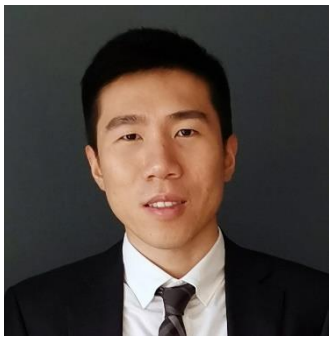
Robert F. Shepherd
Sibley School of Mechanical & Aerospace Engineering, Cornell University, USA

A variety of stretchable sensors exist, typically used as “skins” for high density shape sensing measurements to improve control authority in high degree of freedom (passive or active) continuum structures and actuators. This talk will discuss the use of light as a sensing medium for measuring deformation in the “meat” of these compliant structures and actuators. Two classes of sensors will be presented, one that relies on the transmission of light through arrays of lossy optical lightguides, and another that uses a sort of diffusing wave spectroscopy in combination with machine learning to infer structure. After discussing sensing, I will then discuss how to increase the overall energy density of hydraulically powered robots. Use cases for these sensors and robots will be presented as well as discussion of their relative benefits, current challenges, and future directions as it pertains to soft actuators and deformable interfaces.

Plenary Talk 2　9:45-10:15 (JST), 19:45-20:15 (EST)

Multifunctional Microscale Robots Powered by Soft Artificial Muscles

Yufeng (Kevin) Chen
Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, USA



Several insect species, such as diving flies and diving beetles, exhibit remarkable locomotive capabilities in aerial, aquatic, and terrestrial environments, inspiring the development of similar capabilities in robots at the centimeter scale. In this talk I will present three insect-scale robots capable of multimodal and multiphase locomotion. I will start by presenting a 175 mg, flapping wing robot that can hover in air, swim underwater, and impulsively jump out of the water surface through combustion. I will also introduce a 1.6 g, quadrupedal robot capable of locomotion on land, on the surface of water, underwater, and between these environments. These results demonstrate that microrobots can achieve novel functions that are absent in larger, traditional robots, thereby showing the unique potential of microrobots in applications such as inspection and environmental exploration in cluttered spaces. Furthermore, I am working on creating a new class of microrobots – ones that are powered by high bandwidth soft actuators and equipped with rigid appendages for interactions with environments. Towards improving collision robustness of micro-aerial robots, we develop the first heavier-than-air aerial robots powered by soft artificial muscles that demonstrate open-loop, passively stable ascending flight as well as closed-loop, hovering flight. First, we design and fabricate lightweight (0.1 g), power-dense (600 W/kg), and high bandwidth (500 Hz) dielectric elastomer actuators (DEA) to drive the robots. Second, we increase actuator output mechanical power and improve its control authority by addressing challenges unique to soft actuators, such as nonlinear transduction and dynamic buckling. Third, we demonstrate our robot can both achieve controlled hovering flight and passive inflight collision recovery. Our work demonstrates how soft actuators can achieve sufficient power density and bandwidth to enable controlled flight, illustrating the vast potential of developing next-generation agile soft robots.

Plenary Talk 3　10:30-11:00(JST), 20:30-21:00 (EST)

Bio-manufacture and Use of Extracellular Matrix Derived Hydrogels in Regenerative Medicine

Donald O. Freytes
Joint Department of Biomedical Engineering, North Carolina State/ University of North Carolina-Chapel Hill, USA

Decellularized extracellular matrix (ECM) scaffolds derived from tissues and organs are complex biomaterials used in clinical and research applications. Several decellularization protocols have been described for ECM derivation, each adapted to a particular tissue. One of the major sources of variability in ECM products comes from the tissue source and animal age. Although this variability could be minimized using established tissue sources, other sources of variability arise from the decellularization process itself. Overall, current protocols require manual work and are poorly standardized. The combination of these factors adds variability affecting the uniformity of the final product between batches and could have implications on final bioactivity. Furthermore, each protocol needs to be optimized for each tissue and tissue source making tissue-to-tissue comparisons difficult. Automation and standardization of ECM scaffolds derived from tissue such as heart, skin and vocal folds constitute a significant improvement to current biomanufacturing techniques. Our goal is to develop a biofabrication method for fast and automated derivation of raw material for ECM hydrogel production while preserving ECM composition and controlling lot-to-lot variability. This work presents a versatile, scalable, and automated platform for the rapid production of ECM hydrogels that can be used in microdevices for in vitro testing and for the production of therapeutic agents.

Plenary Talk 4　11:00-11:30(JST), 21:00-21:30 (EST)

Respiration Sensor Sewn Inside Belly Band Measuring Capacitance Built Across Skin Allowing Walking Activity

Minoru Sasaki
Toyota Technological Institute, Japan

A novel wearable respiratory sensor is studied, measuring the capacitive built across the skin. This signal is found to have the information of the skin thickness. When the electrode is on the abdomen, its skin contracts and expands due to the respiration, the effective skin thickness increases and decreases, so the capacitance decreases and increases, respectively. This capacitance sensing does not disturb the subject's respiration neither using the mask nor requiring the mechanical stress like the suite measuring the strain for measuring the body volume change. This means the comfortableness for the subject. When the electrode fits stably on the skin, it is possible to detect the minute body change. One example is the baseline shift caused by eating a meal and changing to a hunger. This capacitance signal is highly sensitive.

Next challenge is monitoring the respiration during the daily activity especially the walk. This is because the 6-min walk is the standard test in medical diagnoses for the lung. At present, the respiration is measured before and after the walk using the spirometer of the desktop equipment. The request from the medical field is monitoring the respiration during the walk. This is the tough request because the body movement makes the large noise. The noise mixture is suppressed. One improvement is the magnet connector, which can reduce the noise allowing the smooth rotation. This becomes the buffer against the body movement and the wire tension. In addition, this button enables the detachment of the sensor circuit from the belly band. The belly band becomes washable. Another improvement is the electrode shape. The walking movement includes some twisting which changes the capacitance between left and right on the abdomen. The coaxial electrode can be insensitive to the twisting. As the result, the respiration during 6-min walk is well monitored.

Plenary Talk 5　15:05-15:35(JST), 01:05-01:35 (EST)

Human Robotics for Augmenting and Empowering People

Kenji Suzuki
Center for Cybernics Research, University of Tsukuba, Japan

Human robotics technology brings out latent human capabilities and potential abilities of people. This is a research domain about the robot-assisted human motor control that synthesizes musculoskeletal biomechanics and neural control. The synchronization is a central feature in human-machine and human-robot interaction. Both entities thus need to perform movements in synergy. These technologies, therefore, have to support or augment the human user without disturbing the intended movement. Key issue is to detect the user's motor intention in a contingent manner with proper consistencies, and continuously adapt the behavior that vary with time. This enables the technologies to be perceived as a natural extension of the body. In addition, the challenges to using soft robots is making their behavior precise and efficient enough to accomplish the given task in a reasonable amount of time. Referring to the human muscle-skeletal system, the integration of both hard and soft robotics technology allows us to proceed to the next step of wearable and assistive robots.

In this talk, several case studies related to human robotics are introduced with examples of wearable robots through the design, implementation and clinical challenge. The importance of collaborations with different fields is also addressed. Two case studies of robot assisted locomotion or care will be introduced: (i) Technology: A novel personal mobility vehicle is developed for supporting and assisting people with disabled lower limbs such as elderly, and/or people with SCI (Spinal Cord Injury) or CP (Cerebral Palsy). (ii) Science: A lower-limb exoskeleton robot control and gait analysis based on body synergies by using a robot suit HAL, including a study on voluntary initiation of movement. We are trying to redesign the future society where independent individuals will be empowered with the aid of technology and the assisted lifestyles will become widely available.

Plenary Talk 6　15:35-16:05(JST), 01:35-02:05 (EST)

The Role of Sense of Agency in Human Motor Control

Wen Wen
The University of Tokyo, Japan

Sense of agency refers to the subjective feeling of controlling one's own actions, and through them, the external events. Sense of agency generates from the integration of ones' own motor commands and the sensory feedbacks. In the past, sense of agency was considered to be no more than a side product of motor control: I control, therefore I feel control. However, recent studies show that sense of agency has great influence on many aspects of motor control, such as decision making, attention, and motor planning. The present talk will introduce the cognitive model and behavioral mechanism of the sense of agency, and will discuss the lasted findings on how the sense of agency influences human behavior.

Plenary Talk 7　16:20-16:50(JST), 02:20-02:50 (EST)

Highly-viscous Microjet Generator: Theory and Applications

Yoshiyuki Tagawa
Department of Mechanical Systems Engineering, Tokyo University of Agriculture and Technology, Japan

The ejection of liquid microjets of high viscosity should open new doors for next-generation technologies such as 3D ink-jet printers and needle-free injection devices. Recently we suggested a novel inkjet generator employing an impulsive force. The generator can eject highly-viscous jets of up to 10,000 mm2/s, which is 500 times viscous than the jet created by existing printers. Although the structure of the device is quite simple, the device is so effective that a viscous honey jet can be created. We have developed a physical model based on a pressure-impulse approach. We experimentally and numerically investigate the velocity of microjets with various viscosities. The model successfully predicts the velocity of the microjets with a wide range of viscosities. We find that higher viscosities lead to reduction of the jet velocity, which can be described by using the Reynolds number (the ratio between the inertia force and the viscous force). It is worth mentioning that the device is capable of ejecting the jets in multiple directions. This enables us to print viscous liquids to an object with irregular surfaces. Thanks to its simple structure, we can easily produce a hand-sized device at low cost.

Plenary Talk 8　16:50-17:20(JST), 02:50-03:20 (EST)

Soft Actuators Based on Electrostatic Forces for Wearable Haptics and Soft Robotics

Herbert Shea
Ecole Polytechnique Fédérale de Lausanne (EPFL), Soft Transducers Laboratory (LMTS), Neuchatel, Switzerland

Directly electrically driving soft actuators can offer advantages over pneumatic actuation (eg no compressor or pump) but adds a number of challenges (eg high voltages). I will present our research on flexible actuators that deliver high strain and high forces, operate at high speed, and do not rely on external compressed air or vacuum supplies. Due to its high energy density, we use electrostatic actuation, using high electric fields to deform elastomers or textile structures, at the mm to cm size scale.

Our devices consist of silicone elastomer and stretchable electrodes, and rely on electrostatic zipping, dielectric elastomer actuation, and electro-hydrodynamics to obtain different types of motion. We have developed a broad range of concepts, including compliant grippers, on-skin haptic devices for VR/AR, and stretchable pumps. I will illustrate how we have addressed several key limitations of directly electrically-driven soft actuators, including obtaining high forces (16 N holding force from a 1 g device), high speeds (5 kHz), complex motion, and reducing drive voltage to 300 V, a level at which we can use SMD components for very compact control electronics. This enabled us to make fast untethered soft robots, robust yet sub-mm thick wearable haptic interfaces, high-force textile clutches for VR gloves, and soft grippers able to delicately manipulate fruit and vegetables. Our ongoing work is aimed at embedding intelligence into these soft machines.

Ver. 1.0 (Tentative)

Call for Papers

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Dec. 5 (Sun) – Dec. 8 (Wed), 2021, Nagoya, Japan

Sponsored by (Tentative)

MHS2021 Organizing Committee; Nagoya University

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IEEE Robotics and Automation Society, Micromachine Center; Robotics and Mechatronics Division, The Japan Society of Mechanical Engineers; The Japan Society for Precision Engineering; The Robotics Society of Japan; Japanese Society for Biomaterials; Japanese Society for Medical and Biological Engineering; Japanese Society for Regenerative Medicine; Society E (Sensors and Micromachines), Institute of Electrical Engineers of Japan; The Society of Instrument and Control Engineers Nagoya University, Institute of Nano Life Systems

in Cooperation with (Tentative)

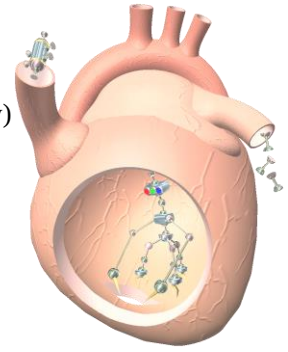
IEEE Robotics and Automation Society, Technical Committee for Energy, Environment, and Safety Issues in Robotics and Automation, IEEE Robotics and Automation Society, Technical Committee for Cyborg and Bionic Systems; Aichi Prefectural Government; Central Japan Economic Federation; Chubu Bureau of Economy, Trade and Industry, METI; Central Japan Industries Association; Japan Science and Technology Agency; Japan Society of Applied Physics; Nagoya Chamber of Commerce & Industry Central Japan Industries Association

Topics: Miniaturization Technology, Micro/Nanomechatronics, Micro/Nanorobotics, Micro/Nanosensors, Micro/Nanoactuators, Micro/Nanofabrication, Micro/Nano Integrated Devices and Systems, Micro/Nano Power Source and Supply, Micro/Nanomachining, Micro/Nano Assembly Technology, Micro/Nanotechnology, Micro/Nano Materials, Intelligent Control Systems, Data Transmission and Communication, Human Centered Robotics and Mechatronics, Human Care and Assisting Systems, Human Interface, Human Science, Artificial Life Technology, Virtual Reality, Multi Media, Software Aspects, Human-Ware Network Systems, Applications (Consumer Electronic Products, Security System and Others in Biological, Medical and Industrial Fields.)

Venue: Noyori Memorial Conference Hall**,** Nagoya University

Language: English

Honorary Chair: Toshio Fukuda (Meijo University)
General Co-Chair: Fumihito Arai (The University of Tokyo)
General Co-Chair: Koichi Suzumori (Tokyo Institute of Technology)
General Co-Chair: Jun Ota (The University of Tokyo)



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