Japan-China Joint Workshop on Recent Advances on Active Soft Materials 2018

August 28(Tue), 2018
Tokyo Denki University, Tokyo, Japan

The Technical Committee on Soft Materials, System Integration Division,
The Society of Instrument and Control Engineers (SICE)

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Welcome

Japan-China Joint Workshop on Recent Advances on Active Soft Materials 2018, organized by the Technical Committee on Soft Materials, SI division, the Society of Instrument and Control Engineers (SICE), will be held on August 28(Tue), 2018, at Tokyo Denki University, Japan.
The workshop is an international conference covering active soft materials including polymer actuators and sensors. The technical program of the workshop will consist of keynote and invited talks, and a poster session.

Organizing committee

Kazuto Takashima (Kyushu Institute of Technology)
Kentaro Takagi (Nagoya University)
Norihiro Kamamichi (Tokyo Denki University)
Kunitomo Kikuchi (Wakayama Univerisity)
Tetsuya Horiuchi (AIST)

Sponsors

Organized by:
The Technical Committee on Soft Material, System Integration division, SICE

In Association with:
The Research Group for Industrialization of Soft Actuator, MRS-J
The Precise Measurement Technology Promotion Foundation

Venue

Conference site:
Room 1204, 2nd Floor, Building No.1
Tokyo Denki University, Tokyo-senju Campus (5 Senju Asahi-cho, Adachi-ku, Tokyo)
Map

Nearest station:
Kita-senju Station (JR Joban Line, JR Ueno-Tokyo Line, Tokyo Metro Hibiya Line, Tokyo Metro Chiyoda Line, Tobu Skytree Line and Tsukuba Express Line)

Registration

Registration fee is free of charge. Pre-registration is not required. On-site registration will be required.
The registration desk will be open from 9:30 am, 28th August, 2018.

Keynote lectures

Prof. Jinxiong Zhou (Xi'an Jiaotong University), *Simulation enabled design of soft robotics*
Dr. Kinji Asaka (AIST), *Electrically-driven polymer-gel actuators*

Invited lectures

Prof. Hidenori Okuzaki (Yamanashi University), *Flexible sensors with highly conductive polymer electrodes*
Prof. Tadashi Ihara (Suzuka University of Medical Science), *Medical applications of soft material actuators and sensors*
Prof. Ying Hu (Hefei University of Technology), *Nanocarbon-based bilayer actuators for various biomimetic motions*
Prof. Bo Li (Xi'an Jiaotong University), *Actuating soft materials in surgery robot applications*
Prof. Zicai Zhu (Xi'an Jiaotong University), *Recent progress on improvement of IPMC actuator and sensor*
Prof. Longfei Chang (Hefei University of Technology), *Rough interface in IPMC: modeling and its influence analysis*

Poster presentations

Takushi Sugino (AIST), Kinji Asaka (AIST)	*Research on nanocarbon polymer actuators*
YingJun An (University of Yamanashi), Hidenori Okuzaki (University of Yamanashi)	*Novel Composites of Conductive Polymer and Shape Memory Polymer for Electroactive Soft Actuators*
Wataru Iwabuchi, Norihiro Kamamichi (Tokyo Denki University)	*Linearizing compensation by PWM driving and feedback control of fishing line artificial muscle*
Kazuki Morita, Yuta Kizaki, Nobutsune Endo, Norihiro Kamamichi (Tokyo Denki University)	*Dielectric elastomer sensor for shape measurement of soft robots*
Toru Ikegame (Nagoya Univ.), Kentaro Takagi (Nagoya Univ.)	*Charging efficiency of a passively-switched flyback converter for dielectric elastomer generator*
Jun Takeda (Nagoya Univ.), Kentaro Takagi (Nagoya Univ.), Zicai Zhu (Xi'an Jiaotong Univ.), Kinji Asaka (AIST)	*Study on simplification of a multi-physical model of IPMC sensor generating voltage as sensing signal*
Kazuto Takashima (Kyushu Institute of Technology)	*Actuators and sensors utilizing stiffness change of shape-memory polymer according to temperature*
Ryuto Kakitsuka (Wakayama University), Kunitomo Kikuchi (Wakayama University), Hidenori Okuzaki (University of Yamanashi)	*Development of a thermoplastic polymer actuator with PEDOT:PSS as a conductive polymer heater*
Satoshi Tanaka (Wakayama University), Ryuto Kakitsuka (Wakayama University), Kunitomo Kikuchi (Wakayama University)	*Development of a stiffness-controllable ionic polymer-metal composite incorporated with a shape memory polymer*
Taisuke Norioka (Wakayama University), Syusake Uchida (Wakayama University), Ryuto Kakitsuka (Wakayama University), Kunitomo Kikuchi (Wakayama University)	*Development of a fabrication process incorporated with fused deposition molding 3D printing technique for Ionic polymer-metal composite*

Program

Time	Schedule	Speaker	Title
10:00 -10:10	Opening		
10:10 -11:00	Keynote lecture AM	Prof. Jinxiong Zhou (Xi'an Jiaotong University)	Simulation enabled design of soft robotics
11:00 -11:30	Invited lecture AM1	Prof. Hidenori Okuzaki (Yamanashi University)	Flexible sensors with highly conductive polymer electrodes
11:30 -12:00	Invited lecture AM2	Prof. Ying Hu (Hefei University of Technology)	Nanocarbon-based bilayer actuators for various biomimetic motions
12:00 -13:00	Lunch		
13:00 -13:30	Poster Session		
13:30 -14:20	Keynote lecture PM	Dr. Kinji Asaka (AIST)	Electrically-driven polymer-gel actuators
14:20 -14:50	Invited lecture PM1	Prof. Bo Li (Xi'an Jiaotong University)	Actuating soft materials in surgery robot applications
14:50 -15:20	Coffee break		
15:20 -15:50	Invited lecture PM2	Prof. Tadashi Ihara (Suzuka University of Medical Science)	Medical applications of soft material actuators and sensors
15:50 -16:20	Invited lecture PM3	Prof. Zicai Zhu (Xi'an Jiaotong University)	Recent progress on improvement of IPMC actuator and sensor
16:20 -16:50	Invited lecture PM4	Prof. Longfei Chang (Hefei University of Technology)	Rough interface in IPMC: modeling and its influence analysis
16:50 -17:00	Closing		

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http://www.ac.ctrl.titech.ac.jp/tcsm/workshop20180828.html

Abstracts

Keynote lecture AM
Prof. Jinxiong Zhou (Xi'an Jiaotong University), *Simulation enabled design of soft robotics*

Invited lecture AM1
Prof. Hidenori Okuzaki (Yamanashi University), *Flexible sensors with highly conductive polymer electrodes*

Invited lecture AM2
Prof. Ying Hu (Hefei University of Technology), *Nanocarbon-based bilayer actuators for various biomimetic motions*

Keynote lecture PM
Dr. Kinji Asaka (AIST), *Electrically-driven polymer-gel actuators*

Invited lecture PM1
Prof. Bo Li (Xi'an Jiaotong University), *Actuating soft materials in surgery robot applications*

Invited lecture PM2
Prof. Tadashi Ihara (Suzuka University of Medical Science), *Medical applications of soft material actuators and sensors*

Invited lecture PM3
Prof. Zicai Zhu (Xi'an Jiaotong University), *Recent progress on improvement of IPMC actuator and sensor*

Invited lecture PM4
Prof. Longfei Chang (Hefei University of Technology), *Rough interface in IPMC: modeling and its influence analysis*

Invited lecture PM5
Prof. Yanjie Wang (Hohai University), *Solutions of critical defects to applications of ionic polymer-metal composites (IPMC)*

Simulation enabled design of soft robotics

Jinxiong Zhou

State Key Laboratory for Strength and Vibration of Mechanical Structures, Shaanxi

Engineering Laboratory for Vibration Control of Aerospace Structures, School of Aerospace,

Xi'an Jiaotong University, Xi'an 710049, China

Abstract: Soft robotics has emerged as a cutting-edge frontier for interdisciplinary research, where design is at the core of soft robotics development. The design of soft robotics is somehow more complicated as compared with its hard counterpart, due mainly to infinite degrees of freedom, large deformation, strong nonlinearity and coupling between multiphysics fields. We present in this talk our recent efforts towards modeling and optimization of soft robotics using continuum mechanics based finite element method. The simulation aids design of soft robotics, and also illuminates underyling physics and working principles of soft robotics. Some future research interests and perspectives toward this direction are also discussed.

BIO: Prof. Jinxiong Zhou obtained his Phd degree in solid mechanics, Northwestern Polytechnical University, 1998. He became an assistant professor of Xi'an Jiaotong University in 2000 and promoted to full professor in 2007. He was the recipient of New Century Talents, Ministry of Education of China in 2006. From 2006.11-2007.11, he was a visiting scholar at Harvard university. He has published 150 peer-viewed journal papers including Adv. Mater., Adv. Func. Mater., APL, and Soft Matter, etc. His h-index is 21 with total 3000 citations.

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Flexible Sensors with Highly Conductive Polymer Electrodes

Hidenori Okuzaki

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Abstract: In this study, fabrication and characterization of flexible sensors driven by piezoionic effect have been demonstrated. The ionic liquid-polyurethane (IL-PU) gels were prepared by casting the solution of 1-ethyl-3-methylimidazoliumbis (trifluoromethylsulfonyl) imide ([EMI][TFSI]) and thermoplastic polyurethane. Then, poly(3,4-ethylenedioxythiophene) doped with poly(4-styrenesulfonate) (PEDOT:PSS) as flexible electrodes were spray-deposited on both sides of the IL-PU gel. Upon bending the gel, positive electric charges are rapidly generated, whereas the equivalent negative charges are formed when the bending stops. On the other hand, the opposite phenomenon was observed when the bent gel recovers to the original straight shape, indicative of an acceleration sensor. The mechanism can be explained in terms of the "piezoionic effect" based on the difference of ionic mobilities between the EMI^+ and $TFSI^-$. On the basis of this phenomenon, we have succeeded in fabricating a wearable sensor glove, in which the flexible sensors located on the three fingers are operating individually. Since the sensor can provide information not only the acceleration but also force, velocity, and displacement, the wet-processbable, stretchable, and wearable flexible sensors based on the piezoionic effect will be available for motion sensors in a wide field of application.

Biography: Hidenori Okuzaki obtained his PhD in polymer science from the Hokkaido University in 1994. He has been working on organic and plastic electronics using conductive polymers since 1994 at the University of Yamanashi as an assistant professor. Since 2014, as a professor, he has been focusing on the synthesis of highly conductive polymers and applications to organic field-effect transistors, flexible supercapacitors, conductive micro- and nano-fibers, soft sensors and actuators.

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Nanocarbon-based bilayer actuators for various biomimetic motions

Ying Hu

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Abstract: Soft actuators can convert external stimuli into mechanical deformation, and have shown greatly application prospect in the fields of soft robots, biomedical devices, and wearable electronics. In this talk, we will present our recent progress on the nanocarbon-based soft actuators. We design and fabricate CNT/polymer bilayer actuators with tubular shape, which show electrically and sunlight induced actuation with large deformation and fast response. Inspired by the flicking finger motion, we develop a new type of soft jumping robot based on the rolled bilayer actuators, which could jump up upon light irradiation accompanied by the somersault. Moreover, a variety of smart robots, including electrical/light induced crawling-type walking robots, mechanical gripper for grapping objects, and ambient sunlight induced blooming of a biomimetic flower, are all designed.

BIO: Prof. Ying Hu obtained his Phd degree in microelectronics, Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences, 2012. He became an assistant professor of Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences in 2010 and associate professor in 2014. In 2016, he joined Hefei University of Technology as a full professor. He has published nearly 30 journal papers including Nat. Commun., Adv. Mater., Adv. Funct. Mater., ACS Nano, Small, etc.

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Electrically-Driven Polymer-Gel Actuators

Kinji Asaka
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Abstract: Polymer gels are composed of polymer matrix filled with a solvent. Some of them are distinguished by remarkable deformation capabilities under the influence of external physical and chemical stimuli. In particular, electrically-stimuli-deformed polymer gels can be applied to soft actuators for various applications. Electrically-driven polymer-gel actuators can be divided into two main types, i.e. ionic gels: which are activated by the electrical transport of ions and/or solvents, and dielectric gels: which are activated by an electric field. We have developed ionic-type polymer-gel actuators such as ionic polymer metal composites (IPMCs) and nano-carbon polymer actuators. In this talk, we present some of recent developments of electrically driven soft actuators based on both types of polymer gels, focusing their electromechanical mechanisms in order to develop high-power generating soft actuators driven by low voltage.

BIO: Dr. Kinji Asaka received his PhD degree in Science from Kyoto University in1990. He is currently a Group Leader of Hybrid Actuator Group, Inorganic Functional Materials Research Institute (IFMRI) at AIST. His current research interests include interfacial electrochemistry and polymer actuators. He is a member of the Society of Polymer Science, Japan and The Society of Instrument and Control and Engineers.

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ACTUATING SOFT MATERIALS IN SURGERY ROBOT APPLICATIONS

Bo Li,[1] Lei Liu,[1] Dichen Li,[2] Hualing Chen,[1] Guiming Chen[1]

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2. State Key Laboratory for Manufacturing System Engineering, School of Mechanical Engineering, Xi'an Jiaotong University, Xi'an 710049, China

Abstract: Conventional surgical robot are in straight-bar shape and made of rigid materials mostly, which fail to adapt to the minimally invasive surgical operation using natural orifices. Therefore, we develop a flexible surgical robot based on soft materials. Multi-DOF deformation and variable stiffness abilities via electro-pneumatic actuation and fiber jamming techniques, is presented. The integrated manufacturing process of the manipulator unit is developed. An experimental test system is set up to obtain the nonlinear relationships between the bending deformation, output force of the pneumatic artificial muscle actuator and the air pressure, by eliminating the instability. The relationships between anti-bending ability of a single unit and negative pressure, fiber arrangement and fiber density are further studied. The optimized design scheme is obtained. Within a complex system, the multi-DOF deformation in bypass, the tracking and the stiffness tunability of the manipulator are demonstrated.

BIO: Bo Li is an associate professor in School of Mechanical Engineering, Xi'an Jiaotong University. He obtained his PhD degree in Instrument Science and Engineering, Xi'an Jiaotong University, 2012. He was a visiting scholar at Harvard university, a post-doctor in National University of Singapore, a guest researcher in AIST, Japan. He has published 44 peer-viewed journal papers with h-index 17 with total 888 citations.

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Medical applications of soft material actuators and sensors

Tadashi Ihara

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Suzuka University of Medical Science, Suzuka 510-0293, JAPAN

Abstract: Medicine is one of the most important field of applications of soft material actuators and sensors. It is progressively advancing in various areas in medicine either as an external devices, as implantable devices, or as temporary transluminal devices. Also, a variety of materials are applied. The author will review several important application of soft material actuators and sensors in medicine. Some of the author's works are also discussed.

Biography: Prof. Tadashi Ihara obtained his PhD degree in biomedical engineering, Duke University, 1990. He became an assistant professor of Suzuka University of Medical Science in 1993 and promoted to full professor in 1995. He was a recipient of Fulbright scholarship in 1990, and was a research fellow at Harvard University. He has published peer-viewed journal papers on SICE Journal of Control, Measurement, and System Integration, Medical and Biological Engineering and Computing, Circulation, Circulation Research, American Journal of Physiology and others.

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Recent progress on Improvement of IPMC actuator and sensor

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Abstract: IPMC has been developed for over twenty years. It is still far from real application in industry. In this talk, I would like to share our recent research progress both on IPMC actuator and sensor. Regarding IPMC actuator, there are three bottleneck points, poor deformation stability especially with humidity, slow response in the case of thick and IL-based actuator, and relative low output force. In Europe, MICACT program dedicated to develop EAP actuator applications in micro scale. Different from that, this talk will show our strategy to promote IPMC application on macro-scale, which is mainly based on a new technology to accelerate IPMC bending safely we developed recently. On the other side, conventional IPMC or IPT sensor etc. works in the form of cantilever. This talk will introduce a new ionic polymer pressure sensor based on a typical ionic polymer, Nafion. Inspired by sensing mechanism of IPMC strip, whose electrical response is induced by elastic stress gradient across thickness, we developed a trapeziform ionic polymer sensor. Under an applied pressure, elastic stress gradient will be generated across the upper and bottom surfaces, and cause cations migrate toward the lower pressure side, i.e. the bottom surface with large area. We will introduce our recent progress on the sensing properties of the new sensor.

Biography: Zicai Zhu, Associate Prof. of Xi'an Jiaotong University.
Obtained the PhD degree in 2013 from Xi'an Jiaotong University. After graduation, worked as a postdoc at SINANO in Chinese Academy of Science in 2013, worked as special researcher at Prof. Kinji Asaka's lab in AIST in 2014 and worked as a researcher at Prof. Avlo Aabloo's lab at University of Tart in 2015. Then went back to Xi'an Jiaotong University in 2016 and worked as an associate professor. Main research interests include ionic EAP actuator, flexible ionic bio-sensors, dielectric gel and soft robots.

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Rough interface in IPMC: modeling and its influence analysis

Longfei Chang[1,2*] , Yanfa Liu[1], Qingzheng Niu[1], Yucheng Wu[1,3*]

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Abstract: Ionic polymer-metal composite (IPMC) is a representative ionic electro-active polymer (EAP) used as soft actuators and sensors. In recent years, its rough interface between the electrodes and substrate polymer has been proved to have crucial influence on its electro-mechanical properties. However, the internal mechanisms are still recognized based on idealized contours, due to the difficulty in the modeling for the interface profile. Here we provides a method for establishing models to effectively catch the main characteristics of real interface morphology, based on Weirstrass-Mandelbrot (W-M) function. The feasibility was well verified by comparing the mass transport results on the established models with those on extracted actual interface profiles. Besides, methods to obtain the core parameters used in W-M function were investigated and an empirical formula was acquired. On the basis of the proposed characterization model, the dependence of the interface roughness on the fabrication procedures as well as its influence on the capacitance and the electro-active displacement were also explored.

BIO: Dr. Longfei Chang obtained her Phd degree in Xi'an Jiaotong University in 2015. She became an assistant professor of Hefei University of Technology in 2016. She has been a visiting scholar at AIST, Japan under the sponsorship of CSC (Chinese Scholarship Council of the Ministry of Education), China during 2013.9 to 2014.9. She has published more than 20 peer-viewed journal papers including APL, JAP, Smart Materials & Structures, etc.

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