Speaker: Koichi Suzumori (Tokyo Institute of Technology)

Title: Soft Robotics as E-kagen Science

Abstract

Since 1986, I have been developing and researching various types of soft actuators and robots, including pneumatic rubber actuators, functional rubber surfaces, hose-free pneumatics. In this workshop, I will give an overview of my research into these soft actuators and robots over the years, including their (future) applications areas. Next, I will discuss my more recent research on thin soft muscles, their benefits as compliant and lightweight actuators, and their applications to soft power support suits, musculoskeletal robots and Giacometti robots. Finally, I would like to talk about the significance of soft robotics in the historical and modern robotics field using the Japanese word "E-kagen". E-kagen (いいかげん) is a so-called Janus-word; a word with two meanings of which one is the reverse of the other. In Japan, the word E-kagen can either mean good, proper and moderate or irresponsible, imprecise and vague depending on the context. E-kagen nicely highlights both sides of soft robotics; its challenges and its merit. If you are curious to know more about how E-kagen applies to soft robotics, please visit the workshop.

Biography

Koichi Suzumori received his Ph.D. degree in mechanical engineering from Yokohama National University in 1990. Between 1984 and 2001, he worked for Toshiba R&D Center and Micromachine Center (Tokyo) on the development of innovative pneumatic actuators. Extending his experience in soft pneumatics actuators, he moved to the Division of Industrial Innovation Sciences of Okayama University in 2001, where he worked as a full professor. In 2014, he joined the Department of Mechanical Engineering at Tokyo Institute of Technology as a full professor and the director of the Suzumori-Endo Lab. His expertise in soft actuators and robots, has led to the development of ultrathin pneumatic muscles and several other innovative soft robots. Furthermore, collaborating with a wide variety of nation-wide academic hospitals, industrial partners, robotics and biological research groups, the research within his group has led to a number of patents, commercial products, and spin-off companies such as s-muscle Co., Ltd. (2016), which commercializes the developed miniature soft artificial muscles.

Speaker: Kenjiro Tadakuma (Tohoku University)

Title: Fiber Jamming Gripper Mechanisms with High Protection Ability

Abstract

A gripper comprising a jamming membrane was developed with the capability of grasping collapsible, soft, and fragile objects without applying heavy pressure. In disaster sites, it is necessary for robots to grab various types of objects, such as fragile objects. Deformable grippers that contain bags filled with powder cannot handle collapsible or soft objects without excessive pressure. We developed a jamming membrane comprising the following three layers: outer layer and inner layer made of rubber and a powder layer in between the outer and inner rubber layer. This jamming membrane allows collapsible, soft, or fragile objects to be held securely without applying too much pressure. We also developed the protecting woven cloth from edge resistant thread for not only membrane grippers but also most of soft bodied structures. In addition to this protecting method, as a next step, we developed the fiber jamming with wire and hole beads with through holes. The gripper mechanisms with this fiber jamming have highly protection ability with no necessity of the vacuuming effect. Therefore, this fiber jamming gripper is quite effective to grasp various sharpen or pointed objects. As a one of the next of soft robotics, and from the viewpoint of engineering, the author set the research target to realize a branched extension torus mechanism inspired by the proboscis of Nemertea that extends and branches at a much faster rate than that of plants. In this presentation, the above robotic mechanisms will be explained with some real prototype models and the basic concept of robotic blood vessels and the first experiment can be shown.

Biography

Kenjiro TADAKUMA is an associate Professor of the Graduate School of Tohoku University from May 2015. He received his PhD degree in mechanical and aerospace engineering from the same institute in 2007. He was a visiting researcher of Massachusetts Institute of Technology from September 2006 to March 2007. He was a postdoctoral associate of the same institute from April 2007 to December 2007. From January 2008 to March 2008, he was the postdoctoral research fellow of the Department of Aerospace Engineering at the Graduate School of Tohoku University. From April 2008 to July 2009, he was an assistant professor of the University of Electro-Communications. From August 2009, he has been an assistant professor of the Graduate School of Osaka University. His research interests mainly include robotic mechanisms omnidirectional mobile robots, gripper mechanism with stiffness-changing as a view point of soft robotics.

Speaker: Gen Endo (Tokyo Institute of Technology)

Title: Development of "Super" tendon-driven mechanisms using high tensile strength synthetic fiber ropes

Abstract

In this talk, we discuss "Super" tendon-driven mechanisms and its control method using high tensile strength synthetic fiber ropes. Recent research progress in a synthetic fiber rope implies that there are possibilities to develop super lightweight, super compact, super long reach and/or super redundant robots by using synthetic fiber ropes as artificial tendons, because of its lightweight, high tensile strength and high flexibility. Soft robots often use these fiber ropes as well. However, their basic physical properties as a robotics component are still unclear. Thus, we investigate various basic properties of synthetic fiber ropes such as durability against repetitive bending, strength degradation by a sharp bending, visco-elasto-plasticity and so on. Our research group also developed a new rope fixation method without decreasing the maximum tensile strength, lightweight compact joint driving mechanism "Bundled Wire Drive", exploiting its low frictional coefficient. Finally, I talk about "Super" long reach articulated manipulator "Super Dragon" for the decommissioning task of Fukushima Daiichi Nuclear Power Plants. Super Dragon has 10 D.O.F, 10-m-long, 0.2 m in diameter and 10 kg payload.

Biography

Gen Endo received his BS, MS, and PhD degrees from Tokyo Institute of Technology, Japan, in 1996, 1998, and 2000, respectively. From 2000 to 2007, he worked for Sony Corp. and was also a visiting researcher at the Advanced Telecommunication Research Institute International. In 2008, he joined the faculty of Tokyo Institute of Technology, as an assistant professor. In 2014, he was an associate professor of Institute of Biomaterials and Bioengineering in Tokyo Medical and Dental University. He is currently an associate professor of Tokyo Institute of Technology. His research interests cover mobile robots, tendon-driven redundant manipulators, welfare robots, and the design of mechanisms.

Speaker: Toshio Takayama (Tokyo Institute of Technology)

Title: Bundled tube locomotive device: the first idea came from the movement of a microorganism

Abstract

Bundled tube locomotive device consists only of few bundled soft inflatable tubes. Although it is a simple device, it can move in a pipe by only inflates its tubes periodically. Because of its softness, the device has high passive adaptability and it also can pass through an elbow pipe without complicated control. Moreover, because of its simple structure, the device is suitable for mass products and applicable for pipe inspection. In this presentation, I will explain how I get the idea of this device from a microorganism, and introduce some types of bundled tube locomotive devices and its extended devices.

Biography

Takayama Toshio received Dr. Eng. degrees from the Dept. of Mechanical and Aerospace Engineering, Tokyo Institute of Technology, Tokyo, Japan, in 2004. From 2004, he was an assistant professor at the Dept. of Mechano-Micro Engineering, Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology, and promoted to an associate professor in 2014. His main work was the mechanical design of mobile robots, robot hands, and medical devices. From 2017 he belonged to the Dept. of Mechanical Engineering, Graduate School of Engineering, Osaka University as an associate professor, for learning microfluidic channel devices. From 2019 he is an associate professor at the Dept. of Mechanical Engineering, Tokyo Institute of Technology.

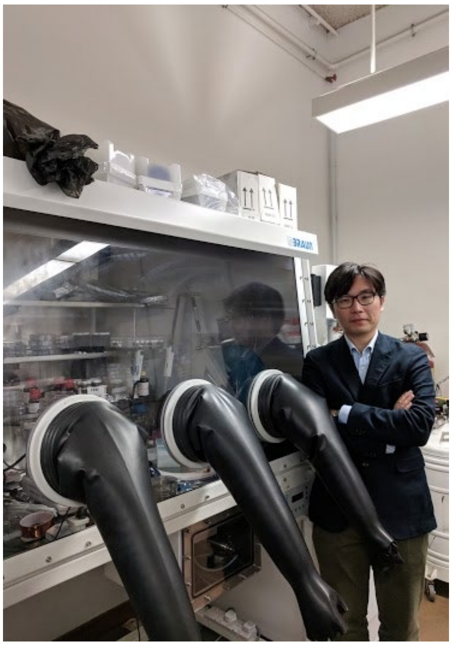
Speaker: Paddy Chan (The University of Hong Kong)

Title: Smart flexible sensors based on organic electronics

Abstract:

The progress of organic electronics is significant since the last decade. Different kind of devices have been successfully developed, and a number of them started to outweigh the conventional inorganic one. In this talk, I will focus on the latest development on the flexible smart sensors based on organic semiconductors under the transistor structure. From sensing the heat to the light and pressure, the class of sensors opens completely new application directions in robotics, biomedical engineering, and other disciplines. By embedding metal nanoparticles into the pentacene thin film, the temperature sensor has achieved a high dynamic range sensing up to 23 bits. For the optical sensor, by using the nano-sprouts generated in the organic thin film, we can achieve photosensitivity of 433 A/W at the light intensity of 120 u W/cm2, making them very suitable for the dim environment optical sensing. Other than these two sensors, I will also talk about the recent development of other biological sensors developed in the Laboratory of Nanoscale Energy Conversion Devices and Physics at HKU.

Biography



Paddy K. L. Chan obtained the bachelor degree in mechanical engineering from The University of Hong Kong in 2002, and PhD degree in mechanical engineering from University of Michigan in 2007. He is also holding a master degree in electrical engineering and compute r science from University of Michigan. He is currently an associate professor of The University of Hong Kong and leading the Laboratory of Nanoscale Energy Conversion Devices and Physics. His current research interests are novel organic electronics and smart sensors. His team has developed a new solution processing approach known as dual solution shearing to deposit the organic active layer with high uniformity up to wafer scale. they also demonstrated 2D active matrix organic transistor sensor array for temperature and optical image mapping.

Speaker: Prof. Hongliang Ren (National University of Singapore)

Title: Collaborative Robotics with Continuum and Compliance

Abstract

Representing a major paradigm shift from open surgery, minimally invasive surgery (MIS) assisted by robots and sensing is emerging by accessing the surgical targets via either keyholes or natural orifices. It is challenging to get delicate and safe manipulations due to the constraints imposed by the mode of robotic access, confined workspace, complicated surgical environments and the limited available technologies, particularly in terms of endoluminal curvilinear targeting and guidance. Addressing the aforementioned challenges and aiming at human-centered flexible robots, this talk will share our recent biorobotic researches in continuum mechanisms, compliance modulations, delicate sensing, collaborative human-robot interactions, mostly in the context of medical applications. The compliant continuum robotics with embodied intelligence allows us to bypass critical important intracranial or intracorporeal structures, to conform its shape to be compliant with curvy passages, and have direct access to the target sites under proper planning and navigation, thus significantly reducing invasiveness and trauma of surgery.

Biography

Hongliang Ren is currently an assistant professor and leading a research group on medical mechatronics in the Biomedical Engineering Department of National University of Singapore (NUS). He is an affiliated Principal Investigator for the Singapore Institute of Neurotechnology (SINAPSE), NUS (Suzhou) Research Institute, and Advanced Robotics Center at National University of Singapore (NUS). Dr. Ren received his Ph.D. in Electronic Engineering (Specialized in Biomedical Engineering) from The Chinese University of Hong Kong (CUHK) in 2008. Prior to joining NUS, he was a Research Fellow at The Johns Hopkins University, Children's Hospital Boston & Harvard Medical School, and Children's National Medical Center, USA. His main areas of interest include Biorobotics & Intelligent Control, Medical Mechatronics, Computer-Integrated Surgery, and Multisensor Data Fusion in Surgical Robotics. Dr. Ren is IEEE Senior Member and currently serves as Associate Editor for IEEE Transactions on Automation Science & Engineering (T-ASE) and Medical & Biological Engineering & Computing (MBEC). He is the recipient of NUS Young Investigator Award, IAMBE Early Career Award 2018 & Interstellar Early Career Investigator Award 2018.

Speaker: Li Zhang (The Chinese University of Hong Kong)

Title: TBD

Abstract

Coming soon

Biography

Coming soon

Speaker: Pakpong Chirarattananon (City University of Hong Kong)

Title: Origami-Inspired Fabrication and the Development of Microrobotic Insects

Abstract

As the platform size is reduced, flight of aerial robots becomes increasingly energetically expensive. Limitations on payload and flight endurance of these small robots prompt researchers to explore alternative lift generation mechanisms, flapping-wing robots, for example, are biologically inspired solutions that exploit unsteady aerodynamics to boost the flight efficiency. In addition, multi-modal locomotion emerges as a viable strategy to prolong operation time. In this talk, we focus on the origami-inspired fabrication methods and the recent developments in the bio-inspired flight platforms. At small scales (micro-millimeters), where traditional manufacturing methods fail, folding techniques have demonstrated success. In addition to the flight demonstration, recent developments include uses of hybrid aerial-aquatic and aerial-surface locomotion as strategies for energy saving. The multi-modal approach has shown promise in both flapping-wing robots and popular rotary-wing robots. Moreover, we briefly discuss alternative robot designs and mechanisms for increased aerodynamic efficiency of flying robots.

Biography

Pakpong Chirarattananon received his Bachelor and Master degrees from University of Cambridge, UK, and a Ph.D. degree from Harvard University under the supervision of Professor Robert Wood in 2014. His graduate work was centred on the dynamics and control for insect-scale flapping-wing robots. In December 2014, he joined the Department of Mechanical and Biomedical Engineering as an Assistant Professor and founded the Robotic and Intelligent Systems Laboratory at City University of Hong Kong. Dr Chirarattananon is broadly interested in applying control and dynamic system theories to study aerial and biologically-inspired robotic systems. He has published in Science, Science Robotics, and has been nominated as the best student paper award finalist at the 2013 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) and the best paper award finalist at the 2014 IEEE International Conference on Biomedical Robotics and Biomechatronics. Dr Chirarattananon is serving as the publication co-chair for the 2019 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM) and the upcoming 2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS).