Final Program : US-Japan Workshop on Soft Matter based Active Materials and Tactile Sensing and Their Integrated Systems, Sheraton Maui, Maui, May 21-23, 2014

Co-organizers: Minoru Taya, University of Washington, Kenji Asaka, AIST
and Makoto Saito, Nabtesco Corp.
Sponsored by Nabtesco Corp. and University of Washington

Purpose of the workshop

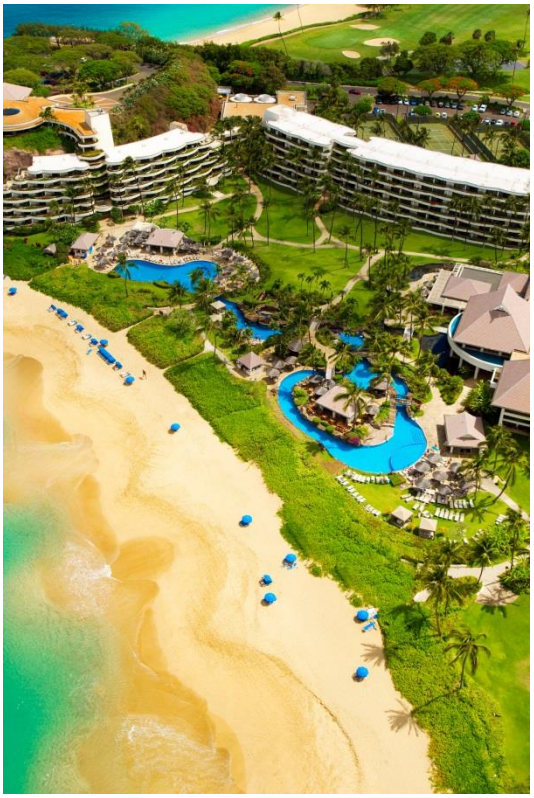
Robotic arms and hands are normally made of rigid bars and the rotating joints, which have been well-suited for industrial robots which require high gripping force capability, but those industrial robots are often tethered with heavy electrical wiring. Untethered robots , such as humanoid robots, have been successfully designed but with still utilize rigid bar-rotating joint linkage systems. Real human hands are made of soft-matters and hard bones with paired active and antagonistic muscles. The soft matter that constitute human and animal hands are natural active materials, requiring continuous nutrition that powers the paired muscles. In addition, the human and animal hands are embedded with a number of tactile sensors, and connecting neuronal systems which are interacting with the above active muscles.

There is a strong need for designing a set of new soft-matter based robotic hands, that would mimic human and animal hands, but instead of biomimetic design of very complicated natural hands, designing of simpler robotic hands based on soft-matter based active material integrated with tactile sensor capability is desired. The soft-matter active materials have been studied in terms of electro-active polymers (EAPs) which cover ferroelectric elastomers, conducting polymers, ionic membranes (Nafilon and Flemion), shape memory polymers, polymer gels and pneumatic elastomer actuators. Each of these EAPs has merits and demerits. Some of the EAPs can perform as tactile sensors if they are correctly designed and integrated into the robotic hands made of the active EAP. Except for ferroelectric elastomer based robotic hands under very high applied voltage, the current EAP based robotic hands are not so successful. Even for the ferroelectric elastomer based robotic hands being successfully designed, integrating a EAP tactile sensor to the ferroelectric elastic robotic hands would be challenging as the magnitudes of the former applied voltage is much smaller than that of the latter, thus electric signals of the former may be overshadowed by the high applied voltage of the EAP actuator. In order to design simpler robotic hands made of EAP, we may turn to a totally new design concept such as origami-crease line based bending mode and 3D fabrics structured active and sensing system. In addition, new design of sensing-diagnosis-actuation under truly integrated control system is desired.

This workshop will address the above challenges and the current limitations of the EAPactuators and sensors, and also discuss new concepts of actuation and sensing systems and integrated control systems. The outcome of the workshop will then recommend the future directions of the promising aspects of the flexible robotic hand system. Invited speakers from both US and Japan represent the main stream of such research and are expected to point out the future directions of the research subjects.

Workshop location

SHERATON MAUI RESORT & SPA - www.sheraton-maui.com
2605 Ka‘anapali Parkway, Lahaina, HI 96761



Sheraton Maui looking from Hotel to beach (atop), bird view of the hotel and beach (left) , bird-of-paradise flower and bird (below)

Program schedule

May 21 Welcome Reception, 6-8 pm : all attendees and their partners are invited

May 22, Thursday, **First Day Workshop**

8:30 – 8:40 Introduction, Minoru Taya

Session I: Ferroelectric active materials and actuators , Session Chair: Yosi Bar-Cohen

8:40 - 9: 20 am, **Rubber to Rigid, Clamped to Undamped: Electrolaminate composite materials with wide-range controllable stiffness and damping** , Roy Kornbluh , SRI

9:20 - 10:00 am, **Miniaturized Dielectric Elastomer Actuators for compliant gripping with integrated sensing, Hebert Shea, EFPL**

10:00 – 10:40 am, **Recent Progress in Dielectric Elastomers, Seiki Chiba, CSI**
10:40 -11:00 break

Session II: Conducting polymer based active materials and actuators, Session Chair: Tosihiro Hirai

11:00 – 11:40 am, **Is artificial muscle fit for robot hands? Prospects for the use of conducting polymer, carbon nanotube and thermally driven nylon actuators, John Madden, UBC**

11:40 am – 12:20 pm, **Conductive Polymers for Electro-Active Polymer Soft Actuators**

Hidenori Okuzaki, Yamanashi University

Lunch 12:20- 1: 30 pm

Session III: Ionic membrane active materials and actuators: Ephrahim Garcia

1:30 – 2:10 pm, **Ionic Electroactive Polymer Actuators based on Nano-carbon Electrodes**

, **Kinji Asaka, AIST Osaka**

2:10 – 2:50 pm, **Humanlike robots – the state-of-the-art and challenges, Yosi Bar-Cohen, NASA JPL**

2:50 – 3:30 pm, **Polymer Electrolytes of Ionic Liquids for Soft Actuators, Masayoshi Watanabe, Yokohama National Univ.**

3:30 – 3: 50 break

Session IV: new concepts of active structures: Makoto Saito

3:50 – 4:30 pm**, Active Knits – a Hierarchical Architectural Approach to Actuation**
Julianna Abel, University of Michigan

4:30 – 5;10 pm , **Bi-stability of Origami-based Structures and its Application to Mechanical Design**, **Sachiko Ishida, Meiji University**

5:10 – 5:50 pm, **Design of actuators and sensors based on Flemion: advantages and limitations, Minoru Taya, University of Washington**

6:30 – 9:00 pm, Banquet dinner: all of invited speakers and their partners are invited. Banquet Toast Speaker, Yujiro Imamura, Nabtesco

May 23, Friday, Second Day Workshop

Session V: new EAP active materials and devices, Session Chair: Kenji Asaka

8:40 – 9:20 am, **Soft Active Polymers by 4D Printing, Martin Dunn, Singapore University of Technology and Design**

9:20 – 10:00 am, **Possibility of Dielectric Polymer Gel Actuators**
How can they be electrically active?, Toshihiro Hirai, Shinshu University

10:00 – 10:20 break

Session VI: Robotic design, Session Chair: Martin Dunn

10:20 – 11:00 am **Bioinspired actuation for high efficiency robotics**
, **Ephrahim Garcia, Cornell University**

11:00- 11:40 am, **Sensor and actuator integration for robotic systems, Masaki Yamakita, Tokyo Inst. Tech.**

11:40- 11:50 am *Concluding remark , Makoto Saito, Nabtesco*

12:00 noon – 1:20 pm Lunch

2:00 pm - Free time, enjoy swimming/snorkeling, hiking, golfing or anything you wish to do in Maui

You could stay overnight of May 23, then leave hotel on May 24, Saturday.

List of invited speakers, their expertise

Name	affiliation	Email address	topics
Roy D. Kornbluh	SRI	roy.kornbluh@sri.com	Dielectric polymer active materials and actuators
Ephrahim Garcia	Cornell University	eg84@cornell.edu	EAP actuators
John Madden	University of British Columbia	jmadden@ece.ubc.ca	Conducting polymers
Herbert Shea	EPFL	herbert.shea@epfl.ch	Dielectric polymer actuators
Yosi Bar-cohen	NASA JPL	yoseph.bar-cohen@jpl.nasa.gov	EAP actuators
Martin Dunn	NUT	martin.dunn@Colorado.edu	Shape memory polymers
Julianna Abel	University of Michigan	jmariee@umich.edu	Knitted SMA actuator
Minoru Taya	UW	tayam@uw.edu	Flemion tactile sensor and Origami-based actuators
Kinji Asaka	AIST	asaka-kinji@aist.go.jp	Ionic membrane actuators
Hidenori Okuzaki	Yamanashi Univ.	okuzaki@yamanashi.ac.jp	conducting polymers
Seiki Chiba	Chiba Science Institute(CSI)	epam@hyperdrive-web.com	dielectric polymer actuators
Toshihiro Hirai	Shinshu Univ.	toshihirohirai@me.com	dielectric polymer gels
Masayoshi Watanabe	Yokohama National Univ.	mwatanab@ynu.ac.jp	Ionic polymers
Sachiko Ishida	Meiji University	sishida@meiji.ac.jp	Origami-based actuator designs
Masaki Yamakita	TIT	yamakita@ac.ctrl.titech.ac.jp	Robotic design