SPIE. SMART STRUCTURES+ NONDESTRUCTIVE EVALUATION

Embassy Suites by Hilton Denver
Denver, Colorado, United States
4 - 8 March 2018

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Special Events

20th Annual EAP-in-Action Session and Demonstrations

Date: **Monday 5 March 2018**
Time: **4:30 PM - 5:45 PM**

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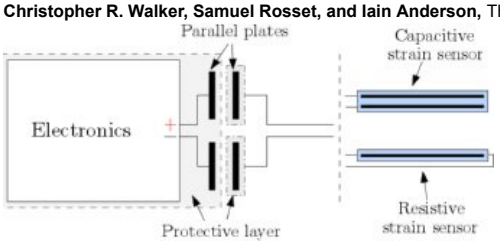
Part of conference 10594 on EAPAD. Review the full conference program here.

Session Chair: **Yoseph Bar-Cohen, Jet Propulsion Lab.**

This Session highlights some of the latest capabilities and applications of Electroactive Polymers (EAP) materials where the attendees are shown demonstrations of these materials in action. Also, the attendees interact directly with technology developers and given "hands-on" experience with this emerging technology. The first Human/EAP-Robot Armwrestling Contest was held during this session of the 2005 EAPAD conference.

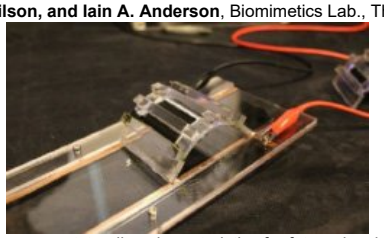
Tentative EAP Demonstrations

Capacitive coupling as an underwater signal transmission interface
Christopher R. Walker, Samuel Rosset, and Iain Anderson, The Univ. of Auckland (New Zealand)



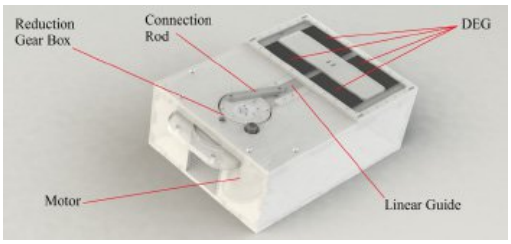
Capacitive coupling will be showcased as a signal transmission method to interface a capacitive strain sensor with electronics underwater. This signal transmission interface has the potential to simplify strain sensor integration into underwater wearables. The demonstration technology could be useful in diver health monitoring, human-interaction, and performance sport coaching applications.

Autonomous soft robots without electronics
E.-F. Markus Henke, Katherine E. Wilson, and Iain A. Anderson, Biomimetics Lab., The Univ. of Auckland (New Zealand)



Multifunctional dielectric elastomers possess outstanding characteristics for future developments in soft robotics. Large actuation combined with piezoresistive switches enables new fast dielectric elastomer logic elements that can directly drive soft robotic structures. Combining soft DE electronics with silicone skeletons enables the design of entirely soft, autonomous robots. This demo will present the design of soft skeletons (see example below), able to undergo large actuations and simultaneously maintaining necessary pre-strains in DE membranes; the integration of multifunctional DE electronics for autonomous signal generation using integrated DE oscillators; and a design that uses DE electronics, soft skeletons and electro static adhesion for locomotion.

An integrated self-priming circuit with electret charge source
Patrin K. Illenberger, Katherine E. Wilson, Udaya K. Madawala and Iain A. Anderson, Biomimetics Lab., Univ. of Auckland (New Zealand)



The Dielectric elastomer generator (DEG) is well suited for harvesting energy from natural motion sources. A DEG requires a source of initial high voltage priming charge to generate energy. In small DEG, a high voltage charge source is expensive and impractical to implement. To overcome this obstacle a Self Priming Circuit (SPC) was developed that uses low voltage and boosts this voltage. In this demo we present an Integrated SPC with an electret charge source that can rapidly boost charge to a high voltage without the need for external initial priming charge. A mechanical setup for evaluating the SPC can be seen in the provided figure.

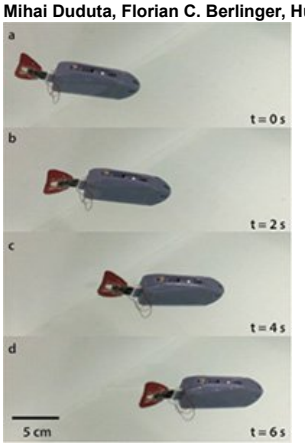
Single channel high voltage power supply with integrated touch screen
Samuel Rosset, Biomimetics Lab, The Univ. of Auckland (New Zealand) and Ecole Polytechnique Fédérale de Lausanne (Switzerland); **Patrin Illenberger**, Biomimetics Lab, The Univ. of Auckland (New Zealand); **Samuel Schlatter Herbert Shea**, Ecole Polytechnique Fédérale de Lausanne (Switzerland); **Iain Anderson**, Biomimetics Lab, The Univ. of Auckland (New Zealand)

A completely independent high-voltage power supply will be demonstrated to drive dielectric elastomer actuators. It can generate a user-programmable voltage between 0 V and 5 kV, either continuously or as a square signal between 1 mHz and 1 kHz. It integrates a large 7'' LCD touch screen and a user-friendly graphic user interface. Its integrated battery makes it possible to use the power supply.

The latest offerings in wearable electroactive polymer technology from StretchSense Ltd.
Eric Ambos, Iain Anderson, StretchSense Ltd. (New Zealand)

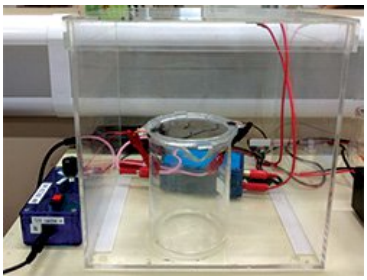
This will include a glove that transmits via Bluetooth to phone or computer hand kinematic data from embedded stretch sensors with on-board inertial measurement. Uses include gaming, virtual reality and good old fashioned air guitar (or violin). The new application software can depict a live 3D rendering of your hand.

An untethered swimming robot powered by dielectric elastomer actuators
Mihai Duduta, Florian C. Berlinger, Hudson Gloria, Radhika Nagpal, Robert J. Wood, and David R. Clarke, Harvard Univ. (USA)



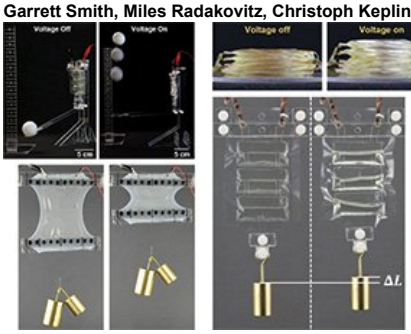
DEAs are rarely used in untethered robots because their force output is too small to enable locomotion via crawling or swimming. A multilayer assembly technique was developed to fabricate stronger bimorph actuators capable of outputting 20 mN of thrust when flapping in water at 1-8 Hz. A 10 cm long robot encapsulating the high voltage power supply that swims at 0.2 body lengths / second will be demonstrated.

Towards electroactive gel artificial muscle structures
Tim Helps, Majid Taghavi, Univ. of Bristol (United Kingdom)



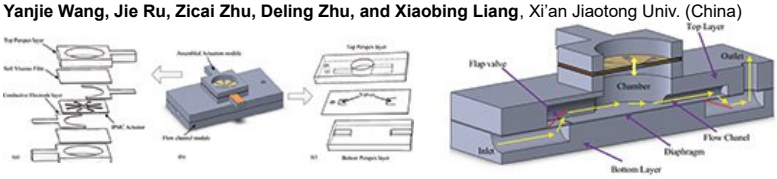
Electroactive gel actuators show great promise as artificial muscles because of their high strain and low elastic modulus but were not yet demonstrated performance characteristics necessary for ubiquity. In this demo newly developed electroactive gel actuators will be demonstrated with performance, achieved by optimization of not just material but also structural design of constituent components.

HASEL: Hydraulically amplified self-healing electrostatic actuators with muscle-like performance
Eric Acome, Shane K. Mitchell, Timothy G. Morrissey, Nicholas Kellaris, Vidyacharan Gopaluni Venkata , Madison B. Emmett, Claire Benjamin, Madeline King, Garrett Smith, Miles Radakovitz, Christoph Keplinger, Univ. of Colorado (USA)



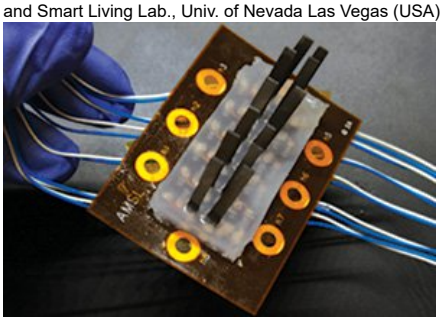
Soft electrostatic actuators that provide muscle-like performance will be demonstrated. These electrically controlled devices are based on a new class of soft actuators, termed hydraulically amplified self-healing electrostatic (HASEL) actuators, which recover from electrical failure while also combining the benefits of pneumatic and dielectric elastomer actuators. Key attributes are presented such as the ability to deliver large actuation force, achieve large actuation strain, output high power, and self-sense deformation for controlled actuation.

Fabrication and characterizations of a full-plastic micropump with petal-shaped ionic polymer-metal composite actuators
Yanjie Wang, Jie Ru, Zicai Zhu, Deling Zhu, and Xiaobing Liang, Xi'an Jiaotong Univ. (China)



As a critical research area, micropump has extensively emerged for many electronics and biological applications, especially for drug delivery. The actuating diaphragm, a key component of micropump, plays an important role in pumping-system. IPMC is a promising material candidate for micropump actuating diaphragm since it can be operated with low input voltages and can produce a large stroke by appropriate structural design. In this demo, we will present a petal-IPMC diaphragm obtained by mechanical cutting into micropump.

Multiple mode ionic polymer-metal composite array for the use in travelling wave actuators and sensing
Sarah Trabia, Robert Hunt , Taeseon Hwang, Qi Shen, Zachary Frank, Justin Neubauer, Zakai Olsen, Tyler Stalbaum, Blake Naccarato, Kwang Kim, Active Materials and Smart Living Lab., Univ. of Nevada Las Vegas (USA)



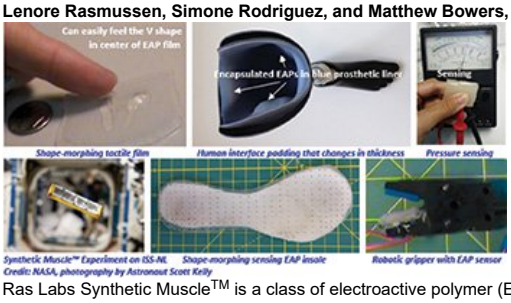
In nature, there are teams of actuator-like limbs that move together, such as cilia. By producing a travelling wave effect, they can transport items, generate flow, and act as sensors. It would be ideal for researchers to be able to reproduce something similar to create more biomimetic systems. Presented is an Ionic Polymer-Metal Composite (IPMC) array that has the ability to work as a team of actuators moving in a travelling wave or a team of sensors, being able to give a reading of the flow across the surface of the array. In this demo an IPMC array that works as an actuator and sensor will be presented.

Applications of smart polymers and their structures
Liwu Liu, Xiongfei Lv, Qinghua Guan, Jinrong Li, Yanju Liu and Jinsong Leng, Harbin Institute of Technology (China)



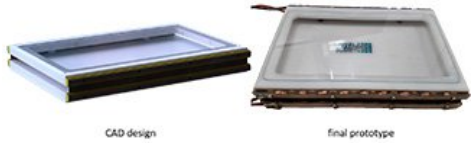
This demonstration will show smart polymers and their structures in action taking advantages of their being light weight, fast response, and large deformation. The demonstration will include the applications of EAP, shape memory polymer (SMP) and other smart structures. Specifically, a smart gripper, based on EAP and SMP materials, will be presented. Different soft actuators with various structures could achieve bend, elongation, contraction and other types of movements.

Synthetic Muscle™: Shape-morphing EAP based materials and actuators
Lenore Rasmussen, Simone Rodriguez, and Matthew Bowers, Ras Labs, Inc. (USA)



Ras Labs Synthetic Muscle™ is a class of electroactive polymer (EAP) based materials and actuators that contract, and with reversed electric input polarity, expand. Several actuators and sensors will be presented including a thick shape-morphing EAP pad that controllably contract or expand and is being used to prototype self-adjusting extremely comfortable prosthetic socket liners and other void-filling continual-fit applications, such as ear buds.

Haptic feedback demonstrators based on strip dielectric elastomer actuators
Philipp Loew, and Daniel Bruch, Univ. des Saarlandes, Lehrstuhl für Intelligente Materialsysteme, Intelligent Material Systems Lab (Germany)

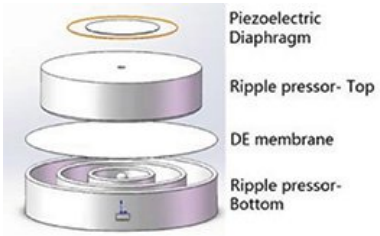


In times where touchscreens become more and more present in our daily lives, a haptic feedback based on the image you are receiving from the screen is helpful to operate a touch device without looking at it. The haptic feedback demonstrator, which is based on strip dielectric elastomer actuators is, is designed to perform this task, especially simulating buttons and rough surfaces.

Loudspeaker based on cone shaped out-of-plane dielectric elastomer actuators
Philipp Loew, and Daniel Bruch, Univ. des Saarlandes, Lehrstuhl für Intelligente Materialsysteme, Intelligent Material Systems Lab (Germany)

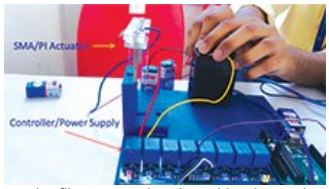
Due to their advantages, such as lightweight, energy efficiency, low cost, compactness and freedom in design, dielectric elastomers are suited to substitute commercial loudspeakers. The presented demonstrator supplies the overall driving motion by an out-of-plane biased cone shaped dielectric elastomer actuator. In contrast to conventional loudspeakers, sound is generated by the active membrane surface.

Dielectric elastomer energy harvester autonomously primed by piezo- and tribo-electricity
Koh Soo Jin Adrian, Liu Chong, Ahmed Haroun, Anup Teejo Mathew, National Univ. of Singapore (Singapore)



A Dielectric Elastomer (DE) Energy Harvester that is autonomously-primed with a piezo- and a tribo-electric source will be demonstrated. The similar nature of piezo- and tribo-electric primers with DE allows a DEG to operate autonomously without the need of an external source of electricity. We present an assembly of a piezo-DEG and tribo-DEG energy harvester. The piezo- and tribo- sources will provide a voltage prime of about 100 V. The DE film then takes over the electrical charges from the piezo- and tribo-source, and amplifies the voltage.

High-frequency actuation of CuAlNi shape memory alloy thin film composites
Ashish K. Shukla, Akash K., Mani Prabu, Jayachandran S., Deepesh Meena, Sachin Bhirodkar, Anbarasu Manivannan, Palani I.A., Indian Institute of Technology (India)

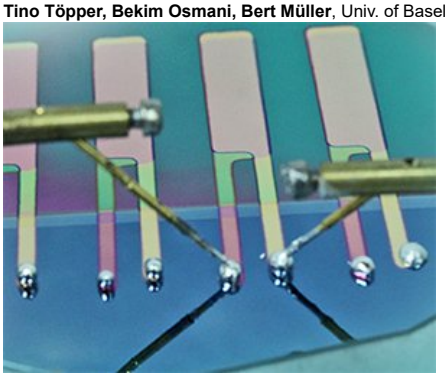


Cu-Al-Ni Shape Memory Alloy/Polyimide composite films were developed by thermal evaporation exhibited two-way displacement without post processing and training. Developed sheets are actuated using joule heating at different frequencies and the displacement was measured using Laser displacement sensor. Wings made of these actuators will be demonstrated using voltages in square waveform with control over pulse width and amplitude.

Hybrid piezoelectric shunt dampers for space rack vibration control: modeling and optimization: CANCELED
Bo Yan, Ke Wang, Zhihong Qiao, Chuanyu Wu, Zhejiang Science and Technology Univ. (China)

In this demo, piezoelectric transducers with some hybrid shunt damping circuit will be demonstrated to reduce vibrations. An electrical absorber was designed and optimized with the modal damping method to suppress the one mode vibration.

Enhancing the capabilities of artificial muscle implants using low-voltage dielectric elastomer sensors
Tino Töpper, Bekim Osmani, Bert Müller, Univ. of Basel (Switzerland)



The reduction of elastomer film thickness to a few hundred nanometers allows dielectric elastomer transducers (DET) to operate with only a few volts. DET nanostructures based on polydimethylsiloxane films are reliably fabricated by molecular beam deposition and in situ ultraviolet radiation curing. As capacitive sensors, these nanometer-thin DETs exhibit outstanding sensitivity of 4 kPa-1 for pressures between 0.01 and 10 kPa, which corresponds to loads between 0.01 and 10 g/mm. This resolution qualifies for resolving pressure changes at urethra. The team envisions this sensor for reliable force feedback integrated into an artificial muscle implant to treat urinary incontinence. Photo: Nanometer-thin dielectric elastomer layers (green) are fabricated by molecular beam deposition on a 2-inch Si-wafer (blue). The embedding Au-electrodes (goldish) are contacted via liquid metal drops.

3D Printing Demonstration Session