ACTUATOR 21

International Conference and Exhibition on New Actuator Systems and Applications

Online-Conference Report

ACTUATOR in a new format

ACTUATOR - 17th International Conference and 11th Exhibition on New Actuator Systems and Applications on February 17 – 19, 2021 – due to Corona in a completely new online format

This time everything was different - as already announced in the GMM Member Info in December 2020. ACTUATOR took place as an online conference and all the announced modules of our concept could be implemented. As a truly international conference, we were able to successfully realize a time zone span of 16 hours (San Francisco to Tokyo) in live sessions at still reasonable local times for our participants by scheduling the 10 plenary lectures for the early afternoon from 3 pm to 5 pm (CET). Before and after each plenary, there was the opportunity to attend short live presentations with discussions on all papers in four parallel sessions for one hour (approx. 20 hours in total). Each contribution was given about 10 minutes predominantly for discussion. Thanks to a professional team of international session chairs, the time frame of the conference could be kept very well. Each participant was able to watch offline about 120 individual conference contributions in prerecorded videos in a relaxed manner, which means about 40 hours of programme.

BROAD PROGRAMME SPECTRUM WITH FOCUS TOPICS

The conference offered a broad spectrum of topics in a total of 23 parallel sessions, with clear focus on piezoelectric actuators and their applications, SMA (shape memory alloy) actuators, MSM (magnetic shape memory) actuators and medical devices. Other focal points were dielectric elastomer and polymer actuators, haptic transducers and human-machine interfaces (HMI), respectively, aerospace applications and ER/MR (electro/magnetorheological) fluid actuators.

With regard to the number of papers presented, some geographical focal points emerged. Tokai University (Prof. Uchida) and Okayama University (Prof. Kanda) strongly represented Japan; the company CEDRAT Technologies (F. Claeyssen), jointly with several universities, came from France, whereas the Technical University of Berlin (Prof. Maas), the Saarland University (Prof. Seelecke) and from Germany's Southwest the Universities of Stuttgart (Prof. Pott), Karlsruhe (Prof. Kohl) and Freiburg (Prof. Wallrabe) came from Germany. Without any claim to completeness, some highlights of the scientific results are presented below.

HIGHLIGHTS WITH PIEZO TECHNOLOGY

There were several interesting contributions in the field of piezoelectric actuators. Okayama University, Japan (K. Omori, T. Kanda) presented an extremely homogeneous jet of droplets generated by a vibrating piezo bending head with a droplet rate of 29 kHz and droplet diameters of 200 µm.

A motor for a horizontal movement in x-y direction as well as for rotations in the z-axis was modelled, realized and experimentally analyzed consisting of 3 hemispherical piezo actuators (25.4 mm diameter, 2 mm thickness) by the University of Stuttgart (F. Schiele, B. Gundelsweiler).

A novel piezohydraulic actuator with 30 mm piezo-disk diameter and a small total volume of 53 m^3 with actuation forces up to 1000 N was presented by the Munich start-up MetisMotion (W. Zoels).

In a plenary lecture, Prof. K. Uchino from Penn State University, USA, comprehensively described the loss mechanisms in oscillating piezo systems.

COMPACT ACTUATORS WITH SHAPE MEMORY

The SAES Getters Group from Milan in Italy has developed a fast actuator with 800 µm thick shape memory wires (SMA) (M. Citro) which had been tested in a standard airbag system. The airbag filling time of 150 ms is still almost twice as high as that of pyrotechnic systems. Together with Alfmeier Präzision SE, SAES owns the joint venture Actuator Solutions GmbH as a manufacturer of miniaturized valves and actuators based on SMA.

Saarland University (M. Mandolino, S. Seelecke) presented the electrocaloric heating and cooling with single-crystal SMA wires and rotating magnets. An overview presentation (J. Mabe) from the aerospace company Boeing, USA was dedicated to the use of shape memory alloys (SMA) in the aircraft industry such as actuators for wing angle adjustment.

The American start-up Shaw Mountain Technology, jointly with Boise University from Idaho, presented a bidirectional valve-free, self-priming micropump (P. Müllner), where the moving pump chambers arise in the deformable surface of a substrate made of MSM material by means of magnetic fields of a rotating permanent magnet. The micropump can withstand a counterpressure of 30 bar.

NEW ACTUATORS FOR MEDICAL APPLICATIONS

Dielectric Elastomer Transducers (DET) with extremely thin layers of less than 1 µm and thus low control voltages of 24 V were presented in a plenary lecture by the University of Basel (B. Müller) for the use in implants. The technology is designed for stack actuators with 10,000 to 100,000 layers and was demonstrated on an artificial sphincter muscle.

Artificial muscles based on the McKibben principle are pneumatically driven by air pressure. From KU Leuven, Belgium (J. Legrand, E. Vander Poorten), a concentric actuator with an inner tube for the use of surgical instruments was presented; it was much slimmer than the classical arrangement. A contractile artificial muscle from Okayama University in Japan (S. Wakimoto, T. Kanda) was equipped with various functional fibers woven into the outer shell to act as sensors.

One application of MEMS (microelectromechanical systems) concerned the robust fabrication and characterization of silicon micropumps with a 25 mm^2 chip area that pump air and water, respectively, at flow rates of 4 ml/min and 0.5 ml/min (H. Leistner, M. Richter, Fraunhofer EMFT). The pump consisted of three anisotropically etched silicon plates with a piezo disk as drive for the pump chamber membrane.

DIELECTRIC ELASTOMER AND POLYMER ACTUATORS

The Sateco XT AG Company in Scherzenbach, Switzerland, has industrialized the series production of Dielectric Elastomer Transducers (DET) in multilayer technology based on the manufacturing process of CTSystems in Dübendorf, Switzerland (D. Haefliger). The transducers consisted of cuboids with edge lengths of 10 or 15 mm with individual layer thicknesses of currently 25 µm. First demonstrators form "buttons-on-demand" for haptic feedback.

Flexible electrodes with low sheet resistance and high long-term stability have not been available for DET until now. Saarland University (J. Hubertus, S. Seelecke) has demonstrated an interesting solution with thin metal layers (10 to 40 nm thick) that are sputtered onto pre-stretched silicone foils and structured by laser. Even after 10 million stretching cycles, the sheet resistance was a few 100 Ω/□ and thus many times lower than for carbon electrodes.

For driving DET, a miniaturized high-voltage amplifier for voltages up to 950 V has been developed at the Technical University of Berlin (S. Junglas, J. Maas) which contains only 2 MOSFETs and has an extremely compact board size of 14.9 mm x 10.4 mm.

MICROACTUATORS

In an overview lecture, F. Stoppel from Fraunhofer ISiT presented new MEMS-based actuators with thin-film piezo layers as well as magnetic layer systems. Thin-film piezo systems made of AlN and AlScN can be fabricated with linear characteristics up to layer thicknesses of 2 µm. Earphones with sound levels up to 110 dB and distortions of <1% have been demonstrated with conventional PZT layers.

Within the framework of the priority programme "Cooperative Multistage Multistable Microactor Systems - KOMMMA" (speaker M. Kohl, Karlsruhe Institute for Technology KIT), funded by the German Research Foundation (DFG), the first interim results were presented in a separate session at ACTUATOR.

APPLICATIONS FOR PRACTICE

Physik Instrumente (PI) (R. Gloess) presented an electromagnetic levitation system for the positioning with six degrees of freedom (DOF). In this system, the drives are separated from the platform so that operation can take place in UHV systems as applied in EUV lithography.

An overview of future intuitive human-machine interfaces (HMI) was given by M. Hafez from CEA LIST in France. There are different requirements for frequency ranges: up to 1 kHz is required for the representation of vibrations, 10 to 100 kHz for the recognition of surface textures. For microfabrication, piezoelectric layers with 3 µm PZT or 4 µm AlN on glass substrates are planned.

In cooperation with ESA (Noordwijk, The Netherlands), a spherical telescope mirror with 200 mm diameter for space applications has been developed at the Free University of Brussels, Belgium (K. Wang, A. Preumont), which contains a layer with 25 organic piezoelectric foil actuators (PVDF-TrFE with 5 µm layer thickness) in the layer system to correct imaging errors.

Although ACTUATOR had to be postponed twice and could finally only take place as an online conference, many innovations were presented. The discussions in the parallel sessions before and after the plenary lectures, highly appreciated by the participants, recorded a high number of attendees. May we emphasize that, compared to other conferences held online, ACTUATOR 2021 was able to offer a maximum of live presentations.

The next ACTUATOR 2022 will hopefully take place as a regular face-to-face conference on June 14 to 16, 2022 at the Rosengarten Congress Center in Mannheim.

Prof. Dr.-Ing. Helmut Schlaak, Technische Universität Darmstadt,

Chairman of the ACTUATOR Conference 2021