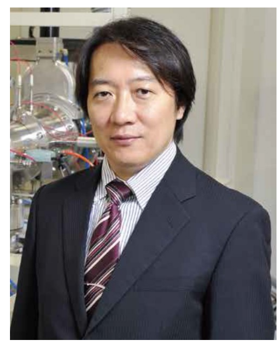
IEEE ICMA 2017 Conference

Invited Workshop on MEMS-based Intelligent Devices

Monday, August 7, 2017
13:30 - 15:00
Conference Room 61, 6F
Sunport Takamatsu Symbol Tower, Takamatsu, Japan



Organizer: Prof. Hidekuni Takao, Kagawa University, Japan

Prof. Takao received his B.S., M.S. and Ph.D. degrees from Toyohashi University of Technology in 1993, 1995 and 1998, respectively. Since 2014, he has been a full professor of Kagawa University, and also holding the director position of Nano-Micro Structure Device Integrated Research Center in Kagawa University. His research interests are high performance silicon MEMS sensors and actuators and their applications to tactile sensing technology. Since 2015, he has been the representative of a JST-CREST project.

List of Speakers and Schedule

Time	Topics	Speaker List
13:30-14:00	MEMS Vibrational Energy Harvesters Using High Density Solid-Ion Electret	Prof. Hiroshi Toshiyoshi The University of Tokyo, Japan
14:00-14:30	3D Fabrication of Microneedle for Blood Collection Biomimicking Mosquito	Prof. Seiji Aoyagi Kansai University, Japan
14:30-15:00	MEMS-based Tactile Display	Prof. Norihisa Miki Keio University, Japan

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Talk 1

MEMS Vibrational Energy Harvesters Using High Density Solid-Ion Electret

Hiroshi Toshiyoshi

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Hiroyuki Mitsuya Saginomiya Seisakusho, Inc.

Abstract:
IoT or Internet-of-Things is also a buzzword in the field of microelectromechanical systems (MEMS), and one might associate it to small sensors integrated in things. It is absolutely true that MEMS takes a very important portion in the IoT technology, as it has already diffused into mobile electronics, by taking various forms of such as microphone, accelerometer, gyroscope, barometer, and else. On the extension of it, we would have no difficulty in visualizing a grain-size gadget equipped with sensors, processors, and wireless communication interface. In our opinion, nonetheless, the true implication of the MEMS technology in the emerging IoT is in the power sources. Provided that electronics have been made to be small enough to fit in a tiny chip, how are we going to supply power to it? Cables are already larger in size than such a MEMS-based IoT device. Small batteries will do the job but for only a limited duration of time, and therefore perpetual power sources are definitely needed to keep them running for long. For this reason, recent MEMS studies focus onto the development of energy harvesters to gain electrical power from the environments such as light, heat, electromagnetic waves, and mechanical vibrations.
In our research group, we perform development of MEMS vibrational energy harvesters based on the electrical induction current caused by the permanent electrical charge so called the electrets. Our target is a 1mW-class power generation from the environmental vibrations of 0.1 G or less, in the frequency range lower than 100 Hz. A high-density electret of a few mC/m^2 is formed on the silicon micromechanical structures, which is mechanically shaken by the vibration to produce electrical currents by induction. In this talk, we look into the mechanism of power generation using electret and discuss the methodology to improve the energy conversion efficiency in terms of the electrical and mechanical designs.
This talk includes the products of research supported by JST-CREST Grant Number JPMJCR15Q4 and by NEDO, Japan.

Dr. H. Toshiyoshi is a Professor in the Institute of Industrial Science (IIS) of the University of Tokyo, Tokyo, Japan, and also with the Research Center for Advanced Science and Technology (RCAST) of the University of Tokyo. Dr. Toshiyoshi received the M.E. and Ph.D. degrees in electrical engineering from the University of Tokyo, Tokyo, Japan, in 1993 and 1996, respectively. He joined the IIS in 1996 as a Lecturer. From 1999 to 2001, he was a Visiting Assistant Professor at the University of California, Los Angeles, CA, US. In 2002, he became an Associate Professor with the IIS, and since 2009 he has been a Professor with the IIS and RCAST at the University of Tokyo.
From 2005 to 2008, he was the Project Leader of the Optomechatronics Project at Kanagawa Academy of Science and Technology (KAST), Kawasaki, Japan, where he led a team on MEMS for optical applications such as image display and fiber-endoscope. From 2011 to 2014, he was the Principal Investigator of a NEXT program (Funding Program for Next Generation World-Leading Researchers) of the Japan Society for the Promotion of Sciences (JSPS) initiated by the Council for Science and Technology Policy (CSTP) of Japan, where he developed the integrated MEMS technology for multi-functional low power electronics.

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Talk 2

3D Fabrication of Microneedle for Blood Collection Biomimicking Mosquito

Seiji Aoyagi, Ph.D.

Professor

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Abstract:

The mosquito's proboscis should be a good model for painless needle. We have observed the cooperative inserting motion of three-piece mosquito's proboscises (one labrum and two maxillae), in which the central and the outer needles are advanced alternatively at several Hz, where jagged edges effectively work as anchors. We have also observed the motion of sucking blood, where human whole blood was embedded in an artificial skin made of glucomannan. Unlike other researches on microneedles, we have been investigating a painless needle for collecting blood by mimicking the mosquito. However, achieving sharp tip and jagged side edges was incomplete, since degrees of freedom based on conventional MEMS technologies is basically limited to two-and-half dimensions.

In this article, microneedles mimicking mosquito were fabricated by employing a three-dimensional laser lithography. An ultra-precision three-dimensional laser lithography system "Nanoscribe GT" is employed. Based on two-photon absorption phenomenon, an extremely small space of less than 200 nm in photocurable polymer material is cross-linked, where a laser beam is focused on. The total cross-linked space finally emerges after development process.

A practical needle of comprising two parts was proposed and fabricated. The functions of three-piece mosquito's proboscises (one labrum and two maxillae) are integrated to two parts. Each half-needle has semicircular channel and jagged edges. By combining the two-halves, one hollow microneedle is realized. Alternative motion like mosquito maxillae is possible. Fluid is introduced into the channel through small holes in the wall, and is drawn up by capillary force.

It was experimentally confirmed that the fabricated needle successfully penetrates PDMS skin. The effectiveness of alternative motion of two parts with 90 deg phase to each other was also investigated. Human whole blood was successfully collected by the fabricated needle from a droplet.

Seiji Aoyagi received his BE, ME, and PhD degrees in precision machinery engineering from the University of Tokyo, Tokyo, Japan, in 1986, 1988, and 1994, respectively. From 1988 to 1995, he was with the Mechanical System Engineering Department at Kanazawa University, Kanazawa, Japan as a research associate and an associate professor. He is currently a full professor in the Mechanical Engineering Department at Kansai University, Osaka, Japan. His current research interests are biomimetics, 3D micro/nano fabrication featuring 3D laser lithography, femtosecond laser machining, etc., MEMS with an emphasis on sensors and actuators for micro robotics, and mechatronics.

More information can be obtained bellow (select language button menu as English on the pages):

http://www2.ipcku.kansai-u.ac.jp/~t100051/resume_aoyagi_j.html

http://www2.ipcku.kansai-u.ac.jp/~t100051/publication_aoyagi_j.html

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Talk 3

MEMS-Based Tactile Display

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Abstract:

Tactile displays can present tactile sensation via physical or electrical stimulation of tactile receptors. Given the current ICT where vision and hearing are almost saturated, tactile displays are promising media for next generation ICT. High resolution tactile displays are preferable where MEMS technologies can contribute. In this presentation, we introduce a mechano-tactile display composed of MEMS-enabling large displacement micro-actuators array and an electro-tactile display consisting of an array of micro-needle electrodes. Both displays exploit the virtues of MEMS and can present a wider variety of tactile sensations than conventional tactile displays. On the other hand, we encountered a new challenge, which is characterization of the presented tactile sensation. The tactile sensation is heavily dependent on the subjects and contains large discrepancies among individuals. I introduce a concept of sample comparison method as one of the quantification methods for tactile sensations.

Dr. Miki is a Professor in the Department of Mechanical Engineering at Keio University. He received Ph.D. in mechano-informatics from University of Tokyo in 2001. Then, he worked at MIT microengine project as a posdoc, later as a research engineer. He joined the Department of Mechanical Engineering at Keio University in 2004 as an assistant professor and became a full professor in 2017. His current research fields range from Biomedical devices to MEMS-based human interface devices. He closely works with medical doctors to develop an implantable artificial kidney. The EEG electrodes that his group developed are ready to be applied in the field of psychology and media arts. He was a researcher of JST PRESTO (Information Environment and Humans) from 2010 to 2016 and Kanagawa Institute of Industrial Science and Technology (formerly, Kanagawa Academy of Science and Technology) from 2010 to present. He is a general chair of the 8 th and 9 th Symposium on Micro-Nano Science and Technology in 2017 and 2018 sponsored by JSME. He co-founded a healthcare startup in 2017.
More information can be obtained in http://www.miki.mech.keio.ac.jp