The workshop is in English

Joint Workshop of Micro/Nano Engineering
National Tsing Hua University and Tohoku University

Time: June 30th, 2023, 13:00 – 15:50 Free admission, no pre-registration required
Location: Aobayama Campus, Kyodoto building (A15), 6F meeting room (611)
Chairs: Prof. Hung-Yin Tsai (Dean of NTHU College of Engineering) and
Prof. Shuji Tanaka (Director of MNC)

SPEAKERS

Prof. Cheng-Yao Lo (NTHU) "Wearable Force Sensors – From Empirical to Practical"

Two capacitive sensing units were designed and embedded into fingerstalls using microelectronics and additive manufacturing. They were connected to a transmission port with a signal converter and Bluetooth module, creating a wearable and wireless force sensing system for sports science. The capacitive signals were converted using a database to show force distribution on finger segments. Badminton players conducted practical examinations, demonstrating the system's effectiveness. Statistical results indicated valid shots (67% professional, 39% amateur) and well-controlled racket-holding attitude (19.69% professional, 35.31% amateur force difference between index finger segments). This system surpasses existing ones, classifying players and distinguishing stability and control, providing scientific evidence in sports science.

Assoc. Prof. Van Toan Nguyen (TU) "Thermoelectric generator and its applications"

Thermoelectric generators (TEGs) have great potential for powering IoT sensing systems by converting thermal energy into electricity. This work focuses on material synthesis, device fabrication, and application demonstration of TEGs. Electrochemical deposition is used to synthesize high-performance thermoelectric materials, including bulk-like material, Pt nanoparticle-embedded material, and Ni-doped material. Novel fabrication methods, such as micro/nano fabrication and assembly technology, are explored to enhance TEG output power and density. Furthermore, successful demonstrations show the feasibility of using TEGs as power sources for portable and wearable electronic devices.

Prof. Sheng-Shian Li (NTHU) "MEMS research at iNEMS NTHU"

Semiconductor has indeed brought us a very strong way in a very short time based on Moore's law. However, more-Moore (size shrinkage) has encountered serious technical and economic challenges while more-than-Moore (transducers) offers another horizon to keep semiconductor in high growth rate. This presentation will cover the research efforts at iNEMS NTHU, including various MEMS transducers and their applications. Two main fabrication platforms, CMOS-MEMS and Piezoelectric MEMS, will be introduced while, through these two platforms, a few examples such as timing devices (oscillators), RF devices (FBAR), motion sensors (accelerometer, gyroscope, and magnetometer), environment sensors (PM2.5), and acoustic devices (CMUT and PMUT) will also be briefly presented. I will use one MEMS device to showcase its design, modeling, simulation, fabrication, testing, packaging, module development, and implementation in smart sensing.

Assist. Prof. Yoshinari Kimura (TU)

We are studying the formation of metal-oxide-semiconductor nanowires using stress-induced migration method and their application to chemical sensors. The stress-induced migration is a facile method of forming nanostructures, including nanowires, by utilizing the diffusion of metal atoms in the oxide film induced by the oxidation and the stress gradient occurred by heating a metal film. This method provides easy control of nanowire shapes on the oxide surface. Copper oxide sensors with a large number of nanowires were effective in detecting low-concentration ethanol solutions. The stress-induced migration method contributes to enhanced performance of chemical sensors.

Prof. Mingsian R. Bai (NTHU) "Telecom Electroacoustics Audio (TEA) lab and research on learning-based audio array signal processing for telepresence"

This talk introduces the Telecom Electroacoustics Audio (TEA) lab and their recent focus on audio telepresence. The lab conducts research on audio signal processing and electroacoustic problems, with a specific interest in Audio Telepresence (AT). AT is gaining importance with the rise of technologies like VR and Metaverse, aiming to create an immersive virtual experience of audio and visual scenes. The talk presents an array-based binaural rendering system that converts array microphone signals into head-related transfer function (HRTF)-filtered outputs for headphone rendering. This model-matching principle (MMP) approach provides more natural immersion than conventional methods and can be implemented using neural networks (NN) for spatial rendering, ambience preservation, and noise reduction.

Project Assoc. Prof. Hisashi Kino (TU)

The scaling of transistors has scaled up integrated circuits. However, the scaling of transistors is approaching its limits, and new integration methods are required. Our group is studying three-dimensional integrated circuits (3D-Ics) to improve the degree of integration of the transistors by stacking Ics. In 3D-Ics, multiple stacked layers of Ics are electrically connected by vertical vias called through-Si vias (TSVs). Recently, 3D-Ics have attracted much attention as solutions to extend Moore's Law and realize More than Moore. In this joint workshop, I would like to introduce 3D-Ics which we are studying.

Assist. Prof. Tsung-Hui Huang (NTHU) "Advanced Computational Mechanics for Extreme Event Applications"

Extreme events are engineering problems involving structures or materials subjected to high strain rates, strong hydrodynamic effects, and damage/fragmentation processes. These problems encompass natural disasters like air blasts, debris flows, and tsunamis, as well as various defense applications such as ballistics, explosive dynamics, and submarine engineering. Conventional numerical methods like the finite element method (FEM) or finite difference method (FDM) pose challenges for these problems due to severe mesh distortion and the presence of weak/strong discontinuities that disrupt the system's regularity. In this presentation, we will demonstrate novel computational methods within the meshfree and machine learning framework that address the aforementioned issues and showcase their application to different extreme event scenarios.

Assist. Prof. Taiyu Okatani (TU)

I am currently engaged in research on metamaterials for robotics applications. Metamaterials are artificially created optical materials, especially composed of micro/nanostructures smaller than the wavelength of electromagnetic wave of interest. In this presentation, I will introduce examples of metamaterial-based sensors and devices that will be necessary for future robots.

Assist. Prof. Ming-Huang Li (NTHU) "Piezoelectric MEMS Devices for Emerging RF Signal Processing Applications"

High-performance RF MEMS devices are crucial elements in many electronic systems, providing frequency control and sensing functionalities. We are dedicated to the development of chip-scale RF microsystems for interdisciplinary applications, utilizing low-loss piezoelectric materials such as aluminum nitride (AlN) and lithium niobate (LiNbO3) to design GHz bulk acoustic wave (BAW) and surface acoustic wave (SAW) devices with high figure-of-merits (FoM). In this presentation, I will briefly showcase our research findings in the following topics: (1) high FoM GHz surface acoustic wave resonators, (2) low propagation loss acoustic delay lines, and (3) RF impedance transformers with large passive voltage gain.

Assist. Prof. Shunsuke Yamada (TU) "Magnetic Actuator using MEMS on PCB"

Mobile devices such as smatphones use many MEMS devices: microphones, temperature and pressure sensors, gyroscopes, accelerometers, switches and more. However, autofocus actuators remain a bulky component that haven't been replaced by MEMS yet. This talk will briefly introduce the development of a three axis magnetic actuator using powder-based Sm-Fe-N magnet and parylene springs with large displacements of 25 um in X and Y directions, and 2° rotation about Z axis. The powder-based magnet can be embedded in the MEMS actuator without assembling, and the parylene springs are compatible with MEMS process, are soft to allow large displacements but tough enough to resist shock impact.