南方科技大学
SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

第一届
振动能源采集技术
国际会议

THE 1ST INTERNATIONAL CONFERENCE ON VIBRATION AND ENERGY HARVESTING APPLICATION (VEH 2018)

NOV. 02-04, 2018

SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

SHENZHEN, CHINA

第一届振动能源采集技术国际会议

The 1st International Conference on Vibration and Energy Harvesting Application (VEH 2018)

Nov. 02-04, 2018

Southern University of Science and Technology

Shenzhen, China

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Hotel Information

维也纳国际酒店(深圳北站店)
龙华区致远中路 2 号,高铁北站西广场 B 座
电话： 0755-83951666，13825297017 (刘经理)
接驳巴士，早上 8:00，一楼大堂集合

Vienna International Hotel (Shenzhen North Station)
No. 2, Zhiyuan Middle Road, Longhua District
Tel. +86 0755-83951666, 13825297017 (Mr. Liu)
Shuttle Bus, 8:00 am, Lobby at ground Floor

Conference Venue

南方科技大学，国际会议厅（行政楼后侧）
广东省深圳市南山区学苑大道 1088 号

International Conference Hall (behind the Administration Building), SUSTech
No. 1088, Xueyuan Blvd, Xili, Nanshan District, Shenzhen, Guangdong, China

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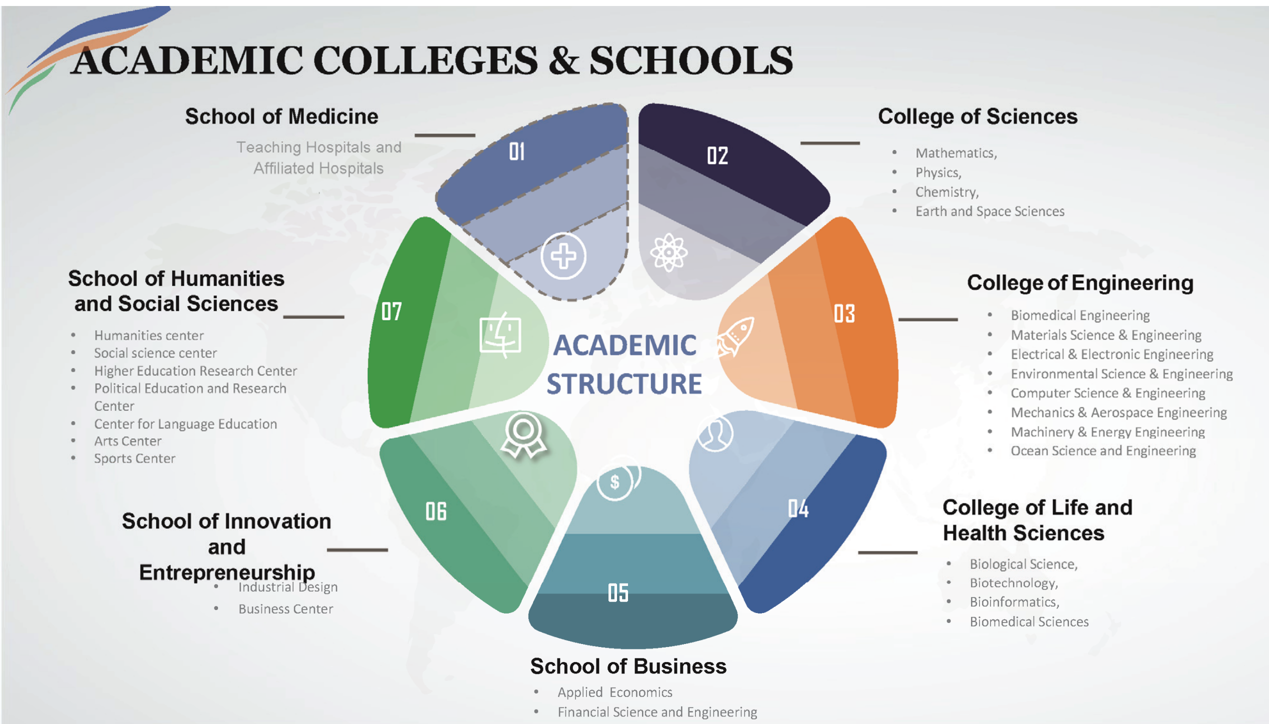
1. About SUSTech

南方科技大学（简称“南科大”）是深圳在中国高等教育改革发展的宏观背景下，举全市之力创建的一所高起点、高定位的高等学校。学校借鉴世界一流理工科大学的学科设置和办学模式，以理学、工学学科为主，兼具医科和特色人文社会科学，在本科、硕士、博士层次办学，在一系列新的学科方向上开展研究，努力成为引领社会发展的思想库和新知识、新技术的源泉。学校扎根中国大地，大力培养创新人才，力争早日建成国际化高水平研究型大学。

南科大目前教研系列教授（tenure/tenure-track）约 350 位，其中院士 24 位，长江学者 18 位，高层次人才比例占 50%以上；学生总数 5381 人，其中本科生 4029 人，硕士、博士研究生 1352 人。2016 年，我校人均获批科研经费位居全国高校第 3 位。2017 年 6 月至 2018 年 5 月，南科大在自然指数排行榜中国内地大学中排名第 26 位。仅四年时间，南科大在 Nature Index 上排名从中国内地大学 55 位升至 26 位。“自然指数 2018 上升之星”增刊显示，在全球 100 家指数表现上升最快的机构中，南方科技大学在榜单中位列第四，居于 1988 年之后建校的年轻大学首位。2018 年 9 月 26 日，泰晤士世界大学排名网发布“2018-2019 泰晤士高等教育世界大学排名”，中国内地 72 所高校上榜。南方科技大学位列中国内地高校第八。

Southern University of Science and Technology（SUSTech）is a public research university established in 2011, funded by Shenzhen Municipality. Widely regarded as a pioneer and innovator in collectively moving China’s higher education forward to match China’s ever-growing role in the international arena, SUSTech aspires to be a globally-renowned university that contributes significantly to the advancement of science and technology by excelling in interdisciplinary research, nurturing creative future leaders and creating knowledge for the world. Located in Shenzhen, one of the fastest growing cities in China and the country's window to the world, SUSTech enjoys strong connections with leading companies in China and renowned universities around the world.

Currently, SUSTech has about 350 tenure/tenure-track professors, 24 academicians and fellows of academies, 18 "Changjiang" scholars; more than 50% of faculties are high-level talents. There are more than 5300 students in SUSTech, including 4029 high quality undergraduate students and 1352 graduate students. In 2016, SUSTech's research fund of per faculty member was ranked No. 3 in all mainland universities of China. In 2018, SUSTech was ranked No. 26 in "Nature Index" among all mainland universities of China. It only takes four years for SUSTech to increase the ranking in "Nature Index" from 55 to 26. The "Nature Index 2018 Rising Stars" showed that among world's 100 fastest-rising organizations, SUSTech was ranked 4th in the list, which is No. 1 among young universities established after 1988. On September 26th, the "Times Higher Education World University Rankings 2019" were released with Southern University of Science and Technology being listed for the first time. SUSTech was ranked 8th among the 72 mainland China universities on the list.



Campus Plan

Total land: **500 Acres**

Building area: **260,000 m^2** (**FIRST PHASE**) +**162,000 m^2**

Building area: **500,000 m^2** (**SECOND PHASE**)

2. Academic activity

2.1 Program at a glance

Date	Times	Activities
Day 0 11.2	15:00-21:00	Registration
Day 1 11.3	8:30-9:10	Opening Ceremony
	9:10-10:30	Session 1 Keynote Talks
	10:30-10:50	Group Photo & Coffee Break
	10:50-12:00	Session 2 Oral presentations
	12:00-14:00	Lunch Break
	14:00-16:00	Session 3 Keynote Talks & Oral presentations
	16:00-16:40	Poster & Coffee Break
	16:40-18:15	Session 4 Oral presentations
	18:15	Conference Banquet
Day 2 11.4	8:30-10:25	Session 5 Oral presentations
	10:25-10:45	Coffee Break
	10:45-12:10	Session 6 Oral presentations
	12:10-14:00	Conference adjourn & Lunch
	14:00	Campus tour

2.2 Keynote talks and invited talks

Title: Energy Harvesting from Vibration and Human Motion

Wei-Hsin Liao (廖维新)
ASME Fellow; HKIE Fellow; IOP Fellow
Chairman and Professor
Department of Mechanical and Automation Engineering
The Chinese University of Hong Kong

Abstract: Most of the ambient energy, which was regarded useless in the past, now is under the spotlight. With the rapid developments on low power electronics, future personal mobile devices and remote sensing systems might become self-powered by scavenging energy from their surroundings. Kinetic energy is one of the promising energy forms in our living environment, e.g., human motion and vibration. We have proposed an energy flow to clarify the functions of piezoelectric energy harvesting, dissipation, and their effects on the structural damping of vibrating structures. Impedance modeling and analysis were performed. We have designed an improved self-powered switching interface for piezoelectric energy harvesting circuits. With electromagnetic transduction, we also proposed a knee-mounted energy harvester that could convert the mechanical power from knee joints into electricity during walking. On the other hand, we have developed magnetorheological (MR) fluid devices with multiple functions, including linear dampers and rotary actuators. Novel self-sensing MR dampers with power generation, which integrate the dynamic sensing, MR damping and power generation functions, were proposed and investigated. In addition, multifunctional rotary actuator was also designed to integrate motor/generator part and MR fluids into a single device. The actuator could function as motor, generator, clutch and brake, with compact size and less power consumption. The developed actuators were promising for various applications. In this talk, related research and key results will be presented.

Biography: Wei-Hsin Liao received his Ph.D. in Mechanical Engineering from The Pennsylvania State University, University Park, USA. Since August 1997, Dr. Liao has been with The Chinese University of Hong Kong, where he is now Chairman and Professor of Mechanical and Automation Engineering. His research interests include smart structures, vibration control, energy harvesting, mechatronics, and medical devices. His research has led to publications of over 220 technical papers in international journals and conference proceedings, 16 patents in US, China, Hong Kong, Taiwan, Japan, and Korea. He was the Conference Chair for the 20th International Conference on Adaptive Structures and Technologies in 2009; the Active and Passive Smart Structures and Integrated Systems, SPIE Smart Structures/NDE in 2014 and 2015. He is a recipient of the *T A Stewart-Dyer/F H Trevithick Prize* 2005, the ASME 2008 *Best Paper Award in Structures*, the ASME 2017 *Best Paper Award in Mechanics and Material Systems*, and three Best Paper Awards in the IEEE conferences. At CUHK, he received the *Research Excellence Award* (2011), and was awarded *Outstanding Fellow of the Faculty of Engineering* (2014). He received the SPIE 2018 *SSM Lifetime Achievement Award*. Dr. Liao currently serves as an Associate Editor for *Mechatronics*, *Journal of Intelligent Material Systems and Structures*, as well as *Smart Materials and Structures*. He is a Fellow of the American Society of Mechanical Engineers, Institute of Physics, and The Hong Kong Institution of Engineers.

Title: Print-circuit-board-enhanced Electret Rotational Energy Harvester for Wearable Devices

Yuji Suzuki
Professor, JSME Fellow
Department of Mechanical Engineering
The University of Tokyo

Abstract: Energy harvesting from human walking is suitable for powering battery-less wearable devices. In such applications, rotational energy harvesters (EHs) have advantages over vibration EHs due to the fact that low-frequency 3-D vibration with 3-axis rotation is dominant for human motion. Among various transduction mechanisms, electret generators are advantageous in terms of higher output power at low frequencies and their low-profile structures. A novel low-profile rotational electret energy harvester (EH) is prototyped for capturing power from low-frequency vibration. CYTOP EGG is employed to realize high surface potential over 800 V. Thanks to cost-effective flexible print circuit boards (PCB), except the center part for the ball bearing housing, the thickness of the rotational part is only 2.8 mm, which is at least less than half of the previous rotational EHs. Output power up to 200 μW has been obtained at a low rotational speed of 1 rps. In addition, a dynamic model of arm-equipped rotational energy harvester (EH) during human walking is proposed toward development of standard testing methods for such energy harvesters. The model describes realistic arm swing based on a two link with shoulder and elbow joints rotation, and includes the electro-mechanical coupling with a rotational electret EH. It is found that simulated output power is in accordance with our experimental data using a multi-link robot. Effects of different design parameters on the output power are also examined with the present model under different walking conditions.

Biography: Yuji Suzuki received the B.S., M.S., and Dr.Eng. degrees in mechanical engineering from the University of Tokyo, Tokyo, Japan, in 1987, 1989, and 1993, respectively. He is currently with the Department of Mechanical Engineering, University of Tokyo, as a Professor. He serves as Steering Committee Member of PowerMEMS Conference, Organizing Committee member of IEEE International Symposium on Electret. He also served as the general co-chair of IEEE MEMS2010 (Hong Kong) and the general chair of PowerMEMS 2017 (Kanazawa). His research interests include MEMS-based energy harvesting using electrets, micro energy conversion such as microscale combustion, and optimal design/control of micro heat and fluid flow.

Title: Energy Harvesting: From Wireless Sensors to Blue Energy

Lei Zuo
ASME Fellow
Professor and Director
NSF IUCRC Center for Energy Harvesting Materials and Systems
Virginia Tech, Blacksburg, VA 24061, USA

Abstract: Energy harvesting has attracted huge research attention in the past two decades. For the academic papers alone, the number of energy harvesting papers published a year increased from about 100 to over 1000 from 2007 to 2017. By converting the environmental energy into electricity, the energy harvesting provides a promising solution to power wireless sensors at mW level without costly wiring or battery replacement. Energy harvesting has also extended to watt level to power portable electronics, like harvesting from human motions. More recently, researchers also investigated the energy harvesting from vehicles and civil structures, at 100 W to 100 KW for self-powered vibration control. Very active research has been going on worldwide on blue energy, to harvest vast amount power from ocean wave oscillations. In this talk, we will review the energy harvesting at various energy scales from history perspective, and examine the challenges in the multiple disciplines of vibration, dynamics, electronics, control, material science and mechatronics design for energy harvesting. The future research directions and commercialization opportunities are also discussed.

Biography: Lei Zuo completed his PhD in Mechanical Engineering from MIT in 2004 and BS with highest honor from Tsinghua University in 1997. He also holds two MS degrees in both Mechanical and Electrical Engineering from MIT. After working on industry for four years, he joined in State University of New York at Stony Brook in 2008 as an assistant professor and was promoted to associate professor in 2013. He moved to Virginia Tech in 2014 and was promoted to full professor rank in 2017. He currently serves the Director of National Science Foundation (NSF) Industry-University Collaborative Research Center (IUCRC) for Energy Harvesting Materials and System.

Lei Zuo research interests include energy harvesting, mechatronics design, vibration control, clean energy manufacturing, marine and hydrokinetic energy, and thermoelectricity. Since 2008 he has secured almost 12 million US dollars of research funding (nearly $10M as the PI) from various federal and state funding agencies as well as industry. Zuo has published over 230 papers in journals and conferences, including 5 with best paper and 2 with best student paper awards. The American Society of Mechanical Engineers (ASME) recognized him as “a pioneering researcher in energy harvesting, especially at larger energy scale” with its 2015 Thar Energy Design Award. He was named as an ASME Fellow in 2016. Zuo is also the sole recipient of the 2017 ASME Leonardo Da Vinci Award/Medal, for his “eminent achievement in the design or invention of a product which is universally recognized as an important advance in machine design”. He also won R&D Awards twice (2015 and 2011) from R&D Magazine, which recognizes the top 100 technology innovations in the word of the year. He currently serves as a technical editor for IEEE/ASME Transactions on Mechatronics and associate editor for ASME Journal of Vibration and Acoustics and IFAC journal Mechatronics.

Title: Micro energy harvesters for self-powered wireless sensor networks

Fei Wang (汪飞)
Associate Professor,
Department of Electrical and Electronic Engineering,
Southern University of Science and Technology (SUSTech)

Wireless sensor networks are low-cost, low-power, and multifunctional sensor nodes that can be used for many applications like monitoring of the environment (humidity, gas, temperature etc.) and the human body (pulse, blood pressure etc.). Though powerful, WSN indeed has a power supply problem that limits the scale of the networks. Most wireless sensor nodes at present are battery-powered, which would lead to a nightmare to replace and dispose the batteries for these thousands of embedded sensors.

Recently, energy harvesting devices have been developed to extract energy directly from our ambient environment such as vibration sources. There are a few challenges for micro-scale vibration based energy harvesters such as the MEMS-compatible fabrication, normalized power density and bandwidth. Based on advanced MEMS technologies, we have developed the optimization methods to improve the normalized power density and the bandwidth of the electrostatic energy harvesters. In particular, the displacement limitation and low air damping effect with perforated electrode or packaging pressure control on the device performance will be discussed. Recently, we have developed a self-healing setup to sovle the charge dacay problem of the electret, which would prolong the lifetime and improve the stability of the energy harvester. With optimized performance, the micro energy harvesting devices could be applied for more sustainable and scalable wireless sensor networks, and will help to provide environment friendly electronics, self-powered systems and the next generation of smart cities.

Fei Wang received the B.S. degree in mechanical engineering from the University of Science and Technology of China, Hefei, China, in 2003, and the Ph.D. degree in microelectronics from the Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Science, Shanghai, China, in 2008. He was a Post-Doctoral Researcher with the Department of Micro- and Nano-technology, Technical University of Denmark, where he had been an Assistant Professor since 2010. Since 2013, he has been an Associate Professor with the Department of Electrical and Electronic Engineering, Southern University of Science and Technology, China.

Dr. Wang served as a TPC Member for the International Conference on Solid-State Sensors, Actuators and Microsystems (Transducers 2017, Transducers 2019), the 13th International Conference on Nano/Micro Engineered and Molecular Systems (NEMS 2018), and the International Conference on Manipulation, Manufacturing and Measurement on the Nanoscale (IEEE 3M-NANO) from 2014 to 2017. His current research interests include micro energy harvesting, microelectromechanical system and NEMS sensors, and semiconductor testing.

Title: Uncertainty Analysis of Nonlinear Energy Harvesters

Shengxi Zhou (周生喜)
Professor
School of Aeronautics
Northwestern Polytechnical University

Abstract: Nonlinear energy harvesters were found to be very sensitive to the excitation conditions. In order to reveal the influence mechanism of the excitation condition on the energy harvesting performance, this paper presents uncertainty analysis for nonlinear monostable energy harvesters. An improved interval extension based on the 2nd order Taylor series is presented as a new uncertainty analysis method. A mathematic example is used to demonstrate that the bounds of responses based on this method are more accurate than the classic interval extension when the dependence of response on the uncertain variable is nonlinear. Meanwhile, results from the Monte Carlo Simulation are used to verify the accuracy of the presented method. The presented method is found to be suitable to quantify the propagation of the uncertain level and frequency of the excitation for the nonlinear monostable energy harvester. Results show that, the output voltage of the nonlinear monostable energy harvester is more sensitive to the excitation frequency than the excitation level, and the influence mechanism is revealed. Overall, the paper fills the research gap on the uncertainty of the excitation conditions on the energy harvesting performance of nonlinear energy harvesters.

Title: Harvesting Stochastic Base Vibration Energy by a Piezoelectric Inverted Beam with Pendulum

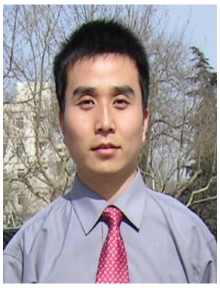
Qin Weiyang (秦卫阳)
Professor
Department of Engineering Mechanics
Northwestern Polytechnical University

Abstract: We proposed a two degree-of-freedom inverted piezoelectric beam with pendulum (IPBP) to promote the performance of vibration energy harvesting. This configuration is composed of an inverted elastic beam and a pendulum attached to its free end. The electromechanical equations governing the nonlinear system were derived. The Harmonic Balance Method is applied to solve the equation and the results prove there exists 1:3 super-harmonic resonance. For validation, the corresponding entity model was established in COMSOL, and simulations were carried out. The simulation results show that owing to the particular nonlinearity, there appears a special bending effect in the amplitude-frequency response, *i.e.*, bending right for the first natural frequency and left for the second natural frequency. The HBM results were verified by the entity simulations. Under stochastic excitations, it could realize jumping between the equilibrium positions and generate large outputs. Furthermore, over a relatively wide range of PSD (Power Spectral Density), it could reach a dense jumping and give a dense high pulse voltage.

Title: Vibration Energy Harvesting and its Potential Applications

Zhengbao YANG (杨征保)
Assistant Professor
Department of Mechanical Engineering
City University of Hong Kong

Abstract: Energy harvesting holds great potential to achieve long-lifespan and self-powered operations of wireless sensor networks, wearable devices and medical implants, and thus has attracted substantial interest from both academia and industry. In today's talk, I will briefly introduce the research work on energy harvesting done in my lab at City University of Hong, and our former lab at the University of Toronto, led by Prof. Jean Zu. We aim to develop energy harvesting systems that can show a high power output, mutli-directional sensitivity and broad operational bandwidth. We have explored a variety of new methods from the mechanical, material and circuit aspects. We also have studied different energy conversion methods, including piezoelectric effect, electromagnetic effect, triboelectric effect and the magnetostrictive effect. Our research indicates that piezoelectric energy harvesters, especially those working in the strong compressive mode, are very promising and may achieve the desired self-powered operations in the near future.



Title: A Two-degree-of-freedom Electromagnetic Energy Harvester for Ultra-low Frequency Excitations

Kangqi Fan (樊康旗)
Associate professor
School of Mechano-Electronic Engineering
Xidian University

Abstract: Converting the ambient waste energy into electricity has been considered as an effective approach for sustaining low-power devices. One of the key issues is how to generate more electricity from ultra-low frequency excitations that are ubiquitous in our environment. To tackle this problem, this report presents a two-degree-of-freedom (2-DOF) electromagnetic energy harvester (EMEH) that is realized simply by magnetically levitating a 1-DOF EMEH in a cylindrical housing. Both experiment and simulation exhibit the advantages of the proposed design, including the tunable operating frequencies, improved power output, and extended operating bandwidth. The experimental measurements show that, under a sinusoidal excitation with an amplitude of 0.5 g (1 g = 9.8 m/s^2), nearly 40% increase in the magnitude of the power and 152% increase in the operating bandwidth are achieved by the proposed harvester. Under the hand-shaking induced excitation, the 2-DOF EMEH can enhance the voltage of a capacitor (33 μF) from 0 V to 5 V within half a second, showing a charging performance much better than that of the 1-DOF EMEH. Moreover, the 2-DOF EMEH successfully sustains the continuous operation of a hygrothermograph using the energy converted from human body motions, demonstrating its potential application in powering some wearable electronics.

Title: Multilevel Bidirectional Power Conversion Circuits for Energy Harvesting Improvement

Junrui Liang (梁俊睿)
Assistant Professor
School of Information Science and Technology
Shanghai Tech University

Abstract: The power conditioning circuits act an important role in the applications of piezoelectric transducers, *e.g.*, energy harvesters and actuators. In piezoelectric energy harvesting (PEH) systems, the development of energy harvesting interface circuit has experienced about four generations since the 2000s: the passive rectifiers, synchronized single-switch circuits, double-switch circuits, and multi-switch circuits. It gradually arrives at an understanding that the increase of voltage transition numbers helps minimize the energy dissipation in power conditioning; on the other hand, since the third generation, the bidirectional energy transfer was introduced under the alias active energy harvesting, energy injection, energy investment, pre-biasing, etc., towards larger energy extraction. More energy extraction creates more income, while less energy dissipation reduces the expenditure. The synergy of both features has led to a substantial increase of the net harvested energy. This talk briefly reviews the development of four generations of energy harvesting interface circuits. Base on that, we introduce a general idea and some practical implementations towards the future development of PEH interface circuits, in particular, the multilevel bidirectional power conversion circuits. The similarities and differences of the existing PEH circuits and the fundamental topologies of the switch-mode power converters are discussed as well towards a better understanding of such interdisciplinary research topic.

Title: Vibration Energy Harvesting with Flexible Electret Films

Xiaoqing Zhang (张晓青)
Professor
School of Physics Science and Engineering
Tongji University

Abstract: Motivated by the demand for self-powered portable wearable electronic systems and self-actuated wireless sensors, the development of the energy harvesters that can convert ambient energy into electricity is of great interest. In this study, we fabricated energy harvesters based on stretchable wave-shaped fluorinated ethylene propylene (FEP) electret films using a predesigned bi-stable structure. The energy harvesting performance of the devices with a length of 30 mm and a width of 10 mm was investigated in a stretching mode at various exciting frequencies, load resistances, seismic masses and surface potentials of the FEP electret films. Typically, films with a material thickness of 12.5 μm and a maximum total thickness of the wavy structure (including the air thickness) of about 160 μm were employed. When charged to a surface potential of -500 V and operated with a seismic mass of 3 g cemented onto the center of the harvester, one obtains a generated power across the optimal load resistance of 355 μW at 22 Hz for an input acceleration of 1 *g* (*g* is the gravity of the earth).

Title: Piezoelectric Thick Film for Energy Harvesters and Self-Powered Sensor

Bin Yang (杨斌)
Associate Professor
Department of Micro/Nano electronics
Shanghai Jiao Tong University

Abstract: With the rapid development of low-power electronics and systems, the development of power supplies for these devices will be a major challenge. However, micro-energy harvesters are an alternative to solve this problem. However, bulk PZT ceramics provide higher electromechanical coupling and harvesting efficiency than deposited piezoelectric thin films. Recently, piezoelectric energy harvesters (PEHs) based on PZT thick films have developed quickly. In this talk, PZT thick-film process will be introduced for vibration-based energy harvester and self-powered sensors.

Title: Broadband Energy Harvesting Using Nonlinear 2DOF MEMS Electret Power Generator

Kai Tao (陶凯)
Associate Professor
School of Mechanical Engineering
Northwestern Polytechnical University

Abstract: Numerous approaches with tunable or broadband mechanisms have been reported to overcome the narrow bandwidth issue of traditional vibration-based energy harvesters, in which performance deteriorates dramatically under off-resonance conditions. This talk presents the modeling and experimental results of a novel nonlinear 2-degree-of-freedom (2DOF) MEMS electret power generator. The proposed system comprises a primary subsystem for power generation, and an accessory subsystem for frequency tuning. Two effective and close peaks with frequency ratio of only 1.13 are achieved for the first time for a 2DOF MEMS device. Upon the increase of acceleration, hardening nonlinearity induced by end-stop effect is involved in the multi-frequency behavior, resulting in resonant frequency drift upwards and further bandwidth convergence. The outcomes of this work could offer new insights for realizing MEMS broadband energy harvester with hybrid frequency broadening mechanisms.

Title: Energy Harvesting Techniques From Ambient Environment

Huicong Liu (刘会聪)
Associate Professor
School of Mechanical and Electric Engineering, Jiangsu Provincial Key Laboratory of Advanced Robotics
Soochow University, China

Abstract: Energy harvesting techniques have received significant attention around the globe for over 20 years. There is abundance of mechanical energy that can be harvested from our ambient environment. In recent years, we have developed various energy harvesters from human motion, vibration, wind flow, ocean waves and so on based on electromagnetic, piezoelectric and triboelectric effects. We presented a non-resonant rotational hybridized generator for scavenging low-frequency human motion energy. We utilized MEMS PZT thick film process and frequency-up-conversion mechanism to improve the output performance at low frequency vibration. We proposed wind energy harvesters for self-powered sensor nodes by integrating an intermittent self-driven power management circuit. We also developed pendulum-based energy harvesting device from ocean wave energy.

Title: Micro Piezoelectric Energy Harvester Fabricated with PZT Thick-Film Using Aerosol Deposition Method

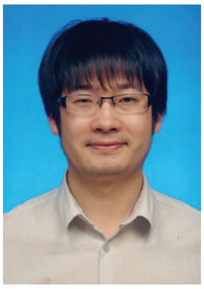
Wen-Jong Wu (吴文中)
Professor
Department of Eningineering Science and Ocean Engineering
National Taiwan University

Abstract: The piezoelectric micro energy harvesters (PMEH) or so called MEMS generators which can scanvege power from ambient vibrations has been an important research topic in the past decade. With the advancement of PMEH and also SOC (system on chip) or SIP (system in package) integrated circuit technologies, it is possible to see a self-powered SOC or SIP in near future. In this presenation, the aerosal deposition method and the characterization of the piezoelectric thick-films deposited will be detailed. The transducer design, piezoelectric material selection, and also the fabrication processes of using stainless steel substrates instead of conventional silicon substrates will also be detailed. The latest results show that the bimorph PMEH fabricated in the dimension of 6mm by 9 mm with two 10μm thick PZT active layers has a maximum output power of 304 μW tested with optimal load under 0.5 g acceleration vibration level in resonant frequency around 120 Hz. A self-powered wireless sensors demo power by the PMEH , and the considerations of interafcing circuit design and PMEH integration will also be presented.

Title: Energy Harvesting from Ambient Vibrations Using Piezoelectric Polymeric Materials: Computational Insights for Structural Monitoring Applications

Giuseppe Quaranta,
Department of Structural and Geotechnical Engineering
Sapienza University of Rome, Italy

Abstract: Advances in sensing technologies and wireless transmission can facilitate the large-scale implementation of sensor networks for structural monitoring applications, thereby allowing assessment and intelligent management of the civil constructions throughout their lifetime. On the other hand, the massive implementation of wireless nodes also poses new and challenging technological issues, such as the search for energy-efficient sensing devices and the use of energy harvesting technologies. In this perspective, advanced, yet efficient, modelling of electro-mechanical systems for energy harvesting and sensing is a fundamental task in order to develop reliable self-powered autonomous electronic devices designated for structural monitoring applications. In the present talk, therefore, we address some important computational issues related to the analysis and optimum design of vibrational energy harvesting devices made of piezoelectric polymeric materials, with focus on electrospun PVDF nanofibers. Specifically, the talk will cover the advanced finite element-based numerical modeling of piezoelectric systems as well as the semi-analytical probabilistic analysis of piezoelectric beams subjected to random vibrations by means of reduced-order models.



Title: Theoretical and Experimental Analyses of Broadband L-Shape Beam-Mass Piezoelectric Energy Harvester Using Nonlinear Resonance

Zhimiao Yan (颜志淼)
Assistant Professor
School of Naval Architecture, Ocean & Civil Engineering
Shanghai Jiao Tong University

Abstract: Unused vibrational energy in ambient environment is one type of renewable energy that has received growing attentions in the recent decade. The piezoelectric energy harvester can convert the vibration energy of the ambient environment into electrical energy to power the small self-powered devices. In this work, we try to develop the broadband energy harvesting based on L-shape beam-mass system. The Hamilton's principle and Gauss law are employed to derive the nonlinear electromechanical-coupled governing equations from the nonlinear geometrical of L-shaped beam-mass piezoelectric energy harvester. The experimental study of the internal resonance is conducted to validate the theoretical model. Moreover, the method of multiple scales is introduced to better investigate the nonlinear properties of the system.

2.3 Technical Program

Day 1: 03 November, 2018, Saturday

8:30-9:10 Opening Ceremony

Chair: Fei Wang

8:30-8:40
Welcome address from the University
8:40-8:55
Opening speech by Honorary Chairs
8:55-9:10
Welcome from the Chairs

9:10-10:30 Session 1

Session Chairs: Wenming Zhang & Junyi Cao

9:10-9:50
Keynote Talk I: Energy Harvesting from Vibration and Human Motion
Wei-Hsin Liao (The Chinese University of Hong Kong)

9:50-10:30
Keynote Talk II: Print-circuit-boad-enhanced Electret Rotational Energy Harvester for Wearable Devices
Yuji Suzuki (The University of Tokyo)

10:30-10:50 Group Photo & Coffee Break

10:50-12:00 Session 2 Nonlinearity

Session Chairs: Zhengbao Yang & Kangqi Fan

10:50-11:10
Invited Talk 1: Uncertainty analysis of nonlinear energy harvesters
Shengxi Zhou (Northwestern Polytechnical University)

11:10-11:30
Invited Talk 2: Harvesting stochastic base vibration energy by a piezoelectric inverted beam with pendulum
Weiyang Qin (Northwestern Polytechnical University)

11:30-11:45
Oral presentation 1: Arbitrary-directional nonlinear multi-stable vibration energy harvester: design and modeling
Lin-Chuan Zhao (Shanghai Jiao Tong University)

11:45-12:00
Oral presentation 2: Comparative studies on broadband piezoelectric energy harvesting with different stoppers
Huliang Dai (Huazhong University of Science and Technology)

12:00-14:00 Lunch Break

14:00-16:00 Session 3 Smart Structure and Applications

Session Chairs: Shengxi Zhou & Weiyang Qin

14:00-14:40
Keynote Talk III: Energy Harvesting: From Wireless Sensors to Blue Energy
Lei Zuo (Virginia Tech, USA)

14:40-15:20
Keynote Talk IV: Micro energy harvesters for self-powered sensing networks
Fei Wang (Southern University of Science and Technology)

15:20-15:40
Invited Talk 3: Vibration energy harvesting and its potential applications
Zhengbao Yang (City University of Hong Kong)

15:40-16:00
Invited Talk 4: A two-degree-of-freedom electromagnetic energy harvester for ultra-low frequency excitations
Kangqi Fan (Xidian University)

16:00-16:40 Poster & Coffee Break

List of Posters:

P1: A non-resonant rotational electromagnetic-triboelectric hybridized generator for harvesting low-frequency and irregular human motion
Cheng Hou (Soochow University)

P2: A frequency up-converted piezoelectric energy harvesting system with broad bandwidth based on MEMS PZT thick film technology
Manjuan Huang (Soochow University)

P3: Harvesting stochastic base vibration energy by a piezoelectric inverted beam with pendulum
Jianan Pan (Northwestern Polytechnical University)

P4: Design and experiment of an ultra-low frequency pendulum wave energy harvester
Yunfei Li (Soochow University)

P5: A novel energy harvester based on piezoelectric stack for harvesting transverse vibration energy of circular section beam abstract
Liufeng Zhang (Tsinghua University)

P6: Shock absorber with adaptive inertance and damping featuring magnetorheological effect
Xianxu Bai (Hefei University of Technology)

P7: Power peaks and power limit of a harmonically excited monostable piezoelectric energy harvester
Chunbo Lan (Nanjing University of Aeronautics and Astronautics)

P8: Investigation on piezoelectric energy harvesting from bridge vibrations subjected to moving vehicles
Zhiwei Zhang (Beijing Jiaotong University)

P9: Performance enhancement of two tandem piezoelectric energy harvesters in flowing fluid
Rujun Song (Shandong University of Technology)

P10: A theoretical model of piezoelectric energy harvesting plates with a RL resonant circuit
Yu Chen (Northwestern Polytechnical University)

P11: Numerical and experimental investigation of a tri-stable energy harvester for rotation motion
Xutao Mei (The University of Tokyo)

P12: Ride analysis of a hydraulic interconnected suspension based on the hydraulic energy regenerative shock absorbers (HIS-HESA)
Junyi Zou (Wuhan University of Technology)

P13: Statistical quantification of DC power generated by bistable piezoelectric energy harvesters when driven by random excitations
Chunlin Zhang (Northwestern Polytechnical University)

P14: On optimization of electromagnetic energy harvester from vibration
Zehao Hou (Xi`an Jiaotong University)

P15: Application of CFD in the analysis of wind piezoelectric energy harvesting
Junlei Wang (Zhengzhou University)

P16: Adaptive switching vibration control of flexible piezoelectric structure
Wei Tang (Northwestern Polytechnical University)

P17: A two-degree-of-freedom electromagnetic energy harvester for low-frequency vibration
Zhenlong Xu (Hangzhou Dianzi University)

P18: An electret-based energy harvesting device with the MEMS technology
Yulong Zhang (Southern University of Science and Technology)

P19: Multi-Shot Synchronized Electric Charge Injection and Extraction (MS-SECIE) Interface Circuit for piezoelectric Energy Harvesting Enhancement
Shiying Wang (ShanghaiTech University)

P20: Wideband MEMS electrostatic energy harvester with dual resonant structure
Yulong Zhang (Southern University of Science and Technology)

P21: Phase-Varibale Control of Synchronized Switch Harvesting on Inductor Interface Circuit towards Broadband Piezoelectric Energy Harvesting Systems
Bao Zhao (ShanghaiTech University)

P22: Effect of packaging pressure on energy harvesting from vibration source
Tianyang Wang (Southern University of Science and Technology)

P23: An electrostatic energy harvester with sandwiched structure of two electret layers
Yulong Zhang (Southern University of Science and Technology)

P24: Perforated electrode for performance optimization of electrostatic energy harvester
Yulong Zhang (Southern University of Science and Technology)

P25: Wireless sensor node with hybrid energy harvesting for air-flow rate sensing
Yushen Hu (Southern University of Science and Technology)

P26: Self-powered wireless sensor node for flow and temperature sensing
Yushen Hu (Southern University of Science and Technology)

P27: Surface charge patterning by laser engraving on organic electrets
Siyan Chen (Southern University of Science and Technology)

16:40-18:15 Session 4 Circuits and Systems

Session Chair: Huicong Liu & Kai Tao

16:40-17:00
Invited Talk 5: Multilevel bidirectional power conversion circuits for energy harvesting improvement
Junrui Liang (ShanghaiTech University)

17:00-17:15
Oral presentation 3: Resistive matching impedance circuit with self-start and sleep mode for impact-type piezoelectric energy harvester
Nan Chen (Northwestern Polytechnical University)

17:15-17:30
Oral presentation 4: Self-powered interface circuit optimization in piezoelectric energy harvesting and application for self-powered wireless sensor nodes
Bin Zhang (Shandong University, Weihai)

17:30-17:45
Oral presentation 5: Synchronous circuits with self-adaptive mechanical switches of viscous material: a parameter study
Weiqun Liu (Southwest Jiaotong University)

17:45-18:00
Oral presentation 6: Magnetic energy harvesting based wireless sensing system for shaft torque measurement
Jiawen Xu (Southeast University)

18:00-18:15
Oral presentation 7: Airflow energy harvesting based on diamagnetic levitation structure
Yufeng Su (Zhengzhou University)

18:15 Conference Banquet

Day 2: 04 November, 2018, Sunday

8:30-10:25 Session 5 Materials and Micro Energy Harvesters

Session Chairs: Giuseppe Quaranta & Junrui Liang

8:30-8:50
Invited Talk 6: Vibration Energy Harvesting with Flexible Electret Films
Xiaoqing Zhang (Tongji University)

8:50-9:10
Invited Talk 7: Piezoelectric thick film for energy harvesters and self-powered sensor
Bin Yang (Shanghai Jiao Tong University)

9:10-9:30
Invited Talk 8: Broadband energy harvesting using nonlinear 2D of MEMS electret power generator
Kai Tao (Northwestern Polytechnical University)

9:30-9:50
Invited Talk 9: Energy Harvesting Techniques From Ambient Environment
Huicong Liu (Soochow University)

9:50-10:10
Invited Talk 10: Micro piezoelectric energy harvester fabricated with PZT thick-film using aerosol deposition method
Wen-Jong Wu (National Taiwan University)

10:10-10:25
Oral presentation 8: Structural and piezoelectric characterization of ZnO thin film for vibration energy harvesting
Peihong Wang (Anhui University)

10:25-10:45 Coffee Break

10:45-12:10 Session 6 Piezoelectric Energy Harvesters

Session Chairs: Xiaoqing Zhang & Bin Yang

10:45-11:05
Invited Talk 11: Energy harvesting from ambient vibrations using piezoelectric polymeric materials: computational insights for structural monitoring applications
Giuseppe Quaranta (University of Rome)

11:05-11:25

Invited Talk 12: Theoretical and experimental analyses of broadband L-shape beam-mass piezoelectric energy harvester using nonlinear resonance
Zhimiao Yan (Shanghai Jiao Tong University)

11:25-11:40
Oral presentation 9: Ultra-low frequency vibration energy harvesting based on a pendulum-like piezoelectric oscillator
Yipeng Wu (Nanjing University of Aeronautics and Astronautics)

11:40-11:55
Oral presentation 10: Modeling and experimental investigation of an asymmetric monostable magnetically coupled dual-beam energy harvester under random excitation.
Wenbin Huang (Chongqing University)

11:55-12:10
Oral presentation 11: Design and analysis of piezoelectric energy harvesting structure based on d_{33} mode
Hai-peng Liu (Beijing Institute of Technology)

12:10-14:00 Conference Adjourn & Lunch

14:00 Campus tour

3. Meals

早餐，6:30-10:30，酒店一楼
晚宴，18:30-22:00，酒店一楼五稻香 VIP 厅
午餐自助，12:00-14:00，南方科技大学专家公寓中餐厅

Breakfast, 6:30-10:30, first floor at the Hotel
Banquet, 18:30-22:00, Wu Dao Xiang VIP Hall, ground floor at the hotel
Lunch buffet, 12:00-14:00, Chinese Restaurant at Guest Houses in SUSTech

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