Smart Material, Adaptive Structures and Intelligent Systems

ASME Smart Material, Adaptive Structures and Intelligent Systems Newsletter Fall 2024

Message from the Chair

Diann Brei ▪ Editor
dibrei@umich.edu

Björn Kiefer, TU Freiberg ▪ Welcome to the very first edition of the ASME Smart Materials, Adaptive Structures, and Intelligent Systems (SMASIS) Division newsletter! I am thrilled to greet you as the current chair of our still new division. This inaugural newsletter marks the beginning of an exciting journey for all of us, as we embark on a mission to further advance the field of smart materials and intelligent systems and to grow our division.

A New Era for Our Division

These past two years have been nothing short of remarkable. Evolving from first a technical committee, then branch, to the full scale of an ASME division, it has already achieved great strides, from a highly successful conference to strategic planning sessions that have set a clear mission and defined our core values. I want to extend my heartfelt thanks to everyone who has contributed to these efforts. Your dedication and hard work have laid a strong foundation for our future endeavors.

Our Mission, Vision, and Motto

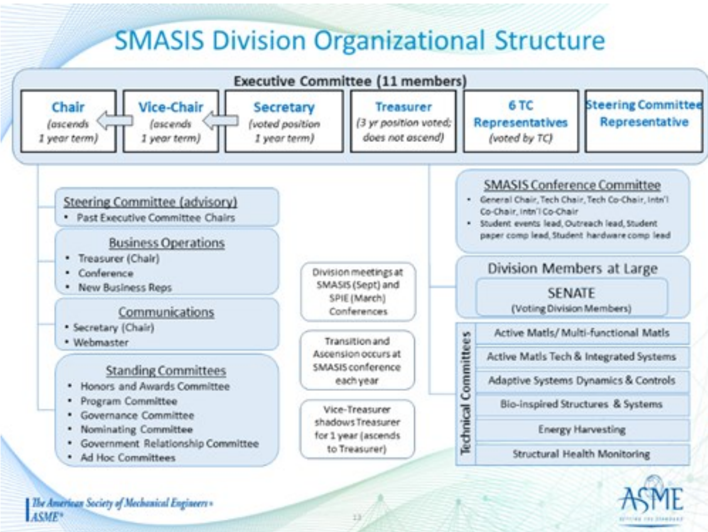
The mission of our interdisciplinary division is that it brings together diverse experts worldwide dedicated to technical advances and applications of smart materials, adaptive structures, and intelligent systems to exchange ideas, advance the field, and impact science, technology and humanity.

Our efforts are inspired by the vision of representing a sustainable global hub that empowers a diverse community of experts to advance the science, education, and technological solutions to rapidly evolving global challenges with smart materials, adaptive structures, and intelligent systems with impactful and transformational technologies.

The way we work together and how we value community interaction is encapsulated in our motto, "*If you want to go fast, go alone. If you want to go far, go together.*" It also reflects our commitment to pushing the boundaries of smart materials technology and fostering a dedication to continuous improvement and excellence.

Organizational Structure

Our division is structured to promote active participation and leadership at various levels. We have several Technical Committees (TCs) focused on different areas of smart materials and systems. These committees are the heart of our technical activities, driving research, development, and collaboration. Our Senate and Executive Committee provide governance and strategic direction, ensuring we stay true to our mission and values.



Get Involved – Join Us

We invite you to become an active member of our division. There are numerous ways to get involved:

- Attend our conferences to network, learn, and share your research.
- Join one of our Technical Committees to collaborate with peers in your area of expertise.
- Nominate deserving individuals for our awards to recognize excellence in our field.
- Volunteer to help judge papers that have been nominated for our division- and TC-level awards.
- Participate in student events and mentoring programs to support the next generation of engineers and researchers.

Share your feedback and ideas to help us continually improve and innovate.

We are always open to new initiatives and look forward to your contributions. Whether you have suggestions for new projects or want to volunteer your time and skills, your involvement is invaluable.

Learn More

To stay informed and engaged, please visit our website (*www.asme.org/get-involved/groups-sections-and-technical-divisions/technical-divisions/technical-divisions-community-pages/smasis-division*) for updates and detailed information about our activities and initiatives. Join our meetings and events to connect with fellow members and stay at the forefront of advancements in smart materials and intelligent systems.

Integration of Emerging Topics

Some of our earliest fields of innovation have now reached levels of maturity in which smart material technology has attained market readiness and integration. The generated scientific knowledge has become part of modern university curricula. But we are still striving to constantly envision, lead and integrate emerging topics. At this year's SMASIS conference, for instance, a new special topics symposium on: "Embodying Physical Computing and Mechano-Intelligence" is part of the program, chaired by Kon-Well Wang (University of Michigan), together with the co-chairs: Suyi Li (Virginia Tech) and Andres F. Arrieta (Purdue University).

A Proud Community

I am incredibly proud of our vibrant and dynamic community. Together, we have created a division that is not only a leader in the field but also a supportive and inclusive network. We are a great group, and I am confident that our collective efforts will continue to drive innovation and excellence.

Words of Thanks

As my four-year tenure comes to an end in September, I want to take this opportunity to give a heartfelt thanks to my fellow EC officers, Rich Beblo (AFRL) — who preceded me in all offices and gave invaluable advice —, Onur Bilgen (Rutgers University), Janet Sater (IDA), Cornel Ciocanel (Northern Arizona University), and Eric Freeman (University of Georgia). But first and foremost, I want to thank Diann Brei (University of Michigan), for her tremendous efforts and support, for embodying the collective memory of our community and for her inspirational leadership (University of Michigan).

As a division, we also want to express our sincere appreciation to Barbara Zlatnik, who in her role as Senior Manager of Technical & Engineering Communities (TEC) Operations is our direct ASME contact, for the continued support.

And finally thanks you all for your scientific contributions, volunteering and dedication to our community. Here's to a bright and innovative future for the SMASIS Division!

With warm regards,
Bjoern Kiefer
Chair, ASME SMASIS Division

Technical Committees

Active Material Technology and Integrated Systems

The Active Material Technology and Integrated Systems Technical Committee (AMTIS) strives to advance the development of technologies utilizing highly integrated active and adaptive structures and material systems. Such advances could be considered in terms of modeling, simulation, design optimization, and testing, as well as innovations in hardware implementation.

Past Chair: Srinivas Vasista, *srinivas@vaeridion.com*
Chair: Patrick Musgrave, *pmusgrave@ufl.edu*
Co-Chair: Alex Pankonien, *alexander.pankonien.1@afrl.af.mil*
Secretary: Sebastian Geier, *sebastian.geier@dlr.de*

Bioinspired Smart Materials and Systems

The Bioinspired Smart Materials and Systems Technical Committee (BSMS) unites engineers, material scientists, and interdisciplinary researchers who are dedicated to learning from and leveraging material architectures, design principals, and functionalities exhibited by biological systems. The purpose of this TC is to foster innovation, collaboration, and dissemination of research efforts that reveal physical mechanisms and to develop novel engineering approaches and applications through experiments, fabrication, modeling and simulation. Focus areas include sensing and actuation, surface engineering, system architectures, soft autonomous robotics and locomotion, mimics of active and passive organs, tissues, and cellular structures. This multidisciplinary field enables new techniques for engineering materials and systems with enhanced functionalities and performance poised for applications in robotics, manufacturing, biomedical devices, computing architectures, and many more.

Past chair: Joseph Najem, *jsn5211@psu.edu*
Chair: Ya Wang, *ya.wang@tamu.edu*
Co-Chair: Caterina Lamuta, *caterina-lamuta@uiowa.edu*
Secretary: Open

Energy Harvesting

The Energy Harvesting Technical Committee (EHTC) is concerned with all aspects of energy harvesting technology from dynamical systems, as well as the related technologies, such as nonlinear dynamics, metamaterials, and power management for energy harvesting systems. Examples of energy harvesting technologies and systems in this context span from NEMS/MEMS power generators for low-power sensor systems to mesoscale and large-scale harvesters for recovering wind and wave energy. Energy harvesting applications including IoT, wearable technologies, and hybrid systems (i.e., w/ solar power) and integrated energy storage

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TOYOTA RESEARCHERS EMPHASIZE COLLABORATIVE APPROACH TO ADVANCE SMART MATERIALS DEVELOPMENT

Researchers at Toyota Research Institute of North America (TRINA) [1,2], based in Michigan, are diligently working on developing smart materials that can change their properties such as shape, stiffness, conductivity, sound transmission, and more, based on the input to adapt to their environment to maintain optimum performance. These efforts align closely with Toyota's vision of providing happiness through sustainable mobility for all individuals, independent of their age and physical limitations. Such smart material-enabled designs can also help in achieving improved performance in other areas such as soft robots and exoskeletons, etc.

Furthermore, it is important to recognize that while smart materials present a promising starting point, using them in design requires a multi-disciplinary approach. For instance, while developing a morphing fender, it became evident that relying solely on a smart material capable of shape-changing is not enough. A structure that can change shape while maintaining stiffness and strength, a skin material that can stretch, a sensor and electronics for control and computer algorithms to oversee entire process are also required. Such complexities demand a multidisciplinary system development, often referred to as programmable systems or programable structures (Figure 1).

The concept of programmable structures capable of adapting to specific requirements has been proposed for many years. Numerous smart materials have been developed in the past, however, their implementation in mobility settings has been limited. The primary hurdles hindering their widespread implementation are higher cost and long-term reliability concerns. While pursuing technology development to address these challenges, considering the extent of research needed, TRINA recognizes the need to work with other researchers in the field. It is assumed that the fundamental challenges can be addressed by the research community collectively through collaborative work, and as the know-how and infrastructure expand, specific applications can be developed for targeted usage.

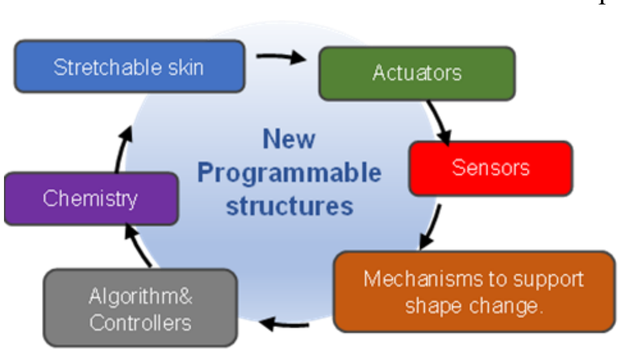

Figure 1. Multi-disciplinary development approach

Consequently, about five years ago, TRINA with support from ASME SMASIS division, initiated the Toyota Programable System Innovation Fellowship. The primary objective of the fellowship is to encourage young faculty to work on a new research topic in programable structures. While the fellowship provides a modest $50K fund, it also brings technical support and access to other testing and computational resources at the TRINA programable systems lab. The research supported under the Toyota Fellowship is expected to encourage additional R&D activities in the field; similar to growing a forest from seeds.

The list of past recipients of the Toyota fellowship is presented in Table 1. We are very happy to share that, in most cases, the creative effort by fellowship recipients, have led to an expansion of research topics. Numerous papers are published, patents are filed and additional funding has been secured from other sources, resulting in significant positive impact on the research infrastructure, and an increase in the smart materials know-how.

In addition to the fellowship, TRINA is also engaged in numerous collaborations with universities as well as early phase research companies. For example, TRINA has been member of smart vehicle concept center (SVC), which is an NSF supported collaborative research center, led by Prof. Dapino at the Ohio State University. Such collaborative centers are very useful in expanding research activity and creating fundamental knowledge which helps further advancement of the smart materials toward products.

One of the interest areas for the programable system application at TRINA is safety components such as airbags, seat belts, bumpers, etc. Imagine airbags that can adjust to the occupant size (Figure 2) and position, seat belts that can tailor the restraint force based on the occupant weight and a bumper that can alter stiffness based

Table 1: Toyota Programmable Systems Innovation Fellowship recipients

Year	Recipients	Institution	Research area	Potential application
2019-20	Juliana Abel	University of Minnesota	Modeling Knitted SMA	Smart fabric
2020-21	James Pikul	University of Pennsylvania	Electro-programable patch for inflatable structures	Shape control of inflatable structures
2021-22	Tadesee Yonas	University of Texas, Dallas	Artificial skin with multilayers using twisted coil actuators	Exoskeleton, Soft robots
2022-23	Ala Qattawi	University of Toledo	3D Printable Iron based SMA	Low-cost complex shape actuators
2023-24	Margaret Coad	University of Notre Dame	Vine robots	Automated restraint system

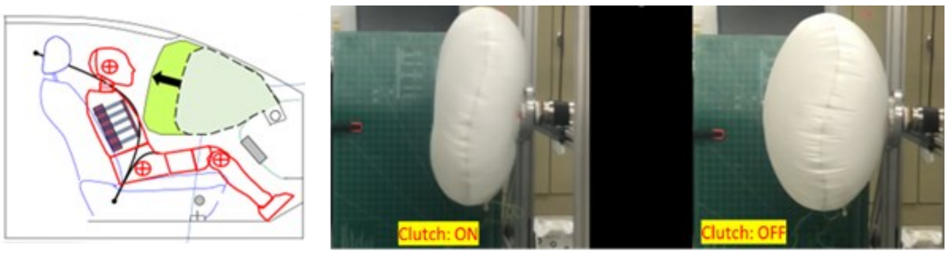

Figure 2. Airbag that would adjust to optimize occupant protection.

on the impact speed. Such capabilities can enhance the safety performance of the vehicle. TRINA is collaborating with Prof. Brei's group at the University of Michigan to develop energy absorbing smart walls that can adapt to protect the occupants of different size in various mobility settings, which can be a personal vehicle or public transport such as bus or train.

While these partnerships are crucial for advancing fundamental knowledge, in-house R & D is equally vital for translating these advancements into practical applications. TRINA team members possess diverse expertise in material science, computational methods, design and development, prototyping, coupled with profound understanding of vehicle development by our R&D colleagues. This comprehensive skill set (Figure 3) enables TRINA to seamlessly bridge the gap between theoretical research and real-world applications, driving innovation and progress in use of the smart materials.

TRINA deeply values outstanding contributions made by members of the ASME SMASIS division and eagerly anticipates ongoing collaborative efforts aimed at advancing expertise in the field of smart materials and programmable systems development. Our objective is to establish a knowledge base that not only impacts TRINA but also empowers all stakeholders to harness low-cost, reliable smart materials in their designs. Through this endeavor, TRINA remains steadfastly committed to realizing Toyota's vision of achieving sustainable mobility and happiness for all. ■

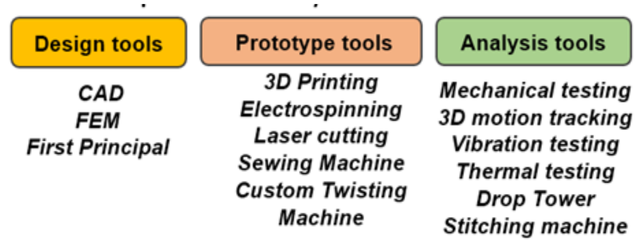

Figure 3. TRINA programable system lab capabilities

Technical Committees (continued)

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for smart systems are of interest. The EHTC serves academic, governmental, and industrial professionals from mechanical and aerospace, civil and environmental, electrical and electronics, and materials science engineering, among other engineering and applied sciences disciplines. We foster the creation of societally significant energy harvesting research areas by bringing together leading researchers from different related academic disciplines and industrial sectors.

Past chair: Shima Shahab, *sshahab@vt.edu*
Chair: Serife Tol, *stol@umich.edu*
Co-Chair: Junrui Liang, *liangjr@shanghaitech.edu.cn*
Secretary: Wei-Che Tai, *taiweich@msu.edu*

Structural Health Monitoring

Description: The Structural Health Monitoring TC brings together diverse experts in fundamental sciences and applied technologies toward embedded and automated structural assessment (structural health monitoring) to advance safety, mitigate failure, reduce down-time, and support sustainability. This includes investigating theory, design, and application of novel sensors, signal analytics, structural mechanics, and related disciplines.

Past chair: Tyler Tallman, *ttallman@purdue.edu*
Chair: Nathan Salowitz, *salowitz@uwm.edu*
Co-Chair: Zhenhua Tian, *tianz@vt.edu*
Secretary: Haifeng Zhang, *haifeng.zhang@unt.edu*

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Active and Multi-Functional Materials

The Active and Multi-Functional Materials TC (AMMTC) brings together leading researchers with backgrounds in mechanical engineering and materials science to help advance fundamental research on materials with embedded functionality. Researchers conduct theoretical, computational, and experimental studies including machine learning, materials characterization, and materials design frameworks. Emphasis is placed on shape morphing materials and composites, considering the interaction between mechanical components and external stimuli, forming a foundational bridge between materials research and application.

Past chair: John Domann, *jpdomann@vt.edu*
Chair: Russell Mailen, *rwmailen@auburn.edu*
Co-Chair: Doug Nicholson, *douglas.e.nicholson@boeing.com*
Secretary: Peter Caltagirone, *peter.e.caltagirone@nasa.gov*

Adaptive Systems Dynamics and Controls

Description: The Adaptive Systems Dynamics and Controls Technical Committee brings together leading researchers and engineers from various academic disciplines, government laboratories, and industrial sectors. Its purpose is to promote the discovery, development, and implementation of mathematical tools and experimental techniques to characterize, model, and control the dynamic behavior of smart materials and distributed adaptive systems. The TC helps enable innovation, collaboration, and dissemination of research efforts with the goal of advancing the science and technology in sensing, actuation, integration, and control of such systems. Emerging areas include uncertainty quantification, physics-informed AI, digital twins that rely on surrogate and reduced order modeling, programmable materials and embodied intelligence in mechanical materials and structures.

Past chair: Suyi Li, *suyili@vt.edu*
Chair: Sriram Malladi, *smalladi@mtu.edu*
Co-Chair: Marco Fontana, *marco.fontana@santannapisa.it*
Secretary: Guangbo Hao, *g.hao@ucc.ie*

Executive Committee

Chair: Bjoern Kiefer, *bjoern.kiefer@imfd.tu-freiberg.de*
Vice Chair: Onur Bilgen, *o.bilgen@rutgers.edu*
Secretary: Eric Freeman, *ecfreema@uga.edu*
Treasurer: Janet Sater, *jsater@ida.org*
Assistant Treasurer: Cornel Ciocanel, *constantin.ciocanel@nau.edu*
Steering Committee Representative: Diann Brei, *dibrei@umich.edu*
TC Chairs: Ya Wang, Serife Tol, Patrick Musgrave, Russell Mailen, Sriram Malladi, Nathan Salowitz, *emails above* ■

Awards

Ephraim Garcia Best Paper Award

Haitian Hao, Apple, Inc.

Dr. Haitian Hao received his M.S. and Ph.D. degrees from the Department of Mechanical Engineering at Purdue University. Dr. Hao attended college and received his B.S. in Mechanical Engineering at Shanghai Jiao Tong University in China. His research interests include thermoacoustic phenomena in solid and fluid media, acoustic metamaterials, and structural vibrations. Dr. Hao is the recipient of the Leo Beranek Medal for Excellence in Noise Control Studies, ASME SMASIS Best Paper Award, etc. Dr. Hao currently works as an N&V test engineer at Apple Inc.

Carlo Scalo, Purdue University

Dr. Carlo Scalo is an Associate Professor in the School of Mechanical, and Aeronautical and Astronautical Engineering (by courtesy) at Purdue University. His research interests focus on computational aeroacoustics, vortex dynamics, low- and high-speed turbulent boundary layers, and hypersonics. In particular, Dr. Scalo has developed computational techniques for prediction of acoustic noise propagation and control in hypersonic boundary layers, low-speed and high-speed transitional and fully developed turbulence and thermoacoustic instability in combustion systems. Scalo has received three distinct Young Investigator Program (YIP) Awards from the Department of Defense in: hypersonic boundary layer transition (Air Force), hypersonic boundary layer turbulence (Navy) and vortex dynamics (Army). He is also the founder of HySonic Technologies – a Purdue start-up that received ONR funding to develop passive control of hypersonic boundary layers and high-speed propulsion systems.

Fabio Semperlotti, Purdue University

Dr. Fabio Semperlotti is a Professor and the Perry Academic Excellence Scholar in the School of Mechanical Engineering at Purdue University and holds a courtesy appointment in the School of Aeronautics and Astronautics Engineering. He received a M.S. in Aerospace Engineering (2000), and a M.S. in Astronautic Engineering (2002) both from the University of Rome “La Sapienza” (Italy), and a Ph.D. in Aerospace engineering (2009) from the Pennsylvania State University (USA). Prior to joining Penn State, Dr. Semperlotti served as a structural engineer for a few European aerospace industries, including the French Space Agency (CNES), working on the structural design of space launch systems (such as Ariane 5 and Vega) and satellite platforms. Dr. Semperlotti is a member of the Ray W. Herrick laboratory and directs the

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Structural Health Monitoring and Dynamics laboratory (SHMD) where he conducts, together with his research group, research on several aspects of structures and materials including structural dynamics and wave propagation, elastic metamaterials, structural health monitoring, and computational mechanics. Dr. Semperlotti has been the recipient of national awards including the National Science Foundation CAREER award (2015), the Air Force Office of Scientific Research Young Investigator Program (YIP) (2015), the DARPA Young Faculty Award (YFA) 2019, and the ASME C.D. Mote Jr. Early Career Award 201

On the use of Negative Thermal Expansion Engineered Structures in Flexural-Mode Solid-State Thermoacoustics

Journal of Sound and Vibration 538 (2022), 117223

Recent numerical studies have shown evidence of self-sustained oscillations in solids due to externally-applied spatial thermal gradients. In analogy with its acoustic counterpart in gases, this phenomenon was dubbed solid-state thermoacoustics (SSTA). Such heat-driven oscillation can give rise to either longitudinal or flexural motion, depending on the specific design of the system. Although an experimental proof of self-sustained motion in flexural-mode SSTA (FSSTA) devices has yet to be produced, previous experimental studies pointed to the reduction of the effective damping as a clear indicator of the thermos-mechanical energy conversion process at the core of the F-SSTA mechanism. The F-SSTA theory suggested that negative thermal expansion (NTE), which is not a common property in natural materials, offers a remarkable opportunity to enhance the F-SSTA instability. The present study explores a design approach that leverages the unique features afforded by the solid state design in order to improve the overall performance of F-SSTA's devices and reduce the technological gap to achieve, in a near future, a successful experimental validation. The proposed design approach leverages a hybrid bilayer beam concept where one of the two layers is designed to exhibit NTE properties. More specifically, the NTE layer is composed of a bi-material octet truss that contracts in the axial direction upon heating. This axial contraction is particularly beneficial to induce a strong thermal bending moment that ultimately enhances the F-SSTA instability. In addition, this work also furthers the conceptual understanding of the F-SSTA process by presenting an analytical perturbation energy budget developed on the basis of a simplified discrete model. These theoretical considerations provide new important insights in the energy conversion mechanism at the basis of the F-SSTA process, hence helping reducing the gap of knowledge towards a successful experimental realization of the F-SSTA effect.

SMASIS Division Best Paper Award in Structural Dynamics and Control

Keyu Chen, The Chinese University of Hong Kong

Dr. Keyu Chen is currently a Research Associate in the Department of Automation and Mechanical Engineering, The Chinese University of Hong Kong, Hong Kong, China. He received the B.S. degree in mechanical engineering from the Beihang University, Beijing, China, in 2015 and the Ph.D. degree in automation and mechanical engineering from The Chinese University of Hong Kong, Hong Kong, China, in 2023. His current research interests include vibration energy harvesting, vibration suppression, and multi-objective optimization.

Shitong Fang, Shenzhen University, China

Dr. Shitong Fang received the B.Eng. degree from Sun Yat-sen University, Guangzhou, China in 2017 and the Ph.D. degree in mechanical engineering from The Chinese University of Hong Kong, Hong Kong, China in 2021. She currently works as an Associate Professor with the College of Mechatronics and Control Engineering, Shenzhen University, China. Her research interests include nonlinear dynamics, vibration energy harvesting, and vibration suppression. Dr. Fang was a recipient of the Outstanding Thesis Award from the Faculty of Engineering, The Chinese University of Hong Kong.

Qiang Gao, Southeast University, China

Dr. Qiang Gao is an Associate Professor in the School of Mechanical Engineering at Southeast University. He received his B.S. and Ph.D. degrees from the Department of Mechanical Engineering at Nanjing University of Science and Technology. Before joining Southeast University, he did the research work at the University of Michigan and The Chinese University of Hong Kong. His research interests focus on smart material and structures, topology optimization and machine learning based design.

Donglin Zou, Shanghai Jiao Tong University, China

Dr. Donglin Zou is currently an Assistant Professor at the School of Mechanical Engineering, Shanghai Jiao Tong University, China. He received his B.S. degree from Wuhan University of Technology, China, M.S. degree from Xi'an Jiao Tong University, China, and Ph.D. degree from Shanghai Jiao Tong University, China. His research interests include structural dynamics, vibration and noise reduction, fluid-structure interaction, computational fluid dynamics, smart materials, and vibration energy harvesting.

Junyi Cao Xi'an, Jiaotong University, China

Dr. Junyi Cao is a Professor in the

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School of Mechanical Engineering at Xi'an Jiaotong University. He received the Ph.D. degree of Mechanical Engineering from Xi'an Jiaotong University, Xi'an, China, in 2006. From September 2013 to September 2014, he was a visiting scholar with the Department of Aerospace Engineering, University of Michigan, Ann Arbor. His main research interests include smart materials and structures, vibration control and energy harvesting. He is a recipient of 2021 Best Paper Award of ASME Journal of Vibration and Acoustics. 23 Awards

Wei-Hsin Liao The Chinese University of Hong Kong

Dr. Wei-Hsin Liao received the Ph.D. degree in mechanical engineering from The Pennsylvania State University, University Park, PA, USA, in 1997. He is currently the Department Chairman and Choh-Ming Li Professor of Mechanical and Automation Engineering, The Chinese University of Hong Kong, Hong Kong, China. His research interests include smart materials and structures, energy harvesting, vibration control, mechatronics, exoskeleton, and prosthesis. Dr. Liao currently serves as an Associate Editor for Journal of Intelligent Material Systems and Structures, and on the Executive Editorial Board of Smart Materials and Structures. He is a Fellow of the American Society of Mechanical Engineers, the Institute of Physics, and the Hong Kong Institution of Engineers. Dr. Liao is the recipient of 2020 ASME Adaptive Structures and Material Systems Award and 2018 SPIE SSM Lifetime Achievement Award.

Enhancing Power Output of Piezoelectric Energy Harvesting by Gradient Auxetic Structures

Applied Physics Letters 120 (2022), 103901

In this Letter, a method is proposed to increase the power output of piezoelectric energy harvesting via gradient auxetic structures. This method is validated through a gradient auxetic piezoelectric energy harvester, which combines a cantilever beam and a gradient auxetic structure. Compared with the normal uniform auxetic structure, the gradient auxetic structure can contribute to a more uniform strain distribution of the piezoelectric cantilever beam; thus, the proposed gradient auxetic energy harvester can produce higher power than the uniform auxetic energy harvester without increasing the stress concentration at the same time. Finite element simulation is performed to analyze the characteristics of the gradient auxetic energy harvester. From the experimental results, under the base excitation of 1 m/s2, the power density of the gradient auxetic energy harvester is increased by 356% and 55%, respectively, compared with the conventional plain energy harvester without auxetic structure and the uniform auxetic energy harvester.

SMASIS Division Best Paper Award in Mechanics and Material Systems

Katherine S. Rile, Purdue Univ.

Katherine Riley received her BS in structural engineering from the University of California, San Diego and her MS and PhD in mechanical engineering from Purdue University. Her research interests include multistable structures, programmable materials, and structures with sensing and memory capabilities.

Subhadeep Koner, University of Tennessee

Dr. Subhadeep Koner received a bachelor's degree in mechanical engineering from Jalpaiguri Government Engineering College in India. Later, he graduated from University of Tennessee with a PhD in mechanical engineering. His research was focused on brain inspired materials and electronic devices for adaptive signal processing, memory and learning. Currently, he works at Lam Research Corporation as a Process Engineer in their R&D division.

Juan C. Osorio, Purdue Univ.

Juan Osorio received his BS and MS degrees in Mechanical Engineering from Universidad de los Andes, Bogota, Colombia, in 2017 and 2019, respectively. He is a Ph.D. student in the School of Mechanical Engineering at Purdue, working at the Programmable Structures Lab. His research interests include finite element analysis, soft robotics, and physical computation with hierarchically multistable structures.

Yongchao Yu, University of Tennessee, Nanyang Technological University, Singapore

Dr. Yongchao Yu received his B.S. and M.S. degrees in electrical engineering from the University of Tennessee, Knoxville, USA, in 2013 and 2015, respectively. He earned his Ph.D. in mechanical engineering from the University of Tennessee, Knoxville, USA, in 2019. Currently, he is a research fellow at the Schaeffler Hub for Advanced Research in Singapore and is also affiliated with the School of Mechanical and Aerospace Engineering at Nanyang Technological University, Singapore. His research interests encompass condition monitoring, machine learning, laser processing, and nanomaterials.

Harith Morgan, Purdue Univ.

Harith Morgan received his M.S. in Mechanical Engineering from Purdue University and his B.S. in Mechanical Engineering from the Massachusetts Institute of Technology. His research interests include control of soft robotics with multistable structures and machine design. Harith currently works as a design engineer at ASML.

Janav P. Udani, Purdue Univ.

Dr. Janav P. Udani has a PhD in Mechanical Engineering from Purdue University. Dr. Udani's doctoral research focused on the mechanics of nonlinear multistable structural sys-

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tems and covered the areas of nonlinear mechanics, dynamics, controls, programmable structures, smart materials, and mechanical computing. Following his doctorate degree, Dr. Udani has been working at 3M on the research and development of hardware and membrane technologies for filtration and purification solutions for the biopharmaceutical purification space.

Stephen A. Sarles, University of Tennessee

Dr. Andy Sarles is an Associate Professor and the James Conklin Faculty Fellow in the Dept. of Mech., Aero. and Biomed. Engr. at the University of Tennessee. His research interests include transport and signaling through biomimetic interfaces and tissue-inspired materials, revealing nanomaterial-membrane interactions, and artificial synapses and neurons for neuromorphic computing. Sarles' work is supported by NSF, AFOSR, & ONR. He is a Fellow of ASME, and recently served as the General Chair of the 2021 ASME Conference on Smart Materials Adaptive Structures and Intelligent Systems (SMASIS)

Andres F. Arrieta Purdue Univ.

Dr. Andres F. Arrieta is an Associate Professor of Mechanical Engineering and Aeronautics and Astronautics Engineering (by courtesy) at Purdue University, where he leads the Programmable Structures Lab. Previously, he worked as a Group Leader at ETH Zurich's CMAS Lab and as a Research Associate at the Dynamics and Oscillations Group at TU Darmstadt. He received his Ph.D. in Mechanical Engineering from the University of Bristol and his BEng from the Los Andes University, Bogota, Colombia. Dr. Arrieta's research focuses on investigating instabilities and nonlinearity in structural mechanics and the fundamental interaction between geometry, hierarchy, and nonlinearity to design structural systems with intrinsic properties enabling adaptation, autonomy, and environmental responsiveness. Current efforts concentrate on the modeling and designing of programmable structures, soft robotics, bioinspired design, embodied intelligence in structures, nonlinear metamaterials, and morphing structures. The Programmable Structures Lab's work has been highlighted by several media outlets, including National Geographic and Nature's News and Views. He has received several personal awards, including the 2021 inaugural Emerging Leaders Award in Smart Materials and Structures (IOP Publications); NSF CAREER Award (2020); the ASME Gary Anderson Award (2018) for "outstanding contributions to the field of Adaptive Structures;" and the ETH Postdoctoral Fellowship (2012).

Neuromorphic Metamaterials for Mechanosensing and Perceptual Associative Learning

Advanced Intelligent Systems 4 (2022), 2200158

Physical systems exhibiting neuromechanical functions promise to enable structures with directly encoded autonomy and intelligence. A neuromorphic metamaterials class embodying bioinspired mechanosensing, memory, and learning functionalities obtained by leveraging mechanical instabilities integrated with memristive materials is reported. The prototype system comprises a multistable metamaterial whose bistable dome-shaped units collectively filter, amplify, and transduce external mechanical inputs over large areas into simple electrical signals using embedded piezoresistive sensors. Dome deformations in nonvolatile memristors triggered by the transduced signals, providing a means to store loading events in measurable material states are recorded. Sequentially applied mechanical inputs result in accumulated memristance changes that allow us to physically encode a Hopfield network into the neuromorphic metamaterials. This physical network learns the history of spatially distributed input patterns. Crucially, the neuromorphic metamaterials can retrieve the learned patterns from the memristors' final accumulated state. Therefore, the system exhibits the ability to learn without supervised training and retain spatially distributed inputs with minimal external overhead. The system's embodied mechanosensing, memory, and learning capabilities establish an avenue for synthetic neuromorphic metamaterials that learn via tactile interactions. This capability suggests new types of large-area smart surfaces for robotics, autonomous systems, wearables, and morphing structures subjected to spatiotemporal mechanical loading.

Active and Multifunctional Materials TC Outstanding Contribution Award

Charles El Helou, Intel, Inc.

Charles is currently a Research Engineer at Intel. Prior to joining Intel, Charles completed his Ph.D. in Mechanical Engineering with the Laboratory of Sound and Vibration Research at the Pennsylvania State University. His dissertation focused on soft electromechanical material systems with sensing and computing capabilities. He established unconventional computer and material architecture design frameworks to program integrated circuits for digital logic processes in autonomous matter. During this period, Charles was also a graduate fellow with the Air Force Research Laboratory where he worked on developing and printing flexible electronic devices. He was initially introduced to academic research while receiving his B.S. in Mechanical Engineering from the Ohio State University.

Benjamin Grossmann, AFRL
Christopher E. Tabor, AFRL
Philip R. Buskohl, AFRL
Ryan L. Harne, Exponent, Inc.

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Mechanical Integrated Circuit Materials

Nature 608 (2022), 699-703

Recent developments in autonomous engineered matter have introduced the ability for intelligent materials to process environmental stimuli and functionally adapt. To formulate a foundation for such an engineered living material paradigm, researchers have introduced sensing and actuating functionalities in soft matter. Yet, information processing is the key functional element of autonomous engineered matter that has been recently explored through unconventional techniques with limited computing scalability. Here we uncover a relation between Boolean mathematics and kinematically reconfigurable electrical circuits to realize all combinational logic operations in soft, conductive mechanical materials. We establish an analytical framework that minimizes the canonical functions of combinational logic by the Quine-McCluskey method, and governs the mechanical design of reconfigurable integrated circuit switching networks in soft matter. The resulting mechanical integrated circuit materials perform higher-level arithmetic, number comparison, and decode binary data to visual representations. We exemplify two methods to automate the design on the basis of canonical Boolean functions and individual gate-switching assemblies. We also increase the computational density of the materials by a monolithic layer-by-layer design approach. As the framework established here leverages mathematics and kinematics for system design, the proposed approach of mechanical integrated circuit materials can be realized on any length scale and in a wide variety of physics.

Energy Harvesting TC Best Paper Award

Guobiao Hu, The Hong Kong Univ.of Science and Technology

Dr. Guobiao Hu is currently an assistant professor with the Internet of Things Thrust at the Hong Kong University of Science and Technology (Guangzhou). He received his Ph.D. degree in Mechanical Engineering from the University of Auckland. Before joining HKUST(GZ), he was a Research Fellow at Nanyang Technological University. His research interests include energy harvesting, acoustic-elastic metamaterials, and smart material structures & systems. Dr. Hu has published over 80 peer-reviewed technical papers in prestigious journals and international conferences, including 5 ESI highly cited papers. He received the Best Paper Finalist Award at the SPIE Conference on Smart Structures/NDE 2018. He has filed 3 patents, including 1 Singapore and 2 Chinese patents. He is named in the world's top 2% of Scientists List (2022) identified by Stanford University. He serves as reviewer for more than 60 SCI journals and guest editor for 5 SCI-indexed journals.

Chunbo Lan, Nanjing University of Aeronautics and Astronautics, China

Dr. Chunbo Lan is currently an assistant professor with the college of Aerospace Engineering at Nanjing University of Aeronautics and Astronautics. He received his Master degree and Ph.D. degree in Engineering Mechanics from Northwest Polytechnical University, China. Before joining NUAA, he was a visiting Ph.D. at the University of Auckland, New Zealand. His research interests focus on vibration energy harvesting and mechanical metamaterial for vibration suppression. Dr. Lan has authored about 40 peer-reviewed papers and received the Science and Technical Award of Shaanxi Province (2021). He serves as Guest Editor for 3 SCI-indexed Journals and reviewer for more than 40 Journals.

Lihua Tang, The University of Auckland, New Zealand

Lihua Tang received his BEng in engineering mechanics and MEng in solid mechanics from Shanghai Jiao Tong University, China, in 2005 and 2008, respectively, and PhD in structures and mechanics from Nanyang Technological University, Singapore, in 2012. He is currently an associate professor with the Department of Mechanical and Mechatronics Engineering, The University of Auckland, New Zealand. He has published over 230 peer-reviewed journal and conference papers. His main research interests include smart materials and adaptive structures, energy harvesting, vibration control, acoustic/elastic metamaterials and thermoacoustics. He currently serves as the associate editor of Journal of Intelligent Material Systems and Structures.

Bo Zhou, Dalian University of Technology, China

Dr Bo Zhou is currently a Professor of Dalian University of Technology (DUT). Dr. Zhou has been engaged in research and development of vibration and noise reduction new energy, applications of ship and marine engineering, and dynamic response characteristics of offshore structures for 20 years. He published more than 90 academic papers and filed 12 Chinese patents.

Yaowen Yang, Nanyang Technological University, Singapore

Prof. Yaowen Yang presently holds the position of a Professor within the School of Civil and Environmental Engineering, while also serving as the Deputy Associate Provost (Continuing Education) in the President's Office, Nanyang Technological University (NTU), Singapore. He stands as a prominent researcher in the areas of small energy harvesting and structural health monitoring. His research interests include aeroelastic and vibration energy harvesting, metamaterials, structural health and geotechnical monitoring and uncertainty analysis in structural dynamics. Accomplished and highly cited in his field, Prof Yang

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has clinched more than S$12 million in research funding, and published over 280 papers in reputable journals and conferences. Prof. Yang's educational background includes a B.Eng and M.Eng from Shanghai Jiao Tong University, followed by a Ph.D. from Nanyang Technological University. He serves as Associate Editor and Editorial Board member for multiple international journals and delivered keynote and invited lectures at many international conferences. Beyond academia, Prof. Yang wears an entrepreneurial hat as well. He established a company aimed at implementing his patented technologies, thereby offering comprehensive solutions for geotechnical, structural, and construction process monitoring, culminating in informed decision-making. For his innovative research strides and entrepreneurial pursuits, Prof. Yang is designated as an iNTUitive Fellow, showcasing his distinguished contributions to the university.

Dynamics and Power Limit Analysis of a Galloping Piezoelectric Energy Harvester under Forced Exitation

Mechanical Systems and Signal Processing 168 (2022), 108724

This paper presents a rigorous analytical solution to the dynamics of a single-degree-of-freedom (SDOF) piezoelectric energy harvester (PEH) under the combined wind and base excitations using the harmonic balance method. The boundaries of the quenching region are predicted using the multi-scale method. An equivalent circuit model (ECM) is established to verify the analytical solution, and the simulation results based on the ECM are in good agreement with the analytical ones. Subsequently, the power limit of the SDOF PEH under the combined excitations is analysed for the first time using the impedance theory based on a simplified model. The maximum power amplitudes at different excitation frequencies are also sought by numerically sweeping the load resistance. It is found that the impedance theory that has been successfully adopted in the literature is inapplicable in analysing the power limit of the SDOF PEH under the combined excitations. The impedance plots obtained based on resistance sweeping clearly indicate that, in contrast to the conclusions given in the literature, impedance matching is not the condition to attain the power limit of the SDOF PEH under the combined excitations. A mathematical proof is provided for a reasonable explanation. Finally, it is demonstrated that numerical simulations based on the original model can verify the power limit calculated based on the simplified model.

Adaptive Systems and Controls TC Best Paper Award

Samikshak Gupta, Michigan Technological University

Samikhshak Gupta, a Graduate Student in Mechanical Engineering at Michigan Technological University. He holds a B.Tech degree in Mechanical Engineering from the National Institute of Technology, Jalandhar (2020). With a keen interest in modal analysis, adaptive structures, structural dynamics, signal processing, and computational mechanics, he wants to "blend his learning into an engaging and enjoyable experience."

Hrishikesh Gosavi, Michigan Technological University

Hrishikesh Gosavi is a Ph.D. candidate at Michigan Technological University. He is from Pune, India and completed his undergraduate studies from Pune University in 2018. He came to Michigan Tech in Fall 2019 to pursue an MS in Mechanical Engineering which he obtained in 2021. His areas of interest include modal analysis, data-driven modeling, metamaterials, traveling waves and structural dynamics.

Vijaya V N Sriram Malladi, Michigan Technological University

Dr. Malladi is an Assistant Professor in the Department of Mechanical Engineering-Engineering Mechanics at Michigan Technological University. He obtained his B.Tech degree in Mining Machinery Engineering from the Indian Institute of Technology, Dhanbad, India, in 2011. He then pursued his M.S. and Ph.D. in Mechanical Engineering from Virginia Polytechnic Institute and State University, completing them in 2013 and 2016, respectively. Dr. Malladi's research interests encompass structural dynamics, adaptive structures, data-driven modeling, and modal testing.

Parametric-Feel Algorithm Developing a Parametric Vectorfitting Model for Event Localization in Calibrated Structure

For smart structures, especially in the context of human activity, the force exerted and the location it happened is of significant relevance. This paper revisits and improves the performance in localizing and characterizing an input force with pre-calibrated structures through vibration measurement. The Force Estimation and Event Localization (FEEL) Algorithm have been discussed as a means of calculating the force of an impact and pinpointing its location. Unlike other time-of-flight approaches, FEEL does not require time synchronization, instead using transfer functions between possible impact locations and sensor locations to estimate force and localize impact. However, this approach is limited to locations where transfer functions are available. To overcome this limitation, a rowing hammer test was used to determine Frequency Response Functions (FRFs) at various points on a beam with a uniform rectangular cross-section. The Vector-Fitting algorithm was then used to improve the FRF approximation by

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moving poles to more advantageous locations, enhancing convergence, and lowering noise. Using the curve fitting approach, residues and FRFs were interpolated for additional locations. The extended FEEL algorithm was then used to localize impacts and estimate forces at these additional locations. This method can be used in applications such as tracking customer movement in retail establishments, detecting falls, tracking rehabilitation progress, and estimating building occupancy.

Active Material Technology and Integrated Systems TC Outstanding Contribution Award

Daniel C. Miller, Paragon Space Development Corporation

Mr. Miller is a Thermal Engineer at Paragon Space Development Corporation. His research and development work focuses on thermal radiator design and research for spacecraft, satellite, and human habitat applications. He also works in thermal management system development for complex and extreme environments such as high-flux electronics, satellite thermal control, and extreme heating, ventilation, air conditioning, and refrigeration (HVACR). Mr. Miller earned his B.S. in Mechanical Engineering from Oregon State University and his M.S. in Mechanical Engineering from Colorado School of Mines, specializing in thermal fluid sciences and concentrating solar power.

Connor J. Joyce, Paragon Space Development Corp.

Connor Joyce is a thermal-fluids engineer at Paragon Space Development Corporation in Houston, Texas. He received a BS in Mechanical Engineering with University Honors from the University of Houston. His research focuses on complex multiphysics problems including the thermal behavior of advanced materials, multiphase flow manipulation in microgravity, and the purification of water using ionomer membrane and frost deposition technologies.

Darren Hartl, Texas A&M

Darren Hartl is an Associate Professor at Texas A&M in the Department of Aerospace Engineering. His work bridges the topics of advanced multifunctional material systems and their integration into aerospace platforms and he held previous joint appointments at the Air Force Research Laboratory (AFRL) in the Materials and Manufacturing Directorate and Aerospace Systems Directorate. Dr. Hartl has over 20 years of experience working with multifunctional and morphing structures and has co-authored 200+ technical publications on the topics of active materials modeling, testing, and integration.

Priscilla Nizio, Texas A&M

Priscilla Nizio is a graduate researcher at Texas A&M University. She received a BS in Chemical Engineering from the University of Houston and is currently pursuing a PhD in Aerospace engineering at Texas A&M University. She is a Pathways graduate student trainee in the Crew and Thermal Systems division at NASA Johnson Space Center. Her research focuses on shape memory alloys for thermal control in extreme environments.

Douglas E. Nicholson, The Boeing Company

BIOGRAPHY: Doug Nicholson currently resides as a technical lead engineer at Boeing Research and Technology (BR&T) on the Integrated Vehicle Systems (IVS) team. His current work focuses on the development and transition of smart materials and adaptive structures for space and aeronautical applications. These activities include standards development, material development and processing, design optimization, system integration, and relevant environment to sub and full-scale flight demonstrations. Doug earned his Ph.D. in mechanical engineering and M.S. in aerospace engineering from the University of Central Florida, and B.S. in mathematics and physics from Florida Atlantic University.

Sean Nevin, The Boeing Company

Sean Nevin currently resides as a mechanical system design and analysis engineer at Boeing Research and Technology (BR&T) on the Integrated Vehicle Systems (IVS) team. His current work focuses on the development and transition of smart materials and adaptive structures for space and aeronautical applications. These activities include standards development, material development and processing, design optimization, system integration, and relevant environment to sub and full-scale flight demonstrations. His research interests include designs with smart materials along with structural and thermal computational analysis (FEA). Sean earned his M.S. in aerospace engineering from the University of Texas A&M, and B.S. in mechanical engineering from Loyola Marymount University.

Othmane Benafan, NASA Glenn Research Center

Othmane Benafan is a materials research engineer in the High Temperature and Smart Alloys Branch at NASA Glenn Research Center. He received his Ph.D. in Mechanical Engineering from the University of Central Florida. His research is focused on developing fit-for-purpose shape memory alloys for aeronautics and space applications. He is currently leading multiple teams to design lightweight actuators and morphing structures for NASA. He is currently the immediate past president of the ASM International Organization on Shape Memory and Superelastic Technologies (SMST), and a past-chairman of

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the joint industry-government-academia Consortium for the Advancement of Shape Memory Alloy Research and Technology (CASMART).

Glen S. Bigelow, NASA Glenn Research Center

Glen Bigelow is a materials research engineer at the NASA Glenn Research Center in Cleveland, OH. He received his BS in Mechanical Engineering and his BS and MS in Metallurgical and Materials Engineering from Colorado School of Mines. His research focuses on shape memory alloy material design, processing, and applications in aeronautics and space.

Darrell J. Gaydosh, NASA Glenn Research Center

Darrell Gaydosh was formerly a senior researcher at HX5, LLC.

Shape Memory Alloys for Regulating TCS in Space (SMARTS): System Design and Thermal Vacuum Demonstration

Proceedings of the 51st International Conference on Environmental Systems ICES-2022-291, 10-14 July 2022, St. Paul, Minnesota

Variable-geometry radiators provide variable heat rejection capability, or turndown, to meet variable heat loads and environments, as might be experienced in a Lunar habitat or interplanetary vehicle carrying astronauts. Shape Memory Alloy (SMA) actuation offers lightweight, compact, and rugged methods for passive control of morphing radiators that vary geometry, providing turndown, in response to thermal stimuli. SMAs for Regulating Thermal control systems (TCS) in Space, or SMARTS, is an SMA enabled radiator system with thermal switch for adverse heating protection. SMA wires are conductively coupled to coolant passages, providing thermally responsive actuation to open and close the composite radiator at design temperatures to passively vary heat rejection, ensuring stable coolant outlet temperatures. SMA actuators, conductively coupled to the radiator, respond to adverse heating on the radiator panels by breaking thermal contact between the panel and the coolant passages at design temperatures. SMARTS has been built at a prototype system level and demonstrated in a relevant thermal vacuum (TVAC) environment. Heat rejection comparable to flat panel radiators was demonstrated with the additional benefits of greater turndown than the NASA roadmap target of 6:1 and passive protection to adverse heating conditions. This work summarizes TVAC test results and demonstrates design and analysis methods employed to tune SMA transition temperatures and predict response to thermal and mechanical loads.

Structural Health Monitoring TC Best Paper Award

Jingxiao Liu, Stanford Univ.

Jingxiao Liu is a post-doctoral fellow in the Geophysics Department at Stanford University. He received his Ph.D. in the Department of Civil & Environmental Engineering with a Ph.D. minor in Electrical Engineering at Stanford University. His research focuses on structural health monitoring, smart infrastructure systems, and smart city applications integrating structural dynamics, signal processing, physics-guided machine learning, mobile sensing, and fiber-optic sensing techniques. He received his M.S. in Civil Engineering from Carnegie Mellon University, and his B.S. in Civil Engineering from Central South University, China. He received the Leavell Fellowship on Sustainable Built Environment and various best paper and presentation awards from ASCE, ASME, and ACM conferences.

Susu Xu, Stony Brook Univ.

Susu Xu is an Assistant Professor in the Department of Civil Engineering at Stony Brook University. She received her Ph.D. in Civil Engineering, a Master's in Machine Learning from Carnegie Mellon University, and her bachelor's degree from Tsinghua University. She has been a postdoctoral research fellow at Stanford University and a research scientist at the AI research team in Qualcomm Technologies. Her research focuses on crowdsensing, physics-informed machine learning, and causal Bayesian inference for enabling resilient, effective, and equitable infrastructure systems. She received the Best Paper Award at the IEEE International Conference of Machine Learning and Applications (ICMLA) in 2018, and was the champion of NeurIPS 2018 Adversarial Vision Challenge. She is also the recipient of the 2019 MIT CEE Rising Star and Dowd Fellowship.

Mario Bergés, Carnegie Mellon University

Mario Bergés is a professor in the Department of Civil and Environmental Engineering at Carnegie Mellon University (CMU). He is interested in making our built environment more operationally efficient and robust through the use of information and communication technologies, so that it can better deal with future resource constraints and a changing environment. Currently his work largely focuses on developing approximate inference techniques to extract useful information from sensor data coming from civil infrastructure systems, with a particular focus on buildings and energy efficiency. Dr. Bergés is the faculty co-director of the Smart Infrastructure Institute at CMU, as well as the director of the Intelligent Infrastructure Research Lab (INFERLab). Among recent awards, he received the Professor of the Year Award by the ASCE Pittsburgh Chapter in 2018, Outstanding Early Career Researcher award from FIATECH in 2010, and

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the Dean's Early Career Fellowship from CMU in 2015. Dr. Bergés received his B.Sc. in 2004 from the Instituto Tecnológico de Santo Domingo, in the Dominican Republic; and his M.Sc. and Ph.D. in Civil and Environmental Engineering in 2007 and 2010, respectively, both from Carnegie Mellon University.

Hae Young Noh, Stanford Univ.

Hae Young Noh is an Associate Professor in the Department of Civil and Environmental Engineering at Stanford University. Her research focuses on indirect sensing and physics-guided data analytics to enable low-cost non-intrusive monitoring of cyber-physical-human systems. She is particularly interested in developing structures to be self-, user-, and surrounding-aware to improve users' quality of life and provide safe and sustainable built environments. The results of her work have been deployed in a number of real-world applications from trains, to the Amish community, to eldercare centers, to pig farms. Before joining Stanford, she was a faculty member at Carnegie Mellon University. She received her Ph.D. and M.S. degrees in Civil and Environmental Engineering and her second M.S. degree in Electrical Engineering at Stanford University. She earned her B.S. degree in Mechanical and Aerospace Engineering at Cornell University. She received several awards, including the Google Faculty Research Awards (2013, 2016), the Dean's Early Career Fellowship (2018), the NSF CAREER Award (2017), and various Best Paper Awards from ASCE, ASME, ACM, IEEE, and SEM conferences.

HIERMUD: Hierarchical Muli-Task Unsupervised Domain Adaptation Between Bridges for Drive-By Damage Diagnosis

Structural Health Monitoring 22 (2022), 1941-1968

Monitoring bridges through vibration responses of drive-by vehicles enables efficient and low-cost bridge maintenance by allowing each vehicle to inspect multiple bridges and eliminating the needs for installing and maintaining sensors on every bridge. However, many existing drive-by monitoring approaches are based on supervised learning models that require massive labeled data from every bridge. It is expensive and time-consuming, if not impossible, to obtain these labeled data. Furthermore, directly applying a supervised learning model trained on one bridge to new bridges would result in low accuracy due to the shift between different bridges' data distributions. Moreover, when we have multiple tasks (e.g., damage detection, localization, and quantification), the distribution shifts become more challenging than having only one task because different tasks have distinct distribution shifts and varying task difficulties. To this end, we introduce HierMUD, the first Hierarchical Multi-task Unsupervised Domain adaptation framework that transfers the damage diagnosis model learned from one bridge to a new bridge without requiring any labels from the new bridge. Specifically, our framework learns a hierarchical neural network model in an adversarial way to extract features that are informative to multiple tasks and invariant across multiple bridges. To match distributions over multiple tasks, we design a new loss function based on a newly derived generalization risk bound to adaptively assign higher weights to tasks with more shifted distributions. To learn multiple tasks with varying task difficulties, we split them into easy-to-learn and hard-to-learn tasks based on their distributions. Then, we formulate a feature hierarchy to utilize more learning resources to improve the hard-to-learn tasks' performance. We evaluate our framework with experimental data from 2 bridges and 3 vehicles. We achieve up to 2X better performance than baseline methods, including average accuracy of 95% for damage detection, 93% for localization, and 0.38 lbs mean absolute error for quantification.

STRUCTURAL HEALTH MONITORING TC RUNNER-UP BEST PAPER AWARD

Long Wang California Polytechnic State University

Dr. Long Wang is an Assistant Professor in Structural Engineering in the Department of Civil and Environmental Engineering at the California Polytechnic State University, San Luis Obispo. Prior to joining Cal Poly, he received his M.S. in Civil Engineering and M.S. in Mechanical & Aerospace Engineering from the University of California Davis, as well as his Ph.D. in Structural Engineering from the University of California San Diego, all under the supervision of Prof. Ken Loh.

Wei-Hung, Chiang National University of Science and Technology, Taiwan

Dr. Wei-Hung Chiang is a Professor in the Department of Chemical Engineering at the National University of Science and Technology in Taiwan. He has broad scientific and engineering interests that encompass functional material design, synthesis and processing, device fabrication and integration. His work has been recognized by scientific publications in high impact journals such as Nature Materials, ACS NANO, and Advance Materials, by mainstream media such as Forbes Magazine and ScienceDaily, and by international conferences (e.g., MRS, AICHE, ECS, and AVS).

Kenneth J. Loh, UC San Diego

Dr. Ken Loh is a Professor and was the former Vice Chair (2018-2021) of the Department of Structural Engineering at UC San Diego. He is the

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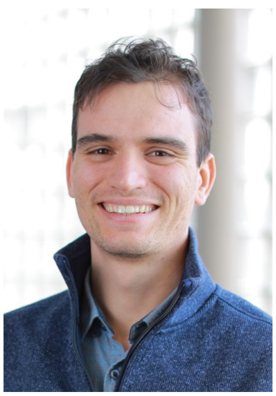
Director of the Active, Responsive, Multifunctional, and Ordered-materials Research (ARMOR) Lab and is the Director of the Jacobs School of Engineering, Center for Extreme Events Research (CEER). He is also an affiliate faculty member of the Materials Science & Engineering Program. His research interests are in multifunctional and stimuli-responsive materials, tomographic imaging techniques, wearable sensors, active metamaterials, and soft material actuators applied towards solving problems related to human performance, structural sustainment, and human-structure interactions.

Topological Design of Strain Sensing Nanocomposites

Scientific Reports 12 (2022), 9179

High-performance piezoresistive nanocomposites have attracted extensive attention because of their significant potential as next-generation sensing devices for a broad range of applications, such as monitoring structural integrity and human performance. While various piezoresistive nanocomposites have been successfully developed using different material compositions and manufacturing techniques, current development procedures typically involve empirical trial and error that can be laborious, inefficient, and, most importantly, unpredictable. Therefore, this paper proposed and validated a topological design-based methodology to strategically manipulate the piezoresistive effect of nanocomposites to achieve a wide range of strain sensitivities without changing the material system. In particular, patterned nanocomposite thin films with stress-concentrating and stress-releasing topologies were designed. The strain sensing properties of the different topology nanocomposites were characterized and compared via electromechanical experiments. Those results were compared to both linear and nonlinear piezoresistive material model numerical simulations. Both the experimental and simulation results indicated that the stress-concentrating topologies could enhance strain sensitivity, whereas the stress-releasing topologies could significantly suppress bulk film piezoresistivity. ■

STUDENT SPOTLIGHT



Timothée Cullaz, University of Toledo ▪ Timothée Cullaz, an exemplary student at the forefront of research within the Shape Memory Alloy, field, stands out for his pioneering work in a Dual PhD program between the University of Toledo and the Ecole Nationale d'Ingénieurs de Brest (ENIB), France, with an expected graduation in May 2024.

His research delves into the durability of laser powder bed fusion NiTi alloys, employing thermal analysis under cyclic loading to unlock new understandings of material behavior. Timothée's work is especially noteworthy for the discovery of high-cycle fatigue mechanisms in NiTi alloys, marking a major advancement in the reliability and utility of smart materials. The groundbreaking outcomes of his study, particularly through self-heating behavior analysis, offer a quick and effective method for assessing fatigue, paving the way for accurate predictions of the SN curves in LPBF-NiTi alloys.

This contribution has a significant impact on the future development of adaptative materials and structures. His findings promise substantial advancements in the engineering and application of smart materials, showcasing the profound capabilities of young researchers in driving innovation and beyond. ■

Diaa Zekry, Princeton University ▪ Diaa Zekry is a doctoral student at Princeton University. His research focuses on developing bio-inspired flight control systems, specifically for unconventional flight systems such as blended wing body aircraft. Diaa has been working closely with the TRINA on their mothership project, which focuses on harvesting wind energy from high-altitude jet streams using an airborne inflatable kite. During his doctoral research, Diaa used wind tunnel experiments to develop a feather-inspired control effector that can provide enough roll and yaw control for the kite. He explored various wing geometries and feather-inspired control effector configurations. This portion of Diaa's work resulted in a publication investigating the interaction between effectors on the wing's upper and lower surface, showing that the optimal configuration differs from what is typically designed for tailless aircraft but is similar to observations of feather deployment patterns during bird flight. Recently, during an internship with TRINA in the summer of 2023, Diaa designed flight maneuvers that enabled the identification of the aerodynamic model of the kite and implemented such maneuvers both in simulations and during flight testing. ■

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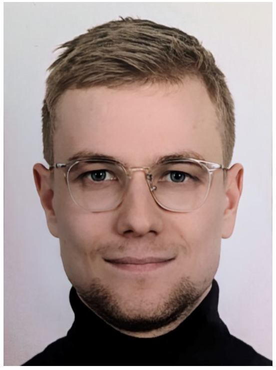

Vincent von Oertzen, TU Freiberg ▪ Vincent von Oertzen will be completing his Ph.D. studies in Mechanical Engineering at TU Bergakademie Freiberg, Germany, in the fall of 2024, with a focus on theoretical and computational mechanics. He embarked on this journey in 2019 by joining the Institute of Mechanics and Fluid dynamics under the guidance of Prof. Bjoern Kiefer, after graduating with a M.Sc. degree top of his class, for which he was awarded the university's Georgius-Agricola Medal. His current research focuses on the modeling of phase transforming solids considering variable scale separations. These are complex material systems, such as shape memory alloys, TRIP matrix composites etc., whose extraordinary behavior is driven by evolving microstructures under thermomechanical loading. His approach centers on the observation that whereas the continuum mechanical modeling of these materials on specific scales has been heavily investigated over the last decades, a proper notion for consistently transferring existing models between arbitrary scales is still not fully developed. Vincent has already published his work in prestigious international journals, such as Shape Memory and Superelasticity, Proceedings in Applied Mathematics and Mechanics, as well as in the ASME SMASIS Proceedings after presenting at the ASME 2023 SMASIS conference. In 2022, his paper Unequally and Non-linearly Weighted Averaging Operators as a General Homogenization Approach for Phase Field Modeling of Phase Transforming Materials was chosen as one of six Editor's Choice Articles for the Shape Memory and Superelasticity journal. In 2021, Vincent was nominated and elected for a three-year GAMM Juniors position, that promotes and connects excellent young researchers within the Association of Applied Mathematics and Mechanics in Germany. In addition to his research, Vincent is actively involved in the teaching of Bachelor's and Master's engineering students at Technische Universität Bergakademie Freiberg and has supervised several theses in the field of continuum solid mechanics. ■

Brianne Hargrove, Penn State University ▪ Brianne Hargrove is a fourth year PhD student in Mechanical Engineering and Alfred P. Sloan Scholar at Penn State University. She obtained a Bachelor of Science in Mechanical Engineering and a minor in Spanish at Penn State in 2019. Her current research involves the design optimization of compliant mechanisms made from smart and flexible materials, such as superelastic Nitinol and highly elastic thermoplastics. In designing for additive manufacturing, the selection of material and geometric parameters is informed by trial-and-error and is often limited to linear-elastic materials. This prompted her research of an optimization-based analytical model to inform novel types of nonlinear-elastic, adaptive and shape-morphing structures. Brianne also was a teaching assistant that helped develop new undergraduate lab courses, which aimed to reinforce engineering topics in a more applied way. Brianne greatly values the role that mentorship has played in her professional growth and leadership. In 2022, she served as a Research Lead Mentor for the EnviRonMentors program to underrepresented high school students and mentored an international student as part of the Lumiere Education research summer program in 2023. She hopes to continue to make engineering more accessible and exciting to underrepresented youth in her engagement with mentorship and outreach. ■

Tan Pan, Pennsylvania State University ▪ Tan Pan is a Ph.D. candidate in Mechanical Engineering at the Pennsylvania State University. She earned her B.S. in Petroleum Engineering in 2017 and her M.S. in Manufacturing Engineering in 2020 from Missouri University of Science and Technology. Her research focuses on programming, design, and optimization of smart materials, especially for magneto-active elastomers (MAE), which can respond to non-contact magnetic fields. Different optimization algorithms are developed including genetic algorithms and machine learning-based approaches to optimize the adaptive structures with MAE. Her works can be potentially applied to biomedical applications requiring patient-specific designs such as orthotics, and non-invasive ventilation masks. In addition, her expertise also involves metal additive manufacturing and material characterization. She also has experience in the design of experiments and statistical analysis. Mentoring skills were developed by being a teaching assistant. ■

Yupei Jian, The University of Auckland ▪ Yupei Jian received his doctoral degree at the University of Auckland, New Zealand in December 2023.

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He worked as a research assistant at the Hong Kong University of Science and Technology before assuming his current position as an Assistant Professor at Southwest Jiaotong University, China.

During his PhD, he concentrated on developing intelligent piezoelectric metamaterial systems. he designed various non-uniform piezoelectric metamaterials that could significantly enhance vibration attenuation performance; With theoretical modeling, numerical simulation and experimental investigation, his recent work reported an adaptive metamaterial system based on digital circuitry that could automatically tailor the vibration attenuation region with the awareness of vibration source spectra (frequency sweep, narrowband or broadband). This breakthrough led to a paper being collected by the journal Smart Materials and Structures as the Highlights of 2023, a distinction given to only 12 regular articles that year.

His research contributions have resulted in the publication of 6 top SCI papers as the first author (5 Q1 and 1 Q2), including one ESI highly cited paper. In addition, he has presented 4 conference papers at influential international conferences in the field of adaptive structures and vibration control, such as SMASIS (2020) and Inter-noise (2023). ■