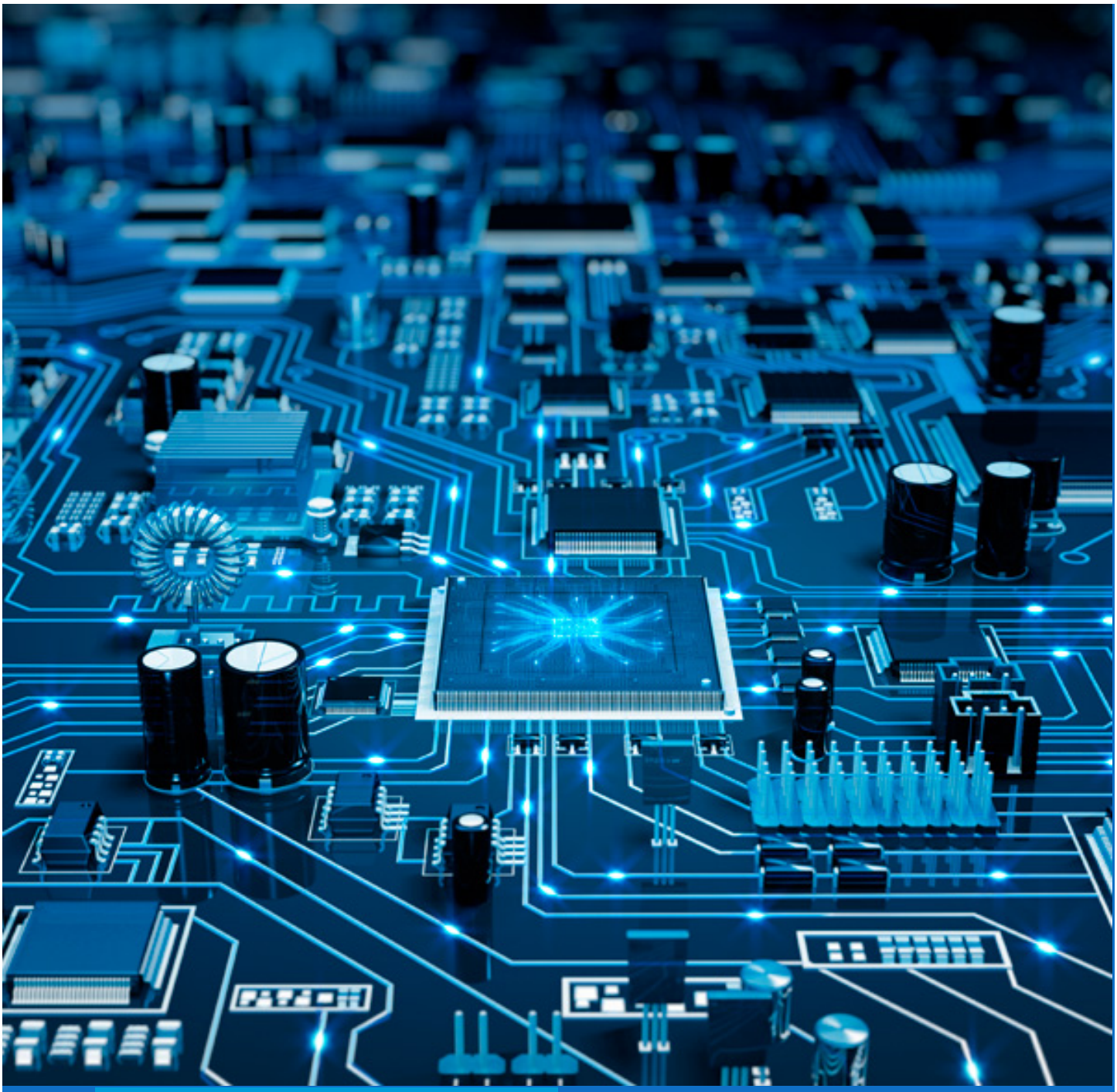


2022 University Technology Showcase

April 21, 2022

Hosted by CEIS and the CoE in Data Science at the University of Rochester

The Role of the Arts and Innovation in Revitalizing Downtown

Welcome

Dear Colleagues,

After a pandemic-caused hiatus in 2020 and a virtual event in 2021, we are absolutely delighted to welcome you to the Memorial Art Gallery for this year's *in-person* University Technology Showcase! This annual event is co-sponsored by the Center for Emerging and Innovative Sciences (CEIS) and the Center of Excellence (CoE) in Data Science, two New York State funded Centers at the University of Rochester. The main goal of the Showcase is to help build and expand connections among industry professionals and academic researchers working on a variety of technology areas including biomedicine, data science, optics, imaging, photonics, sensors, acoustics, materials, and many others.

This year's event will feature a keynote panel session on the role of arts and innovation in revitalizing downtown Rochester. The panelists are Rachel Roberts, Director of the Institute for Music Leadership at the Eastman School of Music; Victoria Van Voorhis, founder and CEO of Second Avenue Learning; and James Senall, President of NextCorps. We are looking forward to a stimulating discussion!

The keynote session will be followed by two parallel events from 2-5 pm; the first being a poster session featuring technology presentations and exhibitor displays from area universities, organizations, and researchers. We hope that discussions in this event will lead to continued interactions that will enable companies to tap into the wealth of technology and expertise available at our institutions of higher education to create regional job growth and economic expansion.

The second event, which is new this year, is the Western New York Augmented and Virtual Reality (AR/VR) Mini-Conference. This event is organized and co-chaired by PhD students from the AR/VR PhD training program at the University of Rochester. Aiming to bring together AR/VR researchers and professionals, the mini-conference will feature talks on immersive technologies by leading experts from industry and academia, as well as brief PhD student introductions to create networking opportunities. This event will be live-streamed for remote participation.

Through the University Technology Showcase and other initiatives, CEIS and the CoE in Data Science aim to foster industry-university collaboration and technology transfer in NY. Both Centers provide NYS matching funds for company-sponsored research at NY universities. The CoE in Data Science also provides full funding for industry-academia collaborations without the requirement of company sponsorship. The CoE in Data Science also funds student internships at small companies and startups in NY. We sponsor workshops and seminars that bring people from industry and academia together to discuss opportunities for technology-driven economic development. Please feel free to contact us to learn more about these programs and to discuss ways that CEIS and the CoE in Data Science can help your enterprise.

Warm Regards,

Mark Bocko, PhD
Director, CEIS

Mujdat Cetin, PhD
Director, COE in Data Science

AGENDA

1:00 P.M. Welcome from Centers Directors Mark Bocko and Mujdat Cetin

1:05 P.M. Welcome Remarks from Assemblymember Harry Bronson

1:10 P.M. "The Role of the Arts and Innovation in Revitalizing Downtown" Panel Discussion with guests Rachel Roberts (Eastman School of Music), Jim Senall (NextCorps), and Victoria Van Voorhis (Second Avenue Learning)

1:35 P.M. Q&A moderated by Paul Ballentine

2:00 P.M. Open Poster Session/Exhibitor Tables in the Ballroom

(please check out the posters and vote for your favorite before 4:00 P.M. – ballot may be found in your registration packet)

and concurrently

Western New York AR/VR Mini-Conference in the Auditorium

4:15 P.M. Winning Poster Announced

University Technology Showcase Speakers

Harry Bronson was first elected to the New York State Assembly in November 2010. The 138th District includes parts of the City of Rochester and the suburban and rural towns of Henrietta and Chili. Before being elected to the state Assembly, he served in the Monroe County Legislature and held leadership positions during his entire tenure, including Minority Leader. As the Chair of the Assembly Standing Committee on Economic Development, Job Creation, Commerce and Industry, Harry oversees economic development and business regulation throughout New York State. Additionally, he is the Assembly's Legislative Liaison to the Finger Lakes Regional Economic Development Council (FLREDC).

Rachel Roberts serves on the faculty of the *Eastman School of Music of the University of Rochester* as the Associate Professor of Music Leadership and Graduate Degree Program Director and as the Director of the *Institute for Music Leadership*. Currently, she teaches and leads Eastman's new *Master of Arts in Music Leadership* degree program. Roberts has held leadership positions in a variety of organizations, including the *Atlanta Symphony Orchestra* where she served as its first Director of Strategic Planning Engagement.

EASTMAN INSTITUTE FOR MUSIC LEADERSHIP

James Senall serves as President of *NextCorps* and has launched several new initiatives within the company including a software accelerator program, a clean tech accelerator, a statewide Entrepreneur-in-Residence program, and an optics, photonics, and imaging accelerator. He has also served in various board roles including Chairman of the *Business Incubator Association of New York State*, board member of the *New York State Economic Development Council*, board member of *Adarza BioSystems*, Executive Committee member of the *University of Rochester's Technology Development Fund* and Investment Committee member of *Launch NY's seed capital fund*.

nextcorps
forward faster

Victoria Van Voorhis is the founder and CEO of *Second Avenue Learning,* an award-winning education technology company based in Rochester. As a leader in the development and design of serious games, software, and interactives, Second Avenue Learning blends pedagogy and technology to serve the K-12, higher education, healthcare, and corporate markets. Van Voorhis has been a thought-leader in the education and technology industry for over a decade. She has had the honor of presenting for both *TEDx* and *Google Tech Talks* and is the President of the Digital Game Industry Association of Rochester.

second avenue
reimagine learning

Western New York Augmented and Virtual Re
(AR/VR) Mini Conference 2022
April 21 from 2pm-5pm at Memorial Art Gall

ARVR Mini Conference Begins after Key Note Speaker in Gallery Auditorium

Co-chairs: Eleni Patelaki, Qinqin Xiao, and Neil Zhang

2:20 – 2:45 **Jim Poore**, CEO, and Co-Founder, Immersitech
(20 min. presentation with 5 min. Q&A) (Host: Neil Zhang)

2:45 – 3:10 **Yunbo Zhang**, Assistant Professor Dept Industrial & Systems Engineering Kate Gleason College of Engineering, Rochester Institute of Technology
(20 min. presentation with 5 min. Q&A) (Host: Qinqin Xiao)

3:10 – 3:20 Mini-presentations by AR/VR trainees: Jin Dou, Ali Vosoughi, Erin Driscoll, and Qinqin Xiao (Host: Neil Zhang)

3:20 – 3:30 Networking & Break

3:30 – 3:55 **Yuhao Zhu**, Assistant Professor, Department of Computer Science, University of Rochester *(20 min. presentation with 5 min. Q&A)* (Host: Qinqin Xiao)

3:55 – 4:20 **Paul Travers,** President and CEO, Vuzix
(20 min. presentation with 5 min. Q&A) (Host: Eleni Patelaki)

4:20 – 4:45 **Qi Yang,** PhD Candidate, Research Presenter for (Saleh Kalantari, Assistant Professor), Human Centered Design, College of Human Ecology, Cornell University *(20 min. presentation with 5 min. Q&A)* (Host: Eleni Patelaki)

4:45 PM Program Close, Final Remarks by *Western New York (AR/VR) Mini Conference* Co-chairs

AR/VR Mini-Conference will be available on Zoom
https://rochester.zoom.us/j/93151555495?pwd=bXljZVljQWRlUTVmMFBuWUlHMnBOQT09

Meeting ID: 931-5155-5495
Passcode: roc

The Western New York ARVR portion of the conference has been partially supported by the National Science Foundation (NSF) under grant DGE-1922591

Western NY AR/VR Mini-Conference Speakers

Jim Poore

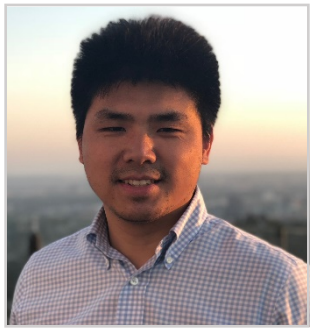
CEO & Co-Founder
Immersitech
https://immersitech.io/about/

Jim has over 20 years' experience in the development and global deployment of advanced technology products with an emphasis on great customer experiences. Career highlights include holding executive roles in strategic marketing, global product management/development, M&A evaluation/integration, and customer experience oversight for global communication and technology leaders, including Level 3 Communications (now Lumen), Global Crossing Ltd., Silicon Graphics/Cray Research and Soleo Communications. Jim is excited to highlight Immersitech, a local technology start-up focused on machine learning based audio software tools designed to improve the overall quality and engagement levels for providers in the business communications, distance learning and social entertainment markets.

Yunbo "Will" Zhang, Ph.D.

Assistant Professor
Dept of Industrial & Systems Engineering
School of Information (affiliated)
Rochester Institute of Technology
https://www.rit.edu/directory/ywzeie-yunbo-zhang
https://www.willyunbozhang.com/

Yunbo "Will" is an Assistant Professor in the Department of Industrial & Systems Engineering at Rochester Institute of Technology, where he is also affiliated with the School of Information (iSchool). He serves as an associated editor of Journal of Intelligent Manufacturing, and the topics board member of Journal of Manufacturing and Materials Processing. His research is at the intersection of mechanical/industrial engineering and computer science, driven by engineering design, geometric modeling, computer vision, artificial intelligence, and human-computer interaction. Specifically, His current research interests include augmented reality-based human-robot interaction, virtual reality-based manufacturing training, machine learning for understanding manufacturing knowledge and skills, and gamification for training. Please visit his personal website at https://www.willyunbozhang.com/ for more details.



Yuhao Zhu, Ph.D.

Assistant Professor
Department of Computer Science – University of Rochester
https://www.cs.rochester.edu/people/faculty/zhu_yuhao/index.html

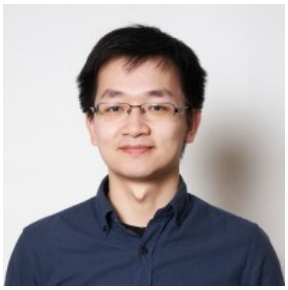
Yuhao is Assistant Professor in the Computer Science Department and an affiliated faculty in the Goergen Institute for Data Science at University of Rochester. Yuhao was awarded his Ph.D. at University of Texas at Austin, and previously held visiting researcher positions at Arm Research (arm.com) and Harvard University. Yuhao's current research interests are applications, algorithms, and systems for visual computing as well as safe computing systems in the AI era. His webpage at https://www.cs.rochester.edu/horizon/ has more to offer!

Paul Travers

President and CEO
Vuzix

Paul is the founder of Vuzix. He has served as President and Chief Executive Officer since 1997; and as a member of the Board of Directors. Prior to Vuzix, Mr. Travers founded both e-Tek Labs, Inc. and Forte Technologies Inc. Paul's vision has been a driving force behind the development of Vuzix products and positioning in the marketplace. With unsurpassed experience in the virtual reality and virtual display fields, Mr. Travers is a nationally recognized industry expert.

Presenting for Professor Saleh Kalantari



Qi Yang

Ph.D. student/Researcher
Human Behavior & Design
Design, Department of Design & Environmental Analysis,
College of Human Ecology
Cornell University https://www.yang-qi.me/

Qi is a Ph.D. student at Professor Saleh Kalantari's DAIL Lab since 2020. He has extensive working knowledge of architecture, design theory, and design thinking along with visual culture and communications. He is currently researching how humans find ways in unfamiliar buildings and develop cognitive agents to help designers evaluate their designs in the early stages. He is passionate about researching and developing tools that enhance designers' creativity and decision-making.

Saleh Kalantari, Ph.D.

Assistant Professor, Human Centered Design,
Department of Design
& Environmental Analysis, College of Human Ecology, Cornell University

Dr. Kalantari is an assistant professor at Cornell University's Department of Human Centered Design. He is the director of the Design and Augmented Intelligence Lab (DAIL) at Cornell, where his research group investigates human–technology partnerships in the design process, and the resulting opportunities for innovation and creativity. Dr. Kalantari's work promotes generative-design approaches and the adoption of new design technologies to improve the relationship between people and their created environment. He takes an interdisciplinary approach to developing innovative AI-aided design tools using biometric sensory data (EEG sensors, heart-rate monitors, motion-capture technology, etc.) to more effectively understand human responses to architectural intervention during the design process.

Technology Supporters

Ain Center for Entrepreneurship / Technical Entrepreneurship and Management (TEAM) M.S. Program

Center for Advanced Ceramic Technology (CACT) at Alfred University

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FLCC Smart Systems Technologies

FLX AI, Inc.

Goergen Institute for Data Science

MARL Startup Studio

Monroe County Finger Lakes PTAC

NYS Science & Technology Law Center

Parverio Inc.

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Studio X, River Campus Libraries

TechRochester

Voice Biometrics Group

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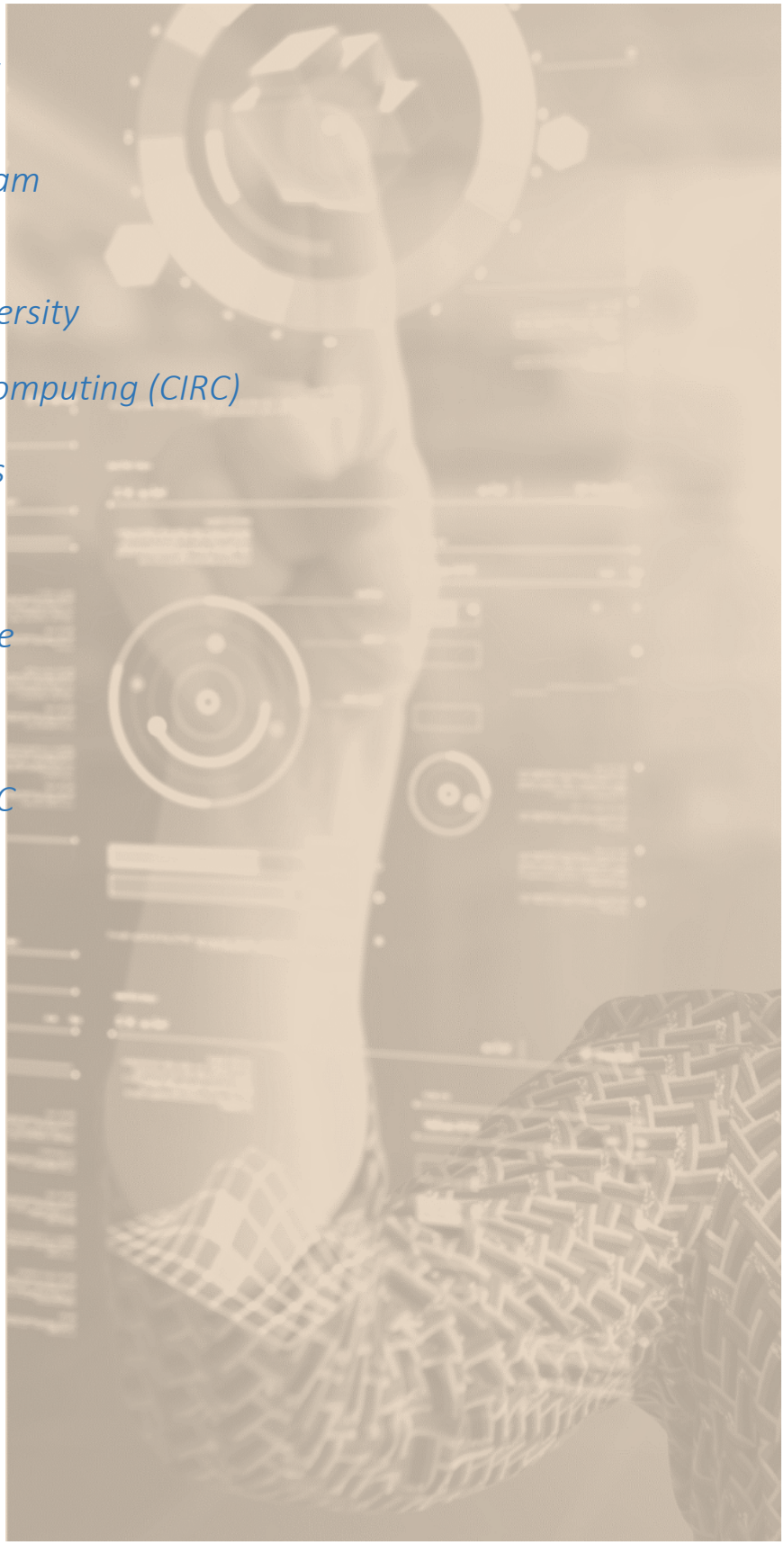

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Carestream Health	*Zeljko Ignjatovic Krystel Huxlin, Wayne Knox, Susana Marcos*		
Clerio Vision, Inc.		Monro, Inc.	*Mitch Lovett, Yufeng Huang*
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Kitware, Inc.		Voice Biometrics Group, LLC	*Zhiyao Duan*

University Technology Showcase Poster Session

AUGMENTED REALITY/VIRTUAL REALITY (1 -3)

1 Application of Augmented Reality, Virtual Reality, and Data Science in Education

Qinqin Xiao
University of Rochester, Rochester, NY

This poster is based on the author's research over the last two years, with a particular emphasis on the application of augmented reality and virtual reality to novel users and K-12 education. The author's various research innovations and attempts to develop systematic STEM curricula cover systematic STEM curricula that incorporate emerging techniques such as augmented/virtual reality-assisted education, occupational training that incorporates cognition awareness, and AI-assisted data science in elementary and secondary education. Three specific research were conducted: Immersive Virtual Reality Training with Error Management for CNC Milling Set-up, System Design of A Human-centered Augmented Reality Robot Programming Interface with Cognition Awareness, and Data Analysis in Machine Learning for K-12 Students.

2 Augmented Reality-enhanced Human-Robot Interaction

Wenhao Yang, Qinqin Xiao, Zhuorui Yong, Yunbo Zhang
Rochester Institute of Technology, Rochester, NY

To solve the problems of complex robot programming tasks, we propose an Augmented Reality (AR) based human-robot interface for planning a collision-free path in a complex environment. Current robot programming methods usually require a high level of experience in robot programming, the time-consuming 3D modeling of the working environment for collision detection, and a tedious and inefficient re-planning to adapt to the environment or task changes. In order to address these problems, an end-to-end AR human-robot interface is proposed, which provides a new affordance to users by enabling them to plan the path in the AR environment. A set of user-interactive tools allow users to define and edit waypoints as the high-level guidance and the direct inputs for the toolpath planning package, Kinematics and Dynamics Library (KDL). With the fast sensing of the workspace and accurate rendering, an in-situ simulation module is utilized for collision check and verification by the users' perception. Users will repeat the process of 1) waypoints definition and editing, and 2) the collision

checking and path feasibility verification until a satisfactory path is obtained. Preliminary testing is conducted in a use case with complex obstacles to verify the effectiveness and the efficiency of the proposed interface.

3 Utilizing Virtual Reality for Pre-Operative Distress in Adults and Children: A Pilot Study

Daniela Martinez B.A., Kate Ackerman M.D., MBA, , M.Sc. Cristiano Tapparello, Ph.D., Michael Hasselberg, M.S., Ph.D., Antonia Kolokythas, D.D.S , Wendi Cross, Ph.D.
University of Rochester, School of Medicine & Dentistry, Rochester, NY

Background: Anxiety and distress have shown to exacerbate the experience of pain (Ploghaus et al., 2001) and increase sedatives and opiates dosages required before, during, and after surgical procedures (Ina & Zeev, 1999). Virtual reality (VR) is a relatively new intervention that has been used to promote relaxation and manage perioperative stress by using the principle of distraction (Eijlers et al., 2019; Ganry et al., 2018).
Primary objective: To investigate if VR reduces perioperative anxiety levels in children and adults across the departments of Oral and Maxillofacial Surgery and Pediatric Procedural Care Ambulatory Centers at the University of Rochester Medical Center/ Strong Memorial Hospital in Rochester, NY.
Method: We will perform a single-center feasibility and acceptability pilot study examining the impact of VR on perioperative distress in pediatric and adult patients by collecting data from 60 children and 30 adults in the span of six months. We will measure pre-operative anxiety using a verbal rating of anxiety for adults during three different time points. For children, we will use the mYPAS Form as a reliable observational measure with four behavior domains. Furthermore, we plan to assess patients' perception of the VR intervention at the end of the procedure using the Acceptability Intervention Measure (AIM). At the end of the study, we will use a Feasibility of Intervention Measure (FIM) for medical staff at each department to assess their perception of the VR intervention and its ability to be successfully implemented in the hospital workflow.

BIOMEDICAL TECHNOLOGY (4 – 7)

4 Disposable Point-of-Care Photonic Diagnostics: Application to Cardiac Biomarkers

Daniel J. Steiner, Michael R. Bryan, Benjamin L. Miller
University of Rochester Medical Center, Rochester, NY

Medical diagnostics play a critical role in healthcare. Patients and physicians require abundant and detailed information to assess health status and treatment. Currently, the process to obtain this information is complicated and slow: a patient sample is obtained and sent to a centralized location for analysis, with the results reported back to the care provider in a few days. To simplify this process, we have developed a Point-of-Care photonic diagnostic system. We use photonic biosensors combined with passive microfluidics to create a fast, quantitative, and multiplex system with readout times of 10 minutes or less directly at the Point-of-Care. This platform eliminates the need for central laboratory analysis, drastically reducing the sample collection to readout time. Additionally, we can test a single sample for many analytes of interest. The initial targets we focus on are C-Reactive Protein and cardiac Troponin I, biomarkers that are used to diagnose and treat overall cardiac health and acute myocardial infarction. These markers are well suited for future pilot studies in urgent care centers and emergency departments.

5 Non-diffractive Acoustic Radiation Force Push Sequences for Shear Wave Viscoelastography

Siladitya Khan, Soumya Goswami, Fan Feng and Stephen McAleavey

Department of Biomedical Engineering, Department of Electrical & Computer Engineering, Rochester Center for Biomedical Ultrasound, Goergen Institute for Data Science, University of Rochester, Rochester, NY

This project develops a noninvasive ultrasound-based imaging modality, which will be applied to assess the viscoelastic properties of hepatic fibrosis. It will be used to monitor in situ changes in biomechanical properties associated with chronic liver injury. Ultrasound being a preferred choice in clinical assessments has been established as an effective modality for monitoring fibrosis progression in patients. Biological tissues being predominantly viscoelastic exhibit frequency dependent shearwave speed and attenuation. Most elastography methodologies estimate the group speed of shear waves but refrain from estimation or measurement of the frequency dependence of shear wave speed or attenuation. Previous studies in our lab have shown, that shear wave propagation in a medium is itself a function of the Acoustic Radiation Force (ARF) push beam geometry and duration. We propose to develop a robust viscoelastic estimator that accounts for variation in excitation and track beam, and that can capture viscosity changes within the tissue based on local dynamics of the propagating shear wave. The overarching aim is to generate maps of the viscoelastic material properties from point-to-point analysis of particle displacement profiles in a parametric fitting fashion. The technology developed in this research program can be easily implemented on

diagnostic ultrasound scanners with minor modifications, with the aim of improving diagnostic accuracy of elastography in chronic liver diseases.

6 Pulsed Terahertz Time Domain Spectroscopy (TDS) of Paraffin-Embedded Pancreatic Ductal Adenocarcinoma (PDAC)

Debamitra Chakraborty, Bradley N Mills, Genyu Chen, Scott A Gerber, Roman Sobolewski
University of Rochester, Rochester, NY

We develop a pulsed terahertz spectroscopy-based imaging technique to study paraffin-embedded murine pancreatic ductal adenocarcinoma (PDAC) tissues. We employ a novel maximum-likelihood estimation (MLE)-based parameter extraction method to map terahertz markers namely refractive index and absorption coefficient which can reflect the tissue characteristics enabling unbiased and reproducible THz measurements. We report a well-resolved differences between the tumor and healthy pancreas along with an enhanced absorbance in tumor tissue compared to its healthy counterpart. Additionally, we probe untreated and stereotactic body radiotherapy (SBRT) treated PDAC tissue to measure degree of cytotoxic responsivity to such therapies.

7 Super-Resolution Ultrasound Method for Transcranial Brain Imaging

Teghan Murray, Bo Wen, and Zeljko Ignjatovic
University of Rochester, Rochester, NY

The research goal of this collaborative work is to explore and demonstrate the use of sub-MHz ultrasound frequencies in combination with super-resolution image reconstruction methods for transcranial brain imaging with sub-millimeter resolution capability. Low-frequency ultrasound allows higher penetration with a possibility of traversing skull layers with reduced losses. Before tissue imaging is commenced, the proposed method first determines an optimal excitation frequency by measuring echoes from skull layers in response to a range of frequencies (e.g., 300 kHz to 800 kHz). During the subsequent imaging procedure, the received echoes from brain tissue are then fit to the imaging model in a least-square sense penalized by a mixed L1 and L2-norm to estimate reflectance coefficients from the brain tissue and recover resolution losses due to the use of frequencies lower than those traditionally used in standard medical ultrasound. The proposed method can increase the imaging resolution up to an order of magnitude as compared to traditional B-mode ultrasound. Preliminary results show that there is a great potential in the proposed method, as it can increase the imaging resolution to accommodate the use of sub-MHz frequencies for transcranial imaging of brain tissue. This method promises to allow for the real-time ultrasound imaging of the human brain for a wide clinical impact, especially in the point-of-care diagnostics of the stroke-related hemorrhaging.

DATA SCIENCE (8 – 13)

8 A Data-Driven Methodology for Considering Feasibility and Pairwise Likelihood in Deep Learning Based Guitar Tablature Transcription Systems

Frank Cwitkowitz, Jonathan Driedger (Chordify), and Zhiyao Duan
University of Rochester, Rochester, NY

Guitar tablature transcription is an important but understudied problem within the field of music information retrieval. Traditional signal processing approaches offer only limited performance on the task, and there is little acoustic data with transcription labels for training machine-learning models. However, guitar transcription labels alone are more widely available in the form of tablature, which is commonly shared among guitarists online. In this work, a collection of symbolic tablature is leveraged to estimate the pairwise likelihood of notes on the guitar. The output layer of a baseline tablature transcription model is reformulated, such that an inhibition loss can be incorporated to discourage the co-activation of unlikely note pairs. This naturally enforces playability constraints for guitar, and yields tablature which is more consistent with the symbolic data used to estimate pairwise likelihoods. With this methodology, we show that symbolic tablature can be used to shape the distribution of a tablature transcription model's predictions, even when little acoustic data is available.

9 Generalizing Voice Anti-spoofing to Unseen Synthetic Attacks and Channel Variation

You Zhang, Fei Jiang, Ge Zhu, Xinhui Chen, Zhiyao Duan
University of Rochester, Rochester, NY

Automatic Speaker Verification (ASV) systems aim to verify a speaker's claimed identity through voice. However, voice can be easily forged with replay, text-to-speech (TTS), and voice conversion (VC) techniques, which may compromise ASV systems. Voice anti-spoofing is developed to improve the reliability of speaker verification systems against such spoofing attacks. One main issue of voice anti-spoofing systems is its generalization ability to unseen synthetic attacks, i.e., synthesis methods that are not seen during training of the anti-spoofing models. We propose one-class learning, where the model compacts the distribution of learned representations of bona fide speech while pushing away spoofing attacks to improve the results. Another issue is the robustness to variations of acoustic and telecommunication channels. To alleviate this issue, we propose channel-robust training strategies, including data augmentation, multi-task learning, and adversarial learning. In this chapter, we analyze the

two issues within the scope of synthetic attacks, i.e., TTS and VC, and demonstrate the effectiveness of our proposed methods.

10 Identify Hidden Biases of AI Algorithms via Human-Machine Collaboration

Zhiheng Li, Anthony Hoogs, Chenliang Xu
University of Rochester, Rochester, NY

AI algorithms have been found to learn biases from data. Therefore, it is urgent and vital to identify biases in AI algorithms. However, the previous bias identification pipeline overly relies on human experts to conjecture potential biases (e.g., gender), which may neglect other underlying biases not realized by humans. To help human experts find the AI algorithms' biases better, we study a new problem—discovering unknown biases of image classifiers. We propose two novel methods to tackle this challenging problem. In the first approach, we use synthesized images to surface unknown biases. For example, by synthesizing images with the same face under different lighting conditions, we show that the gender classifier's predictions vary dramatically for these synthesized images even if the gender of the faces does not change. Our second method directly estimates the bias labels for real images, revealing many unknown biases that humans may not preconceive. For instance, we found that the gender classifier predicts "male" when the input female face has a small "visible hair area" (e.g., ponytail or bun). Our work enables many down-stream applications, such as data auditing, unsupervised debiasing, and bias evaluation.

11 Learning to Aggregate and Refine Noisy Labels for Visual Recognition

Wei Zhu, Zihe Zheng, Haitian Zheng, Hanjia Lyu, Jiebo Luo
University of Rochester, Rochester, NY

More challenging visual recognition tasks such as fine-grained object recognition and image sentiment analysis has received increasing attention in recent years. However, dataset quality is a concern that poses a severe threat to data-driven models, especially deep neural networks. The deep models would generalize poorly on the testing cases when trained to over-fit the training samples with noisy labels. Inspired by the recent progress on learning with noisy labels, we propose a robust learning method to perform robust visual sentiment analysis. Our method relies on external memory to aggregate and filters noisy labels during training. The memory is composed of the prototypes with corresponding labels, which can be updated online. The learned prototypes and their labels can be regarded as denoising features

and labels for the local regions and can guide the training process to prevent the model from overfitting the noisy cases. The experiment results show the effectiveness of our method.

12 Tensor-Based Lightweight CNN for Objective Detection in Aerial Imagery

Manish Sharma and Panos P. Markopoulos
Rochester Institute of Technology, Rochester, NY

Detection CNN architectures often exhibit over-parameterization which results in excessive computational and storage overhead, but also undesired overfitting and reduced performance. In this work, we focus on YOLOrs, a state-of-the-art CNN for target detection in remote sensing imagery, and counteract over-parameterization by enforcing Tensor-Train (TT) structure to its convolutional kernels. In this work, we use TT to reduce the size of a detection CNN. We refer to the resulting network as YOLOrs-lite and compare its performance against standard YOLOrs as well as other state-of-the-art detection networks. Our numerical studies show that the proposed network attains superior detection performance, with storage savings as high as 70%. The proposed network combines light storage with real-time inference, making it quite promising for edge deployment.

13 Towards a Universal Dimensionality Reduction framework for Machine Learning

Navya Nagananda, Andreas Savakis
Rochester Institute of Technology, Rochester, NY

Linear Dimensionality Reduction (LDR) finds applications in machine learning problems that deal with high dimensional data, such as images and videos. Popular LDR methods include Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA), which have well-established geometric interpretations and offer desirable feature representations. We cast these LDR methods as optimization problems over matrix manifolds in a flexible framework called proxy matrix optimization (PMO). This generic and iterative framework solves for the objective function corresponding to the LDR method of choice to obtain the optimal projection to a lower dimension of the input data. Furthermore, the PMO framework is expanded to include the robust L-p norm, which is useful when dealing with outlier data, and incremental versions of PCA and LDA utilized when data is received in small batches. We present the results of our experiments using two of the most commonly used LDR methods: PCA and LDA.

OPTICS, PHOTONICS, IMAGING (14 – 28)

14 Adaptive Optics Visual Simulator of Multifocal Lenses for Myopia Control

Karteek Kunala, Tianlun Zou, Sara Aissati, Len Zheleznyak, Maria Vinas, Susana Marcos
University of Rochester, Rochester, NY

Myopia affects >30% of the population in western countries, and >90% in some areas of Asia. One of the proposed strategies for controlling myopia is the use of multifocal contact lenses with certain distributions for far and near vision. It is not clear if these lenses operate by altering the sign of defocus in the peripheral retina or by modulating the accommodative response. The CEIS-Clerio Vision project explores a new generation of multifocal patterns (proprietary to Clerio Vision) and examines visual function and accommodative response through these patterns. For this purpose, we have developed an Adaptive Optics visual simulator (AO) with various channels including multi-wavelength illumination, a deformable mirror, a spatial light modulator (where the corrections are mapped), a Hartmann-Shack wavefront sensor to measure high order aberrations and residual defocus, a mini display for projection of psychophysical stimulus and a deformable mirror. Preliminary data showed distinct visual function across different multifocal patterns through focus, and stimulated or reduced the accommodative response. Since the myopia control ability of these lenses may depend on their capacity to modulate retinal defocus, we conclude that visual simulators are effective tools to test vision prior to a prescription of these lenses.

15 Complex-Valued Convolutional Neural Networks and their Applications in Photonic Accelerators for RF Modulation Classification

Hector Rubio, Matthew Van Niekerk, Stefan Preble
Rochester Institute of Technology, Rochester, NY

In this work, we present a complex-valued convolutional neural network model used to perform RF modulation classification on current industry-standard datasets. The model is used to determine the plausibility, and the performance of a photonic neural network given design constraints present in this ecosystem. The network architecture and the activation function are two factors that are studied. The number of convolutional layers, the kernel size, and the number of filters per convolutional layer are used to evaluate the classification accuracy of the network. It is shown that, for a fixed filter number (64 per convolutional layer) 4 convolutional layers and a kernel size of 7 provides a classification accuracy of ~91%. For a variable number of filters (number increases with 2^{3+l} where l is the convolutional layer number), 4

convolutional layers and a kernel size of 9 shows a performance of ~88%. In addition, the classification performance of two different complex-valued activation functions is examined, and we find that a cartReLU function provides a 60% increase over the modReLU function. The potential implementation of an on-chip non-linear activation function is also shown. Both of the network approaches presented here match the current performance of state-of-the-art network with a considerable reduction in network size

16 Enhanced On-Chip Phase Measurement by Inverse Weak Value Amplification

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Optical interferometry plays an essential role in precision metrology. Weak value amplification enhances the interferometric signal without amplifying certain technical noises. We implement a generalized form of weak value amplification on an integrated photonic platform with a multi-mode interferometer. We demonstrate a 7dB signal enhancement in our weak value device over a standard Mach-Zehnder interferometer with equal detected optical power, as well as frequency measurements with 2kHz sensitivity by adding a ring resonator.

17 Gabor-domain optical coherence microscopy for evaluating corneal cross-linking

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Corneal cross-linking is one of the treatments for keratoconus. The procedure involves the use of riboflavin and ultraviolet light to strengthen collagen bonds in the cornea. As such, a method for evaluating the biomechanical changes of the cornea undergoing this procedure is of great interest. Elastography is one method to evaluate corneal stiffness. Here, we report preliminary elastography data of evaluating corneal stiffness pre- and post-CXL using a fast and high-resolution optical imaging system — the Gabor-domain optical coherence microscope.

18 High Dynamic Range Measurements of Femtosecond Pulses

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Femtosecond material processing techniques, such as LIRIC (Laser Induced Refractive Index Change) rely on tightly focused mode-locked pulses to achieve the high intensities needed for multiphoton excitation. The temporal profile of these pulses is assumed to be a sharp, narrow peak. However, a portion of the total energy can also be contained in a long component with much lower intensity, ignored by most measurement techniques. We have developed a High Dynamic Range Autocorrelation system to study these low intensity features and their influence on the LIRIC process.

19 Laser Induced Refractive Index Change in Dehydrated Ophthalmic Hydrogels - Feasibility Study

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Laser Induced Refractive Index Change (LIRIC) uses femtosecond laser pulses, at energies below the damage threshold, to locally modify a material's refractive index. LIRIC process can create custom refractive structures in ophthalmic materials such as contact lenses. We have investigated the possibility of inducing refractive structures in dry contact lens materials. Our experiments have shown that LIRIC using 400nm laser light is not only possible in dehydrated silicone hydrogels but is able to induce greater index changes than it was when the materials were in a hydrated state.

20 IGZO TFT Backplane Integration for µLED Flat-Panel Display

Rochester Institute of Technology: Eli Powell, Kaden Profit, Conrad Miszczak, Patricia Meller, Karl D. Hirschman
Corning Incorporated: Sean Garner, Dean Thelen, Robert Manley
Tyndall National Institute: Zhi Li, Brian Corbett

Display technologies have continuously evolved since the advent of cathode ray tube (CRT) displays in the early 1900s. Thanks to modern advancements, current display thicknesses are on the order of centimeters and their area has increased 10-fold. Modern flat panel display (FPD) systems consist of a TFT backplane that controls the filtering of a backlight or the modulation of emissive devices such as OLED or microLEDs (µLEDs). Due to their small size, µLEDs provide higher resolution and better contrast than previous display technologies, and are an active topic in FPD research and development. The primary focus of this work is the process integration of Indium Gallium Zinc Oxide (IGZO) TFTs as an active-matrix backplane for row/column addressing. A single pixel is composed of a µLED driven by an arrangement of 2 transistors and a storage capacitor. The pixels are then arrayed on a glass substrate to control

monochrome and full color (RGB) displays from 1x1cm (50 x 50 pixels) up to 7.6 x 7.6cm (380 x 380 pixels). Optimization of circuit parameters considering size and scan frequency were modeled using existing TFT and µLED electrical device compact models. New process parameters and procedures were established for the hybrid integration of µLEDs with the IGZO TFT backplane. System integration with control circuitry will facilitate demonstration of a new interconnect strategy for µLED display modules.

21 Machine Learning for the Design of Multilayer Optical Filters

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We are developing a NN that provides the design of multilayer optical filters with enhanced properties. The NN should generate optimized designs considering the angle of light incidence, polarization, spectral bandwidth, and the number of bandwidths. One crucial problem is that different filter designs may produce the exact optical response, confusing the NN. Different NN architectures (tandem, convolutional) are explored in our project to solve this problem.

22 Measurement of Collagen Fiber Structure in Photo-Crosslinked Ocular Tissue

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The structure and organization of collagen fibers affect the mechanical strength of the ocular tissue and both properties are correlated. Photo-crosslinking (CXL) is a photo-therapy that increases the number of covalent bonds between collagen fibrils and other fibrils/proteins in the extra cellular matrix. To test the effects of CXL on ocular tissue, samples of rabbit cornea and sclera were treated with two different CXL procedures; riboflavin installation & ultraviolet irradiation (UVX) and rose bengal installation & green (532 nm) irradiation (RGX). Untreated tissue was also kept as a control. After treatment, the tissue was removed from the ocular globe and placed in a custom built second harmonic generation (SHG) microscope, were stacks of cross-sectional images were built from signal collected in the forward direction at different depths. An order coefficient (OC) was defined to quantify the degree of orientation of the fibers (1 when the fibers are perfectly straight and oriented in the same direction, and has a value of 0 when the fibers have a random orientation. In corneas, which were treated in vivo and tested one or two months after treatment, the OC value of collagen fibers increased by 27% and 20% (RGX/UVX, $p<0.01$) after the first month and 38% and 33% (RGX/UVX, $p<0.01$) after two months, with notable increases in the anterior portion of the stroma. In CXL sclera,

the OC value change by +5.1%/+3.9% (RGX/UVX, $p<0.05$) in the posterior-nasal sclera and by -1.5%/+2.2% (RGX/UVX, $p<0.05$) in the posterior-temporal sclera. For most tissue types, the fiber orientation became more uniform in direction and straighter post-CXL. The effects of CXL were greater in the cornea than in the sclera, which is unsurprisingly given the opacity of the sclera. However, the increase in OC value in sclera might make CXL a viable option for the retardation of pathologic myopia.

23 Adaptive Nulling for Steep Aspheres using a Holographic Reference Surface

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National foundries are providing a readily accessible avenue for photonic integrated circuit (PIC) technology, but prompt, efficient and reliable quantitative measurements of the waveguide performance within a PIC (e.g., polarization and loss) in the packaging and testing stage is an important challenge that must still be overcome. Numerical modelling of engineered scattering elements has demonstrated a significant polarization dependence to the input mode. This work experimentally verified the polarization response of engineered scattering elements placed in PICs fabricated through the AIM Photonics Foundry.

24 Polarization Dependence of Engineered Scattering Elements in Photonic Integrated Circuits

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National foundries are providing a readily accessible avenue for photonic integrated circuit (PIC) technology, but prompt, efficient and reliable quantitative measurements of the waveguide performance within a PIC (e.g., polarization and loss) in the packaging and testing stage is an important challenge that must still be overcome. Numerical modelling of engineered scattering elements has demonstrated a significant polarization dependence to the input mode. This work experimentally verified the polarization response of engineered scattering elements placed in PICs fabricated through the AIM Photonics Foundry.

25 Simulation and modeling for 3D localization and 3D orientation for single-emitter microscopy

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Super-resolution imaging based on single-molecule localization achieves high resolution on the order of 10–20 nm [1] with high precision. However, the orientation and position of a single molecule are intrinsically coupled in microscopy imaging [2]. In the technique, CHIDO (Coordinate and Height super-resolution Imaging with Dithering and Orientation), polarization control is used to manipulate the phase distribution in the Fourier plane to even decouple the 3D spatial position, 3D orientation, and wobbling or dithering angle of single molecules [3]. In this research, we present the CHITO technique and further extend such technique by considering a fluorescence mark as a spherical bead for calibration.

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26 Nd:YAG waveguide lasers inscribed with femtosecond laser sources

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We present a comparative study and results of double-track Nd:$Y_3Al_5O_{12}$ (Nd:YAG) waveguide lasers inscribed using femtosecond laser pulses at 515 nm and 1030 nm wavelengths. In addition, we report Nd: YAG double-track laser results with a lasing efficiency of more than 40 %, threshold pump power as low as 10 mW, and propagation loss lower than 0.2 dB/cm, which are the best values reported for similar Nd: YAG waveguide lasers. The waveguide and lasing properties are also compared for different pulse energy, scanning speed, and track separation.

27 Femtosecond Laser Nonstick Coatings on Pharmaceutical Tools

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In this work, we study the femtosecond laser nonstick coatings on common pharmaceutical tools. Through parametric study, we find the optimized laser fabrication parameters to realize superhydrophobicity on the surface of stainless steel, with a contact angle of ~158°. The laser-treated spray nozzle also shows enhanced control in both the size and volume of the droplet, achieving ~8 times higher accuracy and capable of dispensing 66% smaller droplets.

28 Optimizing fabrication parameters of femtosecond laser-treated superhydrophobic needle nozzle using neural network

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In this project, we developed a neural network model to predict the superhydrophobicity of femtosecond laser-treated stainless steel, based on the fabrication parameters. The trained neural network is combined with a genetic algorithm to determine the optimum fabrication parameters. The optimized fabrication parameters will be used to produce superhydrophobic surfaces for pharmaceutical applications.

SENSORS, ACOUSTICS, MATERIALS (29 – 32)

29 Increasing Ising Machine Capacity with Multi-Chip Architectures

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Nature has inspired a lot of problem solving techniques over the decades. More recently, researchers have increasingly turned to harnessing nature to solve problems directly. Ising machines are a good example and there are numerous research prototypes as well as many design concepts. They can map a family of NP-complete problems and derive competitive solutions at speeds much greater than conventional algorithms and in some cases, at a fraction of the energy cost of a von Neumann computer. However, physical Ising machines are often fixed in its problem solving capacity. Without any support, a bigger problem cannot be solved at all. With a simple divide-and-conquer strategy, it turns out, the advantage of using an Ising machine quickly diminishes. It is therefore desirable for Ising machines to have a scalable architecture where multiple instances can collaborate to solve a bigger problem. We then discuss scalable architecture design issues which lead to a multiprocessor Ising machine architecture. Experimental analyses show that our proposed architectures allow an Ising

machine to scale in capacity and maintain its significant performance advantage (about 2200x speedup over a state-of-the-art computational substrate). In the case of communication bandwidth-limited systems, our proposed optimizations in supporting batch mode operation can cut down communication demand by about 4-5x without a significant impact on solution quality.

30 Large-scale quantitative analysis of tonal relationships between melody and lyrics in Cantonese pop songs

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In pop songs of tonal languages, researchers have found that the tones of lyrics characters and melody contours have similar patterns of motion. However, no large-scale quantitative analysis has been done to generalize the phenomenon. The current study explores the extent of relationship between lyrics and melodies quantitatively in a large dataset of pop songs written in Cantonese, a language with one of the richest tonal systems. We propose an automated pipeline using state-of-the-art music information retrieval (MIR) techniques. The results demonstrate significant similarity in both general shapes and local motions of the contours.

31 Music Source Separation with Generative Flow

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Most existing source separation methods require full supervision (i.e., audio mixture and ground-truth sources) for training. In this project, we leverage flow-based generators under source-only supervision to learn source priors and separate music mixtures. Experiments show that our proposed method achieves competitive results to some of the fully supervised systems, and one variant of our proposed system is capable of separating unseen source tracks. This work is funded by the New York Center of Excellence in Data Science and gifts from the Voice Biometrics Group.