University Technology Showcase

Thursday April 13th, 2017

Research Focus Areas

Optics, Photonics and Imaging

Biomedical Technology

Microelectronics, Software and Communications

Energy and Materials

Data Science

WELCOME

Dear Colleagues,

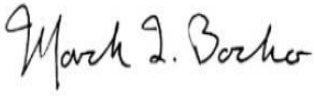
Welcome to the 17th annual University Technology Showcase sponsored by the Center for Emerging and Innovative Sciences at the University of Rochester, a New York State funded Center for Advanced Technology. Our event this year features presentations that represent a sampling of the high quality applied research being conducted at the University of Rochester and the Rochester Institute of Technology. In an expanded event this year, in addition to CEIS sponsored research projects we also are adding posters from the Rochester Center of Excellence in Data Science. The purpose of this annual event is to provide a forum where people from the regional business community can learn about research being conducted at these great research universities. This also provides an opportunity for members of the business and academic communities to meet and discuss topics of mutual interest. We hope that these discussions will lead to continued interactions that will enable companies to tap into the wealth of technology and expertise available at these institutions. The goal of today's event is to help the region and the State to incubate, grow, and attract businesses, resulting in job growth and economic expansion.

To kick off the meeting this year we are pleased to welcome our two speakers, Dr. Robert Fiete from Harris Corporation and Mr. Paul Travers from Vuzix, Inc. We're also very pleased to announce that due to the generosity of UR Ventures and RIT's Intellectual Property Management Office , we are able to make an award of $500 to the best poster, as judged by today's attendees.

The technology showcase is one of the ways that CEIS works to foster industry-university collaboration and technology transfer. We also provide NYS matching funds for companysponsored research on the UR and RIT campuses. Since its founding, CEIS has supported collaborations between more than 100 university researchers and 70 company partners. We also sponsor workshops and seminars that bring people from industry and academia together to discuss opportunities for technology-driven economic development. Feel free to contact us to learn more about these efforts and discuss ways that CEIS can help your enterprise.

Finally, we greatly appreciate your feedback and encourage you to fill in one of the forms handed out at the registration table or to go on line at http://www.ceis.rochester.edu.

Warm Regards,



Mark Bocko, PhD
Director, CEIS

Paul Ballentine, PhD
Executive Director, CEIS

FEATURED SPEAKERS

Bob Fiete, *Chief Technologist and Fellow of Harris Corporation, Space and Intelligence Systems*

Dr. Bob Fiete is Chief Technologist at Harris Corporation, Space and Intelligence Systems. He received his B.S. in Physics and Mathematics from Iowa State University and his M.S. and Ph.D. in Optical Sciences from the University of Arizona. After graduation, he joined Eastman Kodak's Federal Systems Division and managed the Imaging Systems Analysis group where he developed the image chain modeling approach for assessing and optimizing the image quality of space imaging systems and advanced processing algorithms. After his organization was acquired by ITT Corporation in 2007, Dr. Fiete served as Director of R&D for ITT Space Systems Division and then for ITT Exelis Geospatial Systems until Harris acquired Exelis in 2015.

Dr. Fiete was an adjunct professor at the Center for Imaging Science at Rochester Institute of Technology, has chaired conferences on imaging and optics, and served on advisory boards for both industry and government programs. He has taught many courses and seminars, briefed the National Security staff in the White House Situation Room, briefed the House Permanent Select Committee on Intelligence in a congressional hearing, developed the image sharpening process used on the Harry Potter films, and worked with the FBI and DOJ on criminal cases involving image exploitation. Dr. Fiete is the author of three books, five book chapters, forty technical publications, twelve patents, editor of the SPIE Spotlights book series, is a Senior Member of OSA and SPIE, a Fellow of SPIE, and was awarded the Rudolf Kingslake Medal by SPIE.

Paul Travers, *President and CEO of Vuzix*

Paul J. Travers, founded Vuzix in 1997 and is its President and CEO, a NASDAQ listed company. Prior to the formation of Vuzix, Mr. Travers founded both e-Tek Labs and Forte Technologies, one of the first VR companies in the early 90's with a consumer focus. With more than 30 years' experience in the consumer electronics and defense HMD fields, and 27 years' experience in the near-eye display and VR/AR fields; he is a nationally recognized industry expert and innovator.

Vuzix is a leading supplier of Smart-Glasses, Augmented Reality (AR) and Virtual Reality (VR) technologies and products for the consumer and enterprise markets. The Company's products include personal display and wearable computing devices that offer users a portable high quality viewing experience, provide solutions for mobility, wearable displays and virtual and augmented reality. Vuzix holds 51 patents and has 39 additional patents pending and numerous IP licenses in the Video Eyewear field. The Company has won Consumer Electronics Show (or CES) awards for innovation for the years 2005 to 2017 and several wireless technology innovation awards among others. Founded in 1997, Vuzix is a public company (NASDAQ: VUZI) with offices in Rochester, NY; Oxford, UK; and Tokyo, Japan.

RECOGNITION

Center for Emerging and Innovative Sciences

Partner Appreciation Award

2016 Recipient

J. Daniel Newman, Harris Corporation

Dr. Dan Newman is a Senior Staff Scientist and Chief Engineer for Harris's electro-optical sensor system payloads. He manages research and engineering teams, interfaces with government & commercial customers and university partners to develop new, innovative sensor technologies and space qualified sensor subsystems that meet customer needs. Dr. Newman has been with Harris, Exelis and formerly Eastman Kodak Company for over 25 years in a broad range of program management, R&D management and technical lead roles for space based and avionic sensor subsystem development programs.

Dr. Newman has a Ph.D in physics from the University of Rochester and BS in physics from the University of Chicago. He is the author of over 25 technical papers and authored 9 US patents on programmable spectral imaging, uncooled CMOS THz imaging sensors and automated X-Ray scanner calibration methods.

TECHNOLOGY SUPPORTERS

NYSTAR
Empire State Development
Division of Science, Technology & Innovation

UNIVERSITY of ROCHESTER

R·I·T

NYS SCIENCE+TECHNOLOGY LAW CENTER
AT SYRACUSE UNIVERSITY COLLEGE OF LAW

GENESEE COUNTY GCEDC Economic Development Center

MONROE COUNTY FINGER LAKES PTAC Government Contract Counseling

CHERYL DINOLFO
COUNTY EXECUTIVE

FUZEHUB

URVentures

UNIVERSITY of ROCHESTER
Center of Excellence in Data Science

AIM photonics
AMERICAN INSTITUTE for MANUFACTURING INTEGRATED PHOTONICS

FINGER LAKES COMMUNITY COLLEGE
INSTRUMENTATION & CONTROL TECHNOLOGIES
VICTOR CAMPUS CENTER

CIRC

HIGH TECH ROCHESTER
innovate. incubate. grow.

LSI

R·I·T | INTELLECTUAL PROPERTY & TECHNOLOGY TRANSFER OFFICE

Excell PARTNERS

UNIVERSITY of ROCHESTER
AIN CENTER FOR ENTREPRENEURSHIP
"Generating and Transforming Ideas *into* Enterprises That Create Value"

TECHNOLOGY SUPPORTERS

T1 **Center of Excellence in Data Science**

T2 **RIT Offices of Intellectual Property & Technology Transfer and Research Relations**

T3 **UR Ventures**

T4 **FuzeHub**

T5 **High Tech Rochester**

T6 **Monroe County Economic Development /Monroe County Finger Lakes Procurement Technical Assistance Center (MCFL/PTAC)**

T7 **Excell Partners**

T8 **FLCC's Victor Campus**

T9 **Genesee County Economic Development Center (GCEDC)**

T10 **New York State Science & Technology Law Center (NYS STLC) at Syracuse University College of Law**

T11 **Center for Integrated Research Computing (CIRC)**

T12 **AIM Photonics**

T13 **University of Rochester Center for Entrepreneurship/Technical Entrepreneurship and Management (TEAM) M.S. Program at the University of Rochester**

T14 **Light and Sound Interactive (LSI)**

TECHNOLOGY SUPPORTERS

T1 Center of Excellence in Data Science

The Center of Excellence in Data Science (CoE) is housed in the Goergen Institute for Data Science and funded by the New York State Department of Economic Development. The NYSTAR CoE program helps to drive regional economic development through supporting basic research, training, and technology development.

The CoE is committed to applying data science methods and tools to solve some of the world's greatest challenges in sectors including:

- Medicine and health
- Imaging and optics
- Energy and the environment
- Food and agriculture
- Defense and national security
- Economics and finance

The CoE offers support for companies and other partners in the following areas:

- Research: Generate innovative technologies and methods
- Commercialization and incubation: Drive growth of large and small commercial partners by supporting the commercialization of new products and services, and providing access to business acceleration programs
- Consultations and resources: Facilitate access to advanced computing and data visualization facilities, resources, and expertise.

For more information go to: http://www.sas.rochester.edu/dsc/coe/index.html

T2 RIT Offices of Intellectual Property & Technology Transfer and Research Relations

Welcome to RIT's Intellectual Property and Tech Transfer Office (IPMO) and Sponsored Research Offices (SRO). IPMO is responsible for managing RIT's Intellectual Property (IP) portfolio and bringing that IP to the marketplace through licenses to existing or start-up companies. SRO is responsible for connecting RIT's faculty to companies for sponsored research projects. We are all happy to make connections to RIT research faculty across RIT's campus – Imaging, Computing, Sustainability, Microsystems, Engineering, Science and Biomedical topic areas plus many more - see our websites at:
https://www.rit.edu/ipmo; https://www.rit.edu/reasearch.

TECHNOLOGY SUPPORTERS

T3 UR Ventures

At UR Ventures, our mission is to develop UR innovations into valuable products and services to make the world ever better. Unlike traditional academic Technology Transfer operation, UR Ventures has adopted a project management approach for every disclosed invention. Our goal is to locate and secure the resources necessary to get our discoveries into the hands of people who can most benefit from them or to define the gaps standing in the way of success. Every discovery that comes through our door presents a unique challenge. We look forward to meeting those challenges head on.

T4 FuzeHub

Small to medium–sized manufactures can face a number of challenges when trying to move their businesses to the next level. Our mission at FuzeHub is to help you meet these challenges head-on by identifying and connecting you with the resources you need, whether you are just starting out and are trying to get your product market ready or you are looking for opportunities to expand.

Want to learn more about how FuzeHub has helped New York manufacturers? Go to our website, https://fuzehub.com/, and check out some of our featured case studies or take a more in-depth look at our successful connections.

T5 High Tech Rochester

High Tech Rochester (HTR) is a not-for-profit economic development organization and is an authorized center of the NIST funded Manufacturing Extension Partnership (MEP), a manufacturing assistance program. HTR Growth Services provides support in areas such as strategic planning, quality system development, sales and marketing, product development and productivity improvement to all types of manufacturers in the Finger Lakes Region. HTR also runs the Lennox Tech Enterprise Center and the Rochester Bioventure Center in Henrietta, business incubators for high tech startups.

T6 Monroe County Economic Development

Monroe County Economic Development's purpose is promoting and providing economic development opportunities within the County of Monroe, providing additional employment and job opportunities. Through the Monroe County Industrial Corporation (MCIDC), financial assistance is provided to small businesses demonstrating a need that cannot be met entirely from conventional financial sources. The County of Monroe Industrial Development Agency (COMIDA) provides assistance to qualified applicants/projects via tax exemptions and real property tax abatements.

TECHNOLOGY SUPPORTERS

Monroe County Finger Lakes Procurement Technical Assistance Center (PTAC) serves as the official procurement technical assistance center for the Finger Lakes Region. PTAC helps businesses sell their products and services to federal, state and local governments, and the military marketplace.

There is no fee for MCFL PTAC services:

- Assess Readiness
- Analyze Market Opportunities
- Assist with Registrations and Proposal Development
- Identify Bid Leased
- Connect with Government Buyers and Prime Contractors

T7 Excell Partners

Excell is a venture fund that invests in seed and early stage high-tech startups in Upstate New York. With $12 million under management, Excell's portfolio includes investments in medical devices, advanced materials, energy, biotech, agtech, imaging and IT/Software across New York States. Excell is one of the most active seed funds in Upstate New York, with its investments resulting in more than $200 million in follow on funding and creating hundreds of high-paying jobs.

Excell, through its affiliation with the University of Rochester and partnerships with RIT, UB, Syracuse University, Cornell University, and other leading research institutions, is well positioned to tap into the unrealized potential emerging from these institutions; to identity their most promising technologies and to provide the financing, critical services, mentoring, and follow-on capital necessary to bring these companies to a commercial success.

www.excellny.com

T8 FLCC's Victor Campus

FLCC Instrumentation and Control Technologies program, working with 40+ high-tech businesses; addresses need for adaptable technical worker across the Finger lakes Greater Rochester High-tech Ecosystem. Students use LabVIEW software for courses in physics, data acquisition, automation control and robotics along with other skills such as use of microcontrollers and PLCs. Students also complete courses in CAD, Materials and Processing and Lean Six Sigma; along with English and public speaking. Students are required to complete a paid co-op; through which they learn business specific skills; often leading to full time employment with the business. The 2-year degree program has had estimated cumulative economic impact of $15 million over the past four years. This May, the fifth cohort will be graduating, bringing the total number of graduates to over 40.

TECHNOLOGY SUPPORTERS

T9 Genesee County Economic Development Center (GCEDC)

The Genesee County Economic Development Center (GCEDC), formerly known as the Genesee County Industrial Development Agency, was formed in 1970 under Section 18-A of New York State's General Municipal Law and is the County's primary designated agency for the promotion of economic development and economic growth. The agency was reorganized to its current form in 1979. The GCEDC is governed by a seven member, non-compensated, Board of Directors that is made up of business and community leaders that are appointed by the Genesee County Legislature.

T10 New York State Science & Technology Law Center (NYS STLC) at Syracuse University College of Law

The New York State Science & Technology Law Center (NYS STLC) helps researchers, entrepreneurs and companies with new technologies identify potential challenges and devise effective strategies to successfully bring that technology to market. This is accomplished by researching and providing information and education on a wide range of technology-related legal issues, including the protection and commercialization of intellectual property, technology transfer practices, patents, copyright and trademark law, and licensing agreements.

T11 Center for Integrated Research Computing (CIRC)

The University of Rochester established the Center for Integrated Research Computing (CIRC) to provide researchers with technology, software, training, and support necessary to utilize high-performance computing (HPC) and data science technology in research activities in all areas of academic scholarship. CIRC currently maintains systems with aggregated computational performance of about 420 teraFLOPS (including a leadership-class IBM Blue Gene/Q supercomputer), 2.2 petabytes of disk storage, and a variety of scientific software applications and tools.

CIRC hosts a number of collaborative events to help the research community learn how to use computing technology in research and development projects. Consultants, computing time, and a new visualization facility (VISTA Collaboratory) are available to help enable research projects at the University and its business partners.

T12 AIM Photonics

The **A**merican **I**nstitute for **M**anufacturing Integrated **Photonics** (AIM Photonics), is an industry driven public-private partnership that focuses the nation's premiere capabilities and expertise to capture critical global manufacturing leadership in a technology that is both essential to National security and positioned to provide a

compelling return-on-investment to the U.S. economy. The Institute's goal is to emulate the dramatic successes experienced by the electronics industry over the past 40 years and transition key lessons, processes, and approaches to the photonic integrated circuit (PIC) industry. AIM Photonics supports Small and Medium Enterprises, providing practical access and technology on-ramps for U.S. industry, government, and academic communities. We are creating a National PIC manufacturing infrastructure, widely accessible and inherently flexible to meet the challenges of the marketplace with practical, innovative solutions.

T13 University of Rochester Center for Entrepreneurship/Technical Entrepreneurship and Management (TEAM) M.S. Program at the University of Rochester

The University of Rochester Center for Entrepreneurship, launched by a grant from the Ewing Marion Kauffman Foundation awarded to the University in 2003, serves to identify and create new partnerships with alumni, local businesses, and non-profit organizations; coordinates and publicizes school-based experiences, including courses and signature programming; informs faculty of grant and bridging fellowship opportunities; and encourages collaboration among the schools engaged in entrepreneurship education at the University of Rochester and the greater Rochester community. The Center is committed to its mission of generating and transforming ideas into enterprises that create economic or social value. Learn more online at www.rochester.edu/entrepreneurship.

The University of Rochester Center for Entrepreneurship administers a multidisciplinary engineering and business graduate program: the Master of Science in Technical Entrepreneurship and Management (TEAM). This program offers students the opportunity to immerse themselves in a technical concentration of their choice while receiving a strong foundation in entrepreneurial management. Through a fast-paced curriculum at the University's Hajim School of Engineering & Applied Sciences and the Simon Business School, students can complete the 33-credit program in as little as one academic year. A three-semester option, which includes a summer internship, and part-time study are also available. Degree requirements include a semester-long practicum and a written business plan and oral presentation. TEAM students also have access to comprehensive career placement programming and staff. Learn more at www.rochester.edu/team.

TECHNOLOGY SUPPORTERS

T14 Light and Sound Interactive (LSI)

Light and Sound Interactive is a unique international conference in Rochester, NY that brings people together to discuss, teach, learn about, and experience advances in light and sound based technologies. These happen to be two areas for which Rochester is world famous and ones in which the region has incredible strengths. This will be the first time the region will showcase the two of them together for the world to see. The focus is on emerging, rapidly growing applications including virtual and augmented reality, gaming, 3D cinema, immersive environments, drones, self-guided vehicles, and internet of things. The conference will target technologists, entrepreneurs, investors, thought leaders, and enthusiasts. The inaugural LSI will take place September 12-14th, just before the Rochester Fringe Festival, which runs from the 14th to the 23rd. There will be a wide variety of events including keynote speeches, talks aimed at specific topics, panel sessions, hands-on demonstrations, a trade show, a few startup activities, and a job fair.

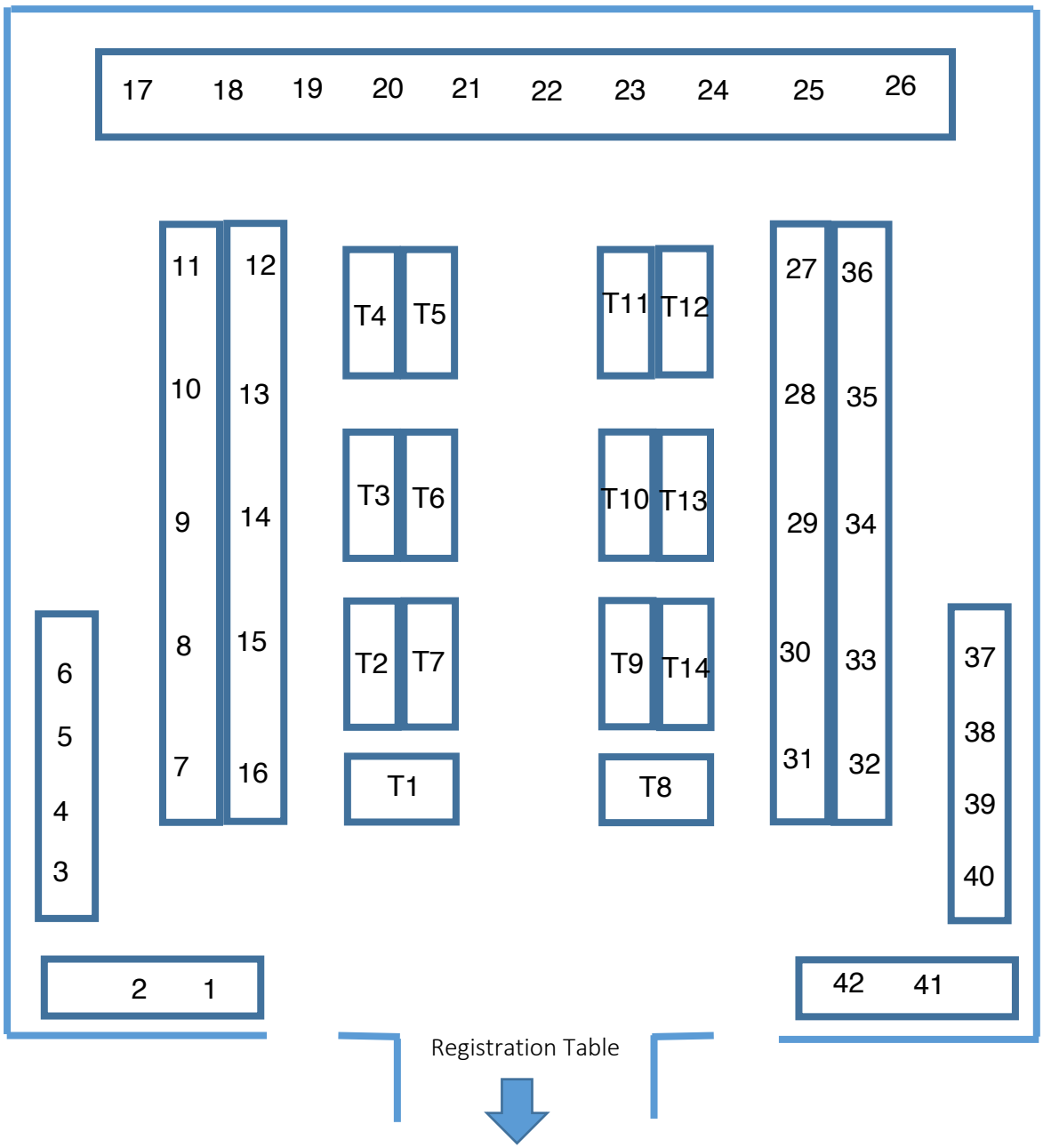
Optics, Photonics, and Imaging
1-14

Biomedical Engineering
15-26

Electrical Engineering, Computer Engineering
27-31

Chemical Engineering, Mechanical Engineering, Materials Science
32-35

Data Science
36-42



POSTER PRESENTATIONS

Optics, Photonics and Imaging

1. **Using quantum-dots to enable deep-UV sensitivity with standard silicon-based imaging detectors**
   Robert Ichiyama, Zoran Ninkov
   Rochester Institute of Technology

2. **Characterizing Si-MOSFET CMOS Devices for Terahertz Detection**
   Katherine Seery, Jack Horowitz, Zoran Ninkov, Andrew P. Sacco, J. Daniel Newman, Kenneth D Fourspring, Paul P.K. Lee, Zeljko Ignjatovic, Moeen Hassanalieragh, Judith Pipher, Craig W. McMurtry
   Rochester Institute of Technology/University of Rochester

3. **Ultrafast Lasers for Advanced Optics/Photonics Fabrication**
   Lauren L. Taylor, Joshua C. Frechem, Jie Qiao
   Rochester Institute of Technology, Chester F. Carlson Center for Imaging Science

4. **Nondestructive/noninvasive three-dimensional imaging with Gabor-domain optical coherence microscopy**
   Cristina Canavesi, Jannick Rolland
   LighTopTech Corporation/University of Rochester

5. **Determination of the Attributes of Aesthetically Pleasing Images and Methods to Improve Consumer Imagers to Make Them More Aesthetically Pleasing**
   Michal Kucer, David Messinger
   Rochester Institute of Technology

6. **Experimental Results for the Detection of Thermal IR Light Using a CMOS Silicon Sensor**
   Craig McMurtry, Judith Pipher, Zeljko Ignjatovic, Dan Newman, Andrew Sacco, Kenneth Fourspring, Zoran Ninkov
   Rochester Institute of Technology/University of Rochester

7. **Volumetric Display for Viewing 3D Images in Real Space**
   Chris Mullarkey, John Howell, Curtis Broadbent
   University of Rochester

8. **Adaptive Optics Bench Testing for Presbyopia Correcting Contact Lenses**
   Aaron Greenbaum, Geunyoung Yoon
   University of Rochester

9. **Further Development of THz Imager Array in Support of Harris' Commercial THz Imaging Development**
   Moeen Hassanalieragh, Zeljko Ignjatovic
   University of Rochester

POSTER PRESENTATIONS

10. Combining Measurements of Polarization and Spatial Coherence
Katelynn A. Sharma, Miguel A. Alonso, Thomas G. Brown
University of Rochester

11. Machine learning based hyperspectral data analysis
Utsav B. Gewali, Sildomar T. Monteiro
Rochester Institute of Technology

12. Refractive Devices & Visual Acuity in Hydrogel Phase Plates Using IRIS
Gustavo A. Gandara-Montano,[a] Sam C. Butler,[b,e] Len A. Zheleznyak,[a,e] Krystel R. Huxlin,[c,d] Geunyoung Yoon,[c,d] Wayne H. Knox,[a] Jonathan D. Ellis[a,b]
[a]The Institute of Optics; [b]Department of Mechanical Engineering; [c]Center for Visual Science; [d]Flaum Eye Institute, University of Rochester/Clerio Vision, Inc.

13. Novel Quantum Well Design of Deep-Ultraviolet Light-Emitting Diodes
Cheng Liu[1], Yu Kee Ooi[1], S. M. Islam[3], Jai Verma[4], Huili (Grace) Xing[3,4,5], Debdeep Jena[3,4,5] and Jing Zhang[1,2]*
[1]Microsystems Engineering and [2]Department of Electrical and Microelectronic Engineering, Rochester Institute of Technology; [3]School of Electrical and Computer Engineering and [5]Department of Materials Science and Engineering, Cornell University; [4]Department of Electrical Engineering, University of Notre Dame
**Presently at Intel Corporation*

14. Polarization-Time-Space Multiplexer for Optimizing Femtosecond Micromachining of Ophthalmic Devices
Ruiting Huang[a], Len A. Zheleznyak,[a,b] Wayne H. Knox,[a,b]
[a]The Institute of Optics; [b]Center for Visual Science, University of Rochester
Clerio Vision, Inc.

Biomedical Engineering

15. Compressive Beamforming for Portable Ultrasound
Swetha George, Zeljko Ignjatovic
University of Rochester

16. Modeling and Optimizing the LIRIC Writing Process
Paul Funkenbusch
University of Rochester

17. 3D Bio-printing Hybrid Hydrogel Tube for Mimicking Physiological Bowel Environment
Rong Fan, Toby Mea, Marine Piou, Jiandi Wan
Rochester Institute of Technology

POSTER PRESENTATIONS

18. Accelerating Optical Biosensor Development with Polymer Microgels
Michael Bryan, Brandon Davis, Benjamin Miller
University of Rochester

19. A Modified TEM Sample Holder for Imaging Large Samples
Kilean Lucas, James McGrath
University of Rochester

20. Comparable Change in the Refractive Index of Feline and Human Corneas after Blue-IRIS
Kaitlin T. Wozniak§,[a] Sara M. Gearhart§,[a] Daniel E. Savage,[a,b,c] Jonathan D. Ellis,[a,d] Wayne H. Knox,[a,b,c] Krystel R. Huxlin[b,c,]*
[a]The Institute of Optics; [b]Center for Visual Science; [c]Flaum Eye Institute; [d]Department of Mechanical Engineering, University of Rochester § Equal first authors

21. Hyperspectral Imaging for noninvasive, comprehensive measurement of microvascular function in humans: a preliminary report
Anthony Pietropaoli
University of Rochester

22. Computational Analysis of Equilibria and Dynamics of Contact Lenses
Kara L. Maki, Rachael Thormann, David S. Ross,
School of Mathematical Sciences, Rochester Institute of Technology

23. Plane Wave and Elastographic Imaging of AAA and Carotid Arteries
Luke A. Cybulski, Michael S. Richards
Cardiovascular Engineering Laboratory, University of Rochester School of Medicine, Department of Surgery

24. Erythrocytes Are Oxygen-Sensing Regulators of the Cerebral Microcirculation
Sitong Zhou, Jiandi Wan and Maiken Nedergaard
Rochester Institute of Technology

25. Towards Automated Clinical Evaluation of Tendon through Shear Wave Elastography
Steve McAleavey, Mark Buckley, Rifat Ahmed, Keshia Mora
University of Rochester

26. Light Diffusing Fiber as a Disinfectant and/or Antimicrobial Agent
Cindy Louka[1], Kaitlyn Matias[2], Spencer Klubben[2], Constantine Haidaris[1], Paul M. Dunman[1]
[1]Department of Microbiology and Immunology, University of Rochester Medical Center; [2]Corning Incorporated

POSTER PRESENTATIONS

Electrical Engineering, Computer Engineering

27. WiFi Direct Group Owner Selection and Group Maintenance Schemes
Utku Demir
University of Rochester

28. Computational Offloading in Mobile Ad Hoc Networks
Colin Funai, Wendi Heinzelman
University of Rochester

29. Superconducting single-photon detectors as smart sensors: photon-energy and photon-number resolution
Alan Shramuk, John Serafini, Roman Sobolewski
University of Rochester

30. Sound-Source Localization on Flat-Panel Loudspeakers
Michael Heilemann, David Anderson, Mark Bocko
University of Rochester

31. Computer Modeling of Telecom Signals in Multimode Optical Fibers
Aku Antikainen, William A. Wood, Govind Agrawal
University of Rochester

Chemical Engineering, Mechanical Engineering, and Materials Science

32. High-Power, Low-Cost CO2 Laser for Laser-Enhanced Pyrolysis
Jordan P. Leidner, John R. Marciante
University of Rochester

33. Generation of Si and III-V Micro- and Nano-Structures via Metal-Assisted Catalytic Etching Techniques
Thomas S. Wilhelm[1,2], Mohadeseh A. Baboli[1,2], Christopher O'Connell[3], Sanjna Lakshminarayanamurthy[3], and Parsian K. Mohseni[1,2]
[1]Microsystems Engineering; [2]NanoPower Research Laboratory; [3]Microelectronic Engineering, Rochester Institute of Technology

34. Selective-Area Epitaxy of III-V Semiconductor Nanowires on Monolayer Graphene, h-BN, and MoS2
Mohadeseh A. Baboli[1,2], Michael A. Slocum[2], Alessandro Giussani[2], Thomas S. Wilhelm[1,2], Hyun Kum[2], Seth M. Hubbard[1,2], and Parsian K. Mohseni[1,2]
[1]Microsystems Engineering; [2]NanoPower Research Laboratory, Rochester Institute of Technology

POSTER PRESENTATIONS

35. Fabrication of Silicon Micropillar Arrays by Carbon-Nanotube-Assisted Chemical Etching

Ian Kecskes[1], Thomas S. Wilhelm[2,3], Mohadeseh A. Baboli[2,3], Ivan Puchades[3,4], and Parsian K. Mohseni[2,3]
[1]Physics and Astronomy; [2]Microsystems Engineering; [3]NanoPower Research Lab; [4]Microelectronic Engineering, Rochester Institute of Technology

Data Science

36. When Fashion Meets Big Data: Discriminative Mining of Best Selling Clothing Features

Kuan-Ting Chen, Jiebo Luo
University of Rochester

37. Pose-Based Action Recognition for Personalized Body Language Understanding

Zhengyuan Yang, Jiebo Luo
University of Rochester

38. Image Based Appraisal of Real Estate Properties

Quanzeng You, Jiebo Luo
University of Rochester

39. Skin Lesion Morphology Characterization and Disease Classification

Haofu Liao, Jiebo Luo
Department of Computer Science, University of Rochester
Art Papier
Department of Dermatology, University of Rochester

40. Change Detection with Deep Learning and Data Augmentation

Andreas Savakis, John Kerekes, Sanghui Han, Michael Gartley, Emmet Ientilucci, Aadeesh Milind Shringarpure, Srinivas Ravi Raagav, Raghavendra Balavalikar-Krishnamurthy
Rochester Institute of Technology
Matt Turek, Keith Fieldhouse
Kitware Corp.

41. Annotating ECG Signals using Recurrent Neural Networks

Andrea Cogliati, Zhiyao Duan
Electrical and Computer Engineering, University of Rochester
Mina Attin, School of Nursing, University of Rochester

42. Computing with the Community: Engaging Local Intelligence to Promote Public Health Innovation

Amen Ptah, Jenny Hernandez, Ruby Reynoso, Madeline Neumiller, Grace Heard, Alessandro Incerto, Yutong He, Ali Hamdani, Henry Kautz, Ann Marie White
University of Rochester

POSTER PRESENTATION

Optics, Photonics and Imaging

1. Using quantum-dots to enable deep-UV sensitivity with standard silicon-based imaging detectors

Robert Ichiyama, Zoran Ninkov
Rochester Institute of Technology

Improving the sensitivity of silicon-based CMOS and CCD in the deep-UV is an area of ongoing interest. Lumogen has been used for this purpose for many years but has several known issues including limitations to its use in both vacuum and radiation harsh environments. Quantum Dots (QD) offers a more robust alternative to Lumogen. The fluorescence wavelength of QDs is tunable and can be fabricated to match the peak sensor quantum efficiency. Aerosol jet printing (AJP) is being used for the deposition of QDs on a variety of substrates and on commercially available sensor arrays. While the films deposited onto various substrates have a surface morphology characterized by aggregate formations, the insight obtained will lead to much more uniform layers in the near future. Organic residues common to this process, that compromise the UV performance, have been minimized.

2. Characterizing Si-MOSFET CMOS Devices for Terahertz Detection

Katherine Seery, Jack Horowitz, Zoran Ninkov, Andrew P. Sacco, J. Daniel Newman, Kenneth D Fourspring, Paul P.K. Lee, Zeljko Ignjatovic, Moeen Hassanalieragh, Judith Pipher, Craig W. McMurtry
Rochester Institute of Technology/University of Rochester

Rochester Institute of Technology (RIT), in collaboration with the University of Rochester and Harris Corporation, are developing room-temperature Si-MOSFET (Silicon Metal Oxide Semiconductor Field Effect Transistor) CMOS devices for use in large focal plane array imaging and detection of THz radiation. Test structures are designed locally and fabricated (350nm process) using the MOSIS facility. These devices utilize asymmetry in both the antenna connection and source-drain size to optimize responsivity. Results are presented from ~200GHz transmission testing of two generations of chip designs (GEN-II and GEN-IV) with single test structure FETs with several antenna configurations and a range of extended source regions.

3. Ultrafast Lasers for Advanced Optics/Photonics Fabrication

Lauren L. Taylor, Joshua C. Frechem, Jie Qiao
Rochester Institute of Technology, Chester F. Carlson Center for Imaging Science

Fabrication of freeform optics requires high-precision material removal to achieve high surface quality and complex and small feature geometries. These are currently restricted by the size and shape of mechanical tools. Ultrafast lasers are a versatile tool for material processing, where the combination of ultrashort pulse duration, tight focusing conditions, and optimized laser parameters can enable localized surface material removal with negligible thermal effects. We have experimentally

and theoretically investigated femtosecond laser-silicon interaction to quantify the impact of laser parameters on material surface characteristics and removal rate, width, and depth to enable deterministic ultrafast laser processing with optimum laser parameters. Thermal and two-temperature models have been developed and integrated to simulate the thermal impact of laser parameters and to predict optimized parameter matrices enabling thermally controlled processing. Experimental validation of optimized laser parameters and resulting surface quality analysis will be presented.

4. Nondestructive/noninvasive three-dimensional imaging with Gabor-domain optical coherence microscopy

Cristina Canavesi, Jannick Rolland
LighTopTech Corp/University of Rochester

Providing high-speed, industrial, micrometer-level resolution in all three dimensions, Gabor-domain optical coherence microscopy (GD-OCM) enables contact lens manufacturers to replace multiple inspection steps with a single measurement done automatically, reducing the opportunity for damaging the samples and human error, and ultimately leading to increased productivity and yield. The resulting improvements in contact lens performance and extended wear effects are poised to have a positive impact on a significant percentage of the population. Additionally, GD-OCM will enable new advances in a wide variety of scientific fields via its capability to non-invasively optically section samples of a variety of material types.

5. Determination of the Attributes of Aesthetically Pleasing Images and Methods to Improve Consumer Images to Make Them More Aesthetically Pleasing

Michal Kucer, David Messinger
Rochester Institute of Technology

With continuous miniaturization of silicon technology and proliferation of consumer and cell-phone cameras, we have seen an exponential increase in the number of images that are captured. Whether the images are stored on personal computers or reside on social networks (e.g. Instagram, Flickr), the sheer number of images calls for methods to determine various image properties, such as object presence or appeal for automatic image management. One of the central problems in consumer photography centers around determining the aesthetic appeal of the image. The problem of determining the aesthetic appeal of an image is challenging because the overall aesthetic value of an image is dependent on its technical quality, composition, emotional value, etc. We present methods and analysis that could potentially lead to building systems better suited in capturing the complexity of image aesthetic appeal.

POSTER PRESENTATION

6. Experimental Results for the Detection of Thermal IR Light Using a CMOS Silicon Sensor

Craig McMurtry, Judith Pipher, Zeljko Ignjatovic, Dan Newman, Andrew Sacco, Kenneth Fourspring, Zoran Ninkov
Rochester Institute of Technology/University of Rochester

We have developed inexpensive CMOS silicon based sensors, which are capable of detecting terahertz frequency (0.1 – 3 THz) radiation. With some modification, we calculated that the same ideas were extensible to even higher frequencies in the thermal infrared, i.e. at shorter wavelengths around 10 microns. We present the initial results from our first experimental devices.

7. Volumetric Display for Viewing 3D Images in Real Space

Chris Mullarkey, John Howell, Curtis Broadbent
University of Rochester

In the midst of all the hype and excitement about 3D virtual reality, we've improved upon a technology which creates 3D reality; no holograms, no illusions, and no glasses required. We use multiple lasers in a hot cesium vapor to draw arbitrary 3D images in real space. The images can be viewed from any angle in full 360 degrees as well as from above and below. Our prototype blue monochrome system is capable of drawing 3D images in a 12" diameter sphere with a resolution of 1 mm. Images and animations are drawn using a vector scan technique. We have also incorporated real-time 3D skeletal tracking using the Microsoft Kinect.

8. Adaptive Optics Bench Testing for Presbyopia Correcting Contact Lenses

Aaron Greenbaum and Geunyoung Yoon
University of Rochester

Presbyopia is a visual condition that all adults over the age of approximately 40 years face. Individuals with presbyopia lose the ability to focus on nearby objects, which significantly impacts quality of life. Although extending depth of focus via a multifocal contact lens to overcome presbyopia is increasingly popular, clinical outcomes with these lenses are variable and often unpredictable. A better understanding of the role of practical factors when a multifocal lens is on the corneal surface improves our ability to predict its performance. The adaptive optics bench testing system was used evaluate the through focus performance of three multifocal designs while simulating the practical factors. Further use of the adaptive optics system will allow through focus evaluation for the contact lenses with different aberrations.

9. Further Development of THz Imager Array in Support of Harris' Commercial THz Imaging Development

Moeen Hassanalieragh, Zeljko Ignjatovic
University of Rochester

POSTER PRESENTATION

A novel detection method for Terahertz radiation in standard CMOS technology based on Thermionic Emission has been investigated and experimentally verified. Theoretical analysis and experimental data have shown that in response to THz radiation a MOSFET transistor under subthreshold biasing conditions exhibits thermionic emission current over the source-to-channel potential barrier that is a much stronger function of the applied THz electric field when compared to other detection mechanisms in standard CMOS. We also demonstrate that the detection is further improved by extending the source region of the MOSFET transistor. Initial measurements indicate the detector's responsivity in excess of 40kV/W and corresponding measured Noise Equivalent Power of 10pW/sqrt(Hz). Thermionic emission detection using conventional CMOS technologies holds much promise due to low cost fabrication, ease of manufacturability, and the ability to integrate more functionality on chip. It also offers a better cost and performance alternative to microbolometers and pyroelectric detectors traditionally used in THz imaging.

10. Combining Measurements of Polarization and Spatial Coherence

Katelynn A. Sharma, Miguel A. Alonso, Thomas G. Brown
University of Rochester

We expand upon previously presented methods to obtain spatial coherence using obstacles and a lens to observe the far-field intensity. Since this measurement does not take up much time, we can cycle through all six polarization states and find that the mutual intensity function changes with polarization. These six measurements allow us to find all the elements of the four-dimensional coherence function.

11. Machine learning based hyperspectral data analysis

Utsav B. Gewali, Sildomar T. Monteiro
Rochester Institute of Technology

Hyperspectral imaging, also called imaging spectroscopy, is the process of capturing reflected or emitted energy at each pixel in an image of a scene over hundreds of narrow, contiguous bands in the electromagnetic spectrum, in the visible and infrared spectral regions. Each pixel of a hyperspectral image is a continuously varying reflectance as a function of wavelength. A variety of material's characteristics can be estimated from its reflectance spectrum as the interaction between the incident light and a material depends on the absorption bands of that material, manifested by its atomic or molecular structure.
Our group has been developing machine learning based methods to analyze airborne and satellite-based hyperspectral images. In the poster, we present two applications of hyperspectral image analysis: land cover mapping and biochemical parameter estimation. Land cover mapping is the task of identifying the material under each pixel of hyperspectral image. It is commonly used for plant species classification, mineral identification, urban scene classification, and change detection. We compare probabilistic graphical model based methods that utilize both spatial and spectral information to identify the materials in the scene.

Biochemical parameter estimation is the process of predicting contents of chemical present in a material from its reflectance spectra. It is commonly used in precision agriculture, forestry, and environmental monitoring.
We propose a multitask Gaussian process to simultaneously predict two or more related biochemical parameters and a new non-stationary covariance function, called exponential spectral angle mapper (ESAM), that is better suited for hyperspectral data due to its resilience to illumination variations

12. Refractive Devices & Visual Acuity in Hydrogel Phase Plates Using IRIS

Gustavo A. Gandara-Montano,[a] Sam C. Butler,[b,e] Len A. Zheleznyak,[a,e] Krystel R. Huxlin,[c,d] Geunyoung Yoon,[c,d] Wayne H. Knox,[a] Jonathan D. Ellis[a,b]
[a]The Institute of Optics; [b]Department of Mechanical Engineering; [c]Center for Visual Science; [d]Flaum Eye Institute, University of Rochester/Clerio Vision, Inc.

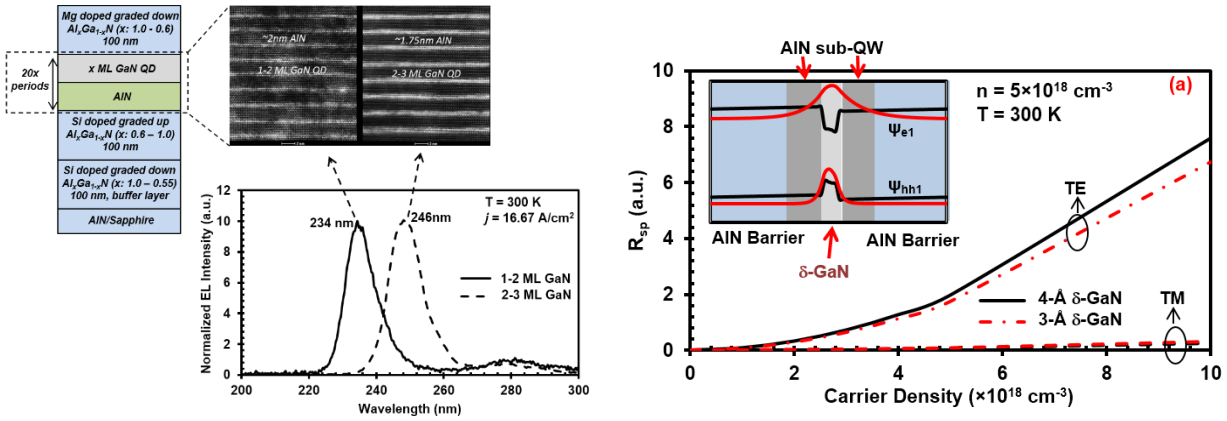
We have previously shown that IRIS – Intra-tissue Refractive Index Shaping can be used to change the refractive index of ophthalmic materials. IRIS works by using tightly focused femtosecond laser pulses from a frequency doubled 810 nm Ti:Sapphire laser at a 405 nm wavelength and an 80 MHz repetition rate with inherent non-linear absorption in the material to changes the material properties. In this work, we demonstrate several refractive devices generated in hydrogel (Contamac58) with Fresnel-based refractive designs to induce refractive power. The refractive change was induced over a 6 mm optical zone using ~1400 stitched segments. For vision testing, an adaptive optics vision simulator was used to correct native aberrations in 5 cyclopleged, visually-intact subjects (2 female, average age: 25±5 years) over a 6 mm pupil, while they viewed a white-light stimulus through a 5.8 mm artificial pupil. We then measured through-focus visual acuity and contrast sensitivity at subjective best focus with hydrogel phase plates in a plane optically relayed to the subjects' pupil. Performance was assessed in two double-masked conditions: viewing through an untreated phase plate or through a treated phase plate containing the IRIS lens. Based on these experiments, we demonstrate that the refractive performance of contact lenses whose refractive power is generated by IRIS show good agreement with the designed refractive power when assessed through the vision simulator.

13. Novel Quantum Well Design of Deep-Ultraviolet Light-Emitting Diodes

Cheng Liu[1], Yu Kee Ooi[1], S. M. Islam[3], Jai Verma[4], Huili (Grace) Xing[3,4,5], Debdeep Jena[3,4,5] and Jing Zhang[1,2]*
[1]Microsystems Engineering and [2]Department of Electrical and Microelectronic Engineering, Rochester Institute of Technology; [3]School of Electrical and Computer Engineering and [5]Department of Materials Science and Engineering, Cornell University; [4]Department of Electrical Engineering, University of Notre Dame
**Presently at Intel Corporation*

High efficiency deep ultraviolet (UV) light emitting diodes (LEDs) operating in the wavelength (□) below 300 nm are required for a wide variety of important

applications such as sterilizations, medical diagnostics and water purifications. High Al-content AlGaN quantum wells (QWs) are employed to pursue such deep-UV LEDs and have been widely studied and reported for 220-280 nm spectral regimes. Nevertheless, those AlGaN-based UV LEDs usually suffer from low external quantum efficiencies (<10%) especially with shorter emission wavelengths. The efficiency in such deep-UV LEDs is limited by the poor carrier injection efficiency; low internal quantum efficiency; and also the low light extraction efficiency. Furthermore, the existence of valence subbands crossover from the conventional AlGaN QWs is of crucial importance too in order to understand the arrangement of the valence subbands. Thus, it is important to explore novel QW active regions which can suppress the challenges and lead to improved quantum efficiencies. This work proposes the use of the AlN-delta-GaN QW structure with 1-4 monolayers of the delta-GaN layer for 234-298 nm UV LED in order to address the issue from the Quantum Confined Stark Effect as compared to the use of the conventional AlGaN QW with similar wavelengths. The valence band structure and corresponding polarization-dependent spontaneous emission of the proposed AlN-delta-GaN QW was investigated by the 6-band ***k·p*** simulations. The AlN-delta-GaN QW-like UV LEDs with 1-4 monolayers of delta-GaN layer were grown on the AlN/sapphire template by plasma-assisted molecular beam epitaxy (MBE). The angle-dependent and polarization-dependent electroluminescence (EL) measurements were conducted to validate the physics from the proposed QW design, showing the dominant TE-polarized emission from the AlN-delta-GaN QW, which indicating the use of the AlN-delta-GaN QW will serve as a promising alternative for deep-UV LEDs



14. Polarization-Time-Space Multiplexer for Optimizing Femtosecond Micromachining of Ophthalmic Devices

Ruiting Huang[a], Len A. Zheleznyak,[a,b] Wayne H. Knox,[a,b]
[a]The Institute of Optics, [b]Center for Visual Science, University of Rochester
Clerio Vision, Inc.

We are evaluating the use of a polarization space-time multiplexer unit for use with a femtosecond micromachining system for writing ophthalmic devices. Our

prototype device uses polarization to split femtosecond laser pulse trains into two separately controllable beams that can be combined collinearly to act as a repetition-rate multiplier, or non-collinearly to act in several different ways. One particularly interesting manner is to use this to write two structures simultaneously, or one structure at twice the spatial resolution. This concept can be extended to writing more complex 3D structures. We present preliminary results in scaling, as well as alternative schemes for repetition rate scaling.

Biomedical Engineering

15. Compressive Beamforming for Portable Ultrasound

Swetha George, Zeljko Ignjatovic
University of Rochester

We propose a novel Compressive-beamforming ultrasound imaging method that is a dramatic departure from conventional approaches and has the potential to disrupt the state-of-the-art in ultrasound imaging. Rather than using an expensive linear array with hundreds of transducer elements and associated electronics, the new method eliminates the expensive electronic components (amplifiers, A/D and D/A converters) connected to each element of the array and replaces them with a single channel that is shared by the entire array, to significantly reduce array complexity and allow genuinely portable implementations. The proposed system uses unfocused imaging of the target medium via a binary-coded aperture, which gives much improved spatial resolution and reduces the sidelobe artifacts commonly seen in traditional ultrasound systems, and allows a significant speed up of image acquisition. This inexpensive and easily portable ultrasound imaging method that can be made available to healthcare providers in rural communities, remote villages, and field hospitals, may have a profound impact on health and quality of life for humans.

16. Modeling and Optimizing the LIRIC Writing Process

Paul Funkenbusch
University of Rochester

LIRIC is a multi-photon absorption process that is used to locally change the refractive index of cornea tissue and hydrogels. The LIRIC process requires a high numerical aperture beam with a known optical quality that is scanned rapidly through the material. This process depends on numerous parameters, including NA, beam quality, pulse width, laser repetition rate, focal spot velocity, and material properties. In this project a framework model of the LIRIC writing process is being established, with non-linear effects and coupling between parameters examined using design of experiments methods. The overall objective is to optimize the LIRIC process for both hydrogel and cornea tissue applications.

POSTER PRESENTATION

17. 3D Bio-printing Hybrid Hydrogel Tube for Mimicking Physiological Bowel Environment

Rong Fan, Toby Mea, Marine Piou, and Jiandi Wan
Rochester Institute of Technology

3D printing of biological architectures that mimic the structural and functional features of *in vivo* tissues is of great interest in tissue engineering and the development of transplantable organ constructs. Printable bio-inks that are compatible with cellular activities play critical roles in the process of 3D bio-printing. Although a variety of hydrogels have been used as bio-inks for 3D bio-printing, they inherit poor mechanical properties and/or the lack of essential protein components that compromise their performance. Here, a hybrid Matrigel/agarose hydrogel system has been demonstrated that possesses both desired rheological properties for bio-printing and biocompatibility for long-term (11 days) cell culture. The agarose component in the hybrid hydrogel system enables the maintenance of 3D-printed structures, whereas Matrigel provides essential microenvironments for cell growth. When human intestinal epithelial HCT116 cells are encapsulated in the printed Matrigel/agarose constructs, high cell viability and proper cell spreading morphology are observed. Moreover, Salmonella suspension was applied in flow condition to infect the cell-laden tube and the interaction between HCT116 cells and Salmonella was studied. The developed system enables addressing several critical factors *in vivo* and will be effective to mimic the physiological bowel environment for studying colon cancer and tissue engineering.

18. Accelerating Optical Biosensor Development with Polymer Microgels

Michael Bryan, Brandon Davis, Benjamin Miller
University of Rochester

Serum levels of cytokines, growth factors, and other cell-secreted molecules have been identified as important biomarkers for a range of pathological processes including cancer, cardiovascular and immunologic disease. There is a critical need for fast, inexpensive, and highly multiplexed biosensing platforms to enhance serum protein detection in the clinic, and to promote identification of new relevant biomarkers in the lab. Arrayed Imaging Reflectometry (AIR) is a sensitive, label-free biosensing platform for specific, multiplexed detection of biomolecules in a complex medium such as serum. Multiplexed AIR microarrays created by printing capture antibodies directly on a silicon substrate are effective; however, from one antibody to another, they feature variations in antibody immobilization, spot thickness, and sensitivity. To address these challenges and improve uniformity of multiplexed AIR microarrays, capture antibodies were conjugated to Poly(*N*-isopropylacrylamide) microgel particles (PNIPAM). Here, we report our progress toward multiplex detection of seven cancer-relevant biomarkers, using AIR microarrays printed with antibody-conjugated PNIPAM microgel particles.

POSTER PRESENTATION

19. A Modified TEM Sample Holder for Imaging Large Samples

Kilean Lucas, James McGrath
University of Rochester

Imaging particles that have been captured in the pores of silicon nanomembranes allows for an understanding of the mechanisms of particle capture and retention. The best imaging technique for doing this is transmission electron microscopy, which allows us to image the pores and particles at magnifications upwards of 500,000 x. However, TEM sample grids are historically limited to a width of 3 mm, which is impractical for microdevice/microsystem applications. The 'membrane' chip format that is used in these systems has dimensions of 5.4 mm x 5.4 mm so it is not possible to image these membranes in a standard TEM holder. By modifying a standard TEM sample holder to accommodate the larger dimensions of the silicon chip, it was possible to load and image a larger format, TEM ready sample. This allows for the processing of larger TEM samples giving a never before seen capability for this type of electron microscopy.

20. Comparable Change in the Refractive Index of Feline and Human Corneas after Blue-IRIS

Kaitlin T. Wozniak§,[a] Sara M. Gearhart§,[a] Daniel E. Savage,[a,b,c] Jonathan D. Ellis,[a,d] Wayne H. Knox,[a,b,c] Krystel R. Huxlin[b,c,]*
[a]The Institute of Optics; [b]Center for Visual Science; [c]Flaum Eye Institute; [d]Department of Mechanical Engineering, University of Rochester
§ Equal first authors

Blue Intra-tissue Refractive Index Shaping (Blue-IRIS) is a new method with potential to correct ocular refraction non-invasively in humans. To date, Blue-IRIS has only ever been applied to cat corneas and hydrogels. To test comparability of refractive index change achievable in cat and human tissues, we used Blue-IRIS to write identical phase gratings in *ex-vivo* feline and human corneas. Femtosecond pulses (400nm) were focused ~300 µm below the epithelial surface and scanned to write phase gratings with lines ~1 µm wide, spaced 5 µm apart, using a scan speed of 5 mm/s. Additional cat corneas were used to test writing at 3 and 7 mm/s. The first-order diffraction efficiency was immediately measured and used to calculate the refractive index change attained. Our data show that Blue-IRIS can be used to induce comparable refractive index changes in feline and human corneas. These results suggest that Blue-IRIS can be effective in human corneas, an essential requirement for further developing its use as a clinical vision correction technique.

21. Hyperspectral Imaging for noninvasive, comprehensive measurement of microvascular function in humans: a preliminary report

Anthony Pietropaoli
University of Rochester

Disorders of the microvasculature are a final common pathway causing organ dysfunction in a variety of common disease states. In particular, sepsis syndrome is

characterized by widespread microvascular dysfunction that results in multi-system organ dysfunction and death. Sepsis is a devastating public health problem, accounting for the majority of deaths in U.S. hospitals. Detection and quantification of microvascular dysfunction has potential to aid in the diagnosis, prognostication, and treatment of sepsis. Unfortunately clinically applicable non-invasive methods for comprehensively assessing microvascular function do not exist. Hyperspectral imaging is an imaging modality that utilizes comprehensive spectral measurement ranges. This technique has potential to non-invasively quantify metrics of interest within living tissue, using their spectral signatures. Herein, we present our experimental protocols to acutely manipulate microvascular function in human subjects and quantify these changes using available experimental methods, while simultaneously performing hyperspectral imaging. Our next steps are to compare results from the established research methodologies to the simultaneously obtained hyperspectral imaging. We will thereby determine whether hyperspectral imaging can be practically applied for measurement of microvascular dysfunction in patients with sepsis and other diseases of the microvasculature.

22. Computational Analysis of Equilibria and Dynamics of Contact Lenses.

Kara L. Maki, Rachael Thormann, and David S. Ross
School of Mathematical Sciences, Rochester Institute of Technology

In this poster, we show results of computations based on two mathematical models: a model of the equilibrium stresses in a radially-symmetric contact lens and in the tear film induced by a lens on a radially-symmetric eye, and a model of the suction-pressure-gradient-driven dynamics of a re-centering lens on an eye. The equilibrium calculations show the effects of lens shape, eye shape, and material parameters on suction pressure and on the internal stresses in the lens for a variety of real lens and eye shapes. The re-centering calculations show the dynamics of a lens perturbed from equilibrium by a blink under the influence of tear-film drag induced by gradients in the suction pressure distribution/

23. Plane Wave and Elastographic Imaging of AAA and Carotid Arteries

Luke A. Cybulski, Michael S. Richards, Ph.D.
Cardiovascular Engineering Laboratory, University of Rochester School of Medicine, Department of Surgery

Abdominal aortic aneurysms constitute a significant health problem and current methods for assessing the need for surgical repair are unreliable. It is the goal of this work to obtain a screening tool to further inform the state of these vascular pathologies by providing information related to their biomechanics (e.g. stiffness, stress). In this work, we use high frame-rate, plane wave ultrasound imaging of aortic tissue mimicking phantoms, made from a hydrogel material, to obtain estimates of the pulse wave velocity (PWV) of a pressure wave propagating within the vessel, like those generated by a heart contraction. Using the Moens-Korteweg equation, we can relate the PWV and known vessel geometry to the stiffness of the vessel tissue. We have performed tests on homogenous, tube-like aorta phantoms

with known stiffnesses, which are dictated by the concentration of the polyvinyl alcohol (PVA) polymer in the gel. For 10% PVA, we measure pulse wave velocities of 2.84 ± 0.07 and 2.68 ± 0.06 m/s for framerates of 1055 and 1908 FPS, respectively, compared to an accepted value of 2.71 m/s. For 15% PVA, we measure pulse wave velocities of 7.02 ± 0.10, 4.53 ± 0.06 and 4.71 ± 0.11 m/s for frame-rates of 1908, 2392, and 3205 FPS, respectively, compared to an accepted value of 4.52 m/s. For 20% PVA, we measure a pulse wave velocity of 7.30 ± 0.74 and 6.28 ± 0.13 for frame-rates of 1908 and 4854 FPS, respectively, compared to an accepted value of 6.34 m/s. Our measurements suggest that low frame-rates will overestimate the pulse wave velocity.

24. Erythrocytes Are Oxygen-Sensing Regulators of the Cerebral Microcirculation

Sitong Zhou, Jiandi Wan Maiken Nedergaard
Rochester Institute of Technology

We demonstrate that hypoxia affects the flow velocity of human red blood cells (RBCs) in a microfluidic channel with the size of 5-7 μm, comparable to the size of capillaries in vivo. In particular, we flow RBCs through a reservoir with a microfluidic constriction and detect the velocity of RBCs using a high-speed camera. Sulfite sink was used to reduce the oxygen concentration. The results show that the velocity of RBC increases linearly as the oxygen concentration reduced. Ex vivo experiments revealed for the first time that RBCs themselves act as O_2 sensors that autonomously regulate their own deformability and thereby flow velocity through capillaries in response to physiological decreases in O_2 tension. Mechanistic investigation is currently undergoing in our lab.

25. Towards Automated Clinical Evaluation of Tendon through Shear Wave Elastography

Steve McAleavey, Mark Buckley, Rifat Ahmed, Keshia Mora
University of Rochester

Musculoskeletal (MSK) conditions are the leading cause of disability and the leading cause of physician office visits in the United States. Diseases associated with the musculoskeletal system affect 50% of individuals over age 18 and 75% of individuals over age 65, with an increased incidence expected due to both an aging population and increasing involvement in physical activities. Though MRI can provide accurate diagnosis of MSK conditions, it is expensive and not widely available. Ultrasound shear wave elastography (USWE) is a promising technology with high potential to address this need. Existing implementations of USWE are not well suited to characterization of MSK tissues, particularly tendon. We present an experimental platform for evaluation of USWE in *ex vivo* porcine tendon. This platform allows for the assessment of tendon under a wide range of loads and allows implementation of novel ultrasound imaging pulse sequences. We demonstrate transverse wave excitation and tracking in tendon using a conventional linear array ultrasound transducer. Angular dependence of ultrasound

backscatter coefficient in tendon is demonstrated. This platform will assist in our goal to create inexpensive ultrasound technology for the diagnosis of MSK conditions.

26. Light Diffusing Fiber as a Disinfectant and/or Antimicrobial Agent

Cindy Louka[1], Kaitlyn Matias[2], Spencer Klubben[2], Constantine Haidaris[1], and Paul M. Dunman[1]
[1]Department of Microbiology and Immunology, University of Rochester Medical Center; [2]Corning Incorporated

Antibiotic resistant bacterial infections are major healthcare concern, leading to unacceptable rates of morbidity and mortality and costing the U.S. healthcare system approximate $45 billion, annually. The shrinking arsenal of effective therapeutics for the treatment of antibiotic resistant species necessitates novel strategies for the therapeutic intervention of bacterial pathogens. To that end, high intensity blue-violet light is recognized to display antimicrobial activity toward bacterial species of immediate and emerging healthcare concern. However, product development has been hampered by a number of limitations; chiefly among these is the absence of an applicable light delivery system. Corning® Fibrance® Light-Diffusing Fiber is a thin and flexible glass fiber that radially illuminates light along its length, similar to a string of light that may overcome light delivery issues. Accordingly, we have evaluated the antimicrobial performance of Fibrance® light delivery toward a panel of multidrug resistant bacterial species.

Electrical Engineering, Computer Engineering and Computer Sciences

27. WiFi Direct Group Owner Selection and Group Maintenance Schemes

Utku Demir
University of Rochester

The wide diffusion of mobile devices that natively support ad hoc communication technologies has led to a number of protocols for enabling and optimizing Mobile Ad Hoc Networks (MANETs). Nevertheless, the actual utilization of MANETs in real life is still limited, in part due to the lack of protocols for the automatic creation and evolution of ad hoc networks. Recently, a novel ad hoc protocol named WiFi Direct has been proposed and standardized by the WiFi Alliance with the objective of facilitating the interconnection of nearby devices. WiFi Direct provides high performance direct communication among devices, includes different energy management mechanisms, and is now available in most modern mobile devices. However, the current WiFi Direct implementations require user interaction for setting up and maintaining the connection. In this paper, we propose and analyze three practical schemes for creating self-organizing and self-healing WiFi Direct networks using Android OS devices. Experimental results show that our proposed approaches are feasible with different overhead in terms of prior knowledge about the network and coordination between the devices. These techniques provide the

first known approaches for the automatic creation and maintenance of MANETs using every day mobile phone devices.

28. Computational Offloading in Mobile Ad Hoc Networks

Colin Funai, Wendi Heinzelman
University of Rochester

As the number of mobile devices that natively support ad hoc communication protocols increase, large ad hoc networks can be created not only to facilitate communication among the mobile devices, but also to assist devices that are executing computationally intensive applications. Prior work has developed computation offloading systems for mobile devices, but this work has focused exclusively on offloading to single hop neighbors, due in part to the practical challenges of setting up multi-hop networks using existing ad hoc communication protocols. However, limiting the offloading of computation to one-hop neighbors inherently restricts the number of devices that can participate in the distributed computation. By presenting a heuristic, aimed at avoiding partitioning the network, as well as an iterative task assignment algorithm that can optimize the assignment of computational tasks to devices in a multi-hop cooperative network, we are able to evaluate the effect of computational offloading. Experimental results, obtained from an implementation on Android devices, are integrated with an analytical model that enables the evaluation of system performance under a variety of conditions. These experimental and analytic results demonstrate the benefit of enabling computation offloading to all devices in a multi-hop cooperative network.

29. Superconducting single-photon detectors as smart sensors: photon-energy and photon-number resolution

Alan Shramuk, John Serafini, Roman Sobolewski
University of Rochester

Superconducting single-photon detectors (SSPDs) are nanostructured devices made from ultrathin superconducting nanostripes, they are typically operated at liquid helium temperature, and exhibit high detection efficiency, in combination with very low dark counts, fast response time, and extremely low timing jitter, within a broad wavelength range from ultraviolet to mid-infrared (up to 6 μm). In most current applications, SSPDs are made of NbN and are operated as simple photon counters. The main thrust of the "Smart Sensor for Classical and Quantum Data Links" project sponsored by HYPRES Inc. is development of a smart version of the SSPD device that could be implemented in various single-photon sensing applications. We demonstrate that SSPDs can be successfully used in photon-number and photon-energy resolving experiments. We present a new operation regime of SSPDs by integrating them with a read-out consisting of a low-noise cryogenic high-electron-mobility transistor and a high-load resistor. Our scheme enables to obtain information on energy of the incident photons, as well as demonstrates the photon-number-resolving capability of meander-type SSPDs. It also allows us to distinguish the origin of dark counts from the actual photon response in SSPDs. We also explore

SSPDs integrated with Josephson-junction–based mixed-signal circuits to provide readout, tuning, and control of the detector. These digitally assisted will have performance characteristics far surpassing those of the traditional, analog SNSPDs. We will target high-value applications in quantum networks for quantum information applications including high data rate quantum key distribution. Our smart sensor should also find many applications in classical data channels for energy-efficient computing, LIDAR, and laser communications.

30. Sound –Source Localization on Flat Panel Loudspeakers

Michael Heilemann, David Anderson, Mark Bocko
University of Rochester

A method is described for creating a two-dimensional audio display by spatially controlling the bending vibrations of a panel. This method can simultaneously produce multiple independent audio sources on the surface of the panel by using an array of force actuators to govern the shape and location of each source. The spatial vibration profile of the panel is dynamically controlled via signal processing means. Demonstrations on a prototype panel with an array of eight actuators show that the vibration profile of the panel approximates the user-defined target shape at all frequencies within the actuator array bandwidth. Target shapes can be independently superimposed, allowing the panel to simultaneously reproduce multiple primary audio sources. Additionally, audio displays employing this method can be used to manipulate the sound field for beam-forming and wave field synthesis applications.

31. Computer Modeling of Telecom Signals in Multimode Optical Fibers

Aku Antikainen, William A. Wood, Govind Agrawal
University of Rochester

We implement a numerical propagation equation solver to simulate optical pulse propagation in multimode and multicore fibers. The program is capable of solving systems of Generalized nonlinear Schrödinger equations (GNLSE) that account for dispersion, losses, linear coupling between polarizations and different spatial modes, nonlinear coupling, and intramodal optical Kerr and Raman effects. The solver can also solve the Manakov equation which is a special case of the GNLSE with averaging over random linear coupling and fiber birefringence. We also present examples of recent results from our simulations. The propagation equation solver will be useful for the design, optimization, and performance testing of next-generation fiber-optic communication networks utilizing space-division multiplexing alongside with wavelength-division multiplexing.

POSTER PRESENTATION

Chemical Engineering, Mechanical Engineering, and Materials Science

32. High-Power, Low-Cost CO2 Laser for Laser-Enhanced Pyrolysis

Jordan P. Leidner, John R. Marciante
University of Rochester

Laser-enhanced pyrolysis has recently been demonstrated to provide a substantial energy and cost savings over the conventional heat-only production method for generating olefin from shale gas (specifically, converting ethane into ethylene). To reap this cost benefit and enable a new market for otherwise wasted (burned) ethane at the refineries, high-power lasers must be realized at low cost, in direct opposition to the common trend. Although lasers are commonly characterized by low-divergent beams of small diameter, this trait not only leads to high cost for high-power lasers, but is also unnecessary for the current application. To this end, a simple strategy was employed using ultra-low-cost commodity lasers that were spatially tiled to provide the requisite power scaling. The result is a nearly 25x-lower cost laser system that was used for proof-of-concept laser pyrolysis experiments in conjunction with our commercial partner.

33. Generation of Si and III-V Micro- and Nano-Structures via Metal-Assisted Catalytic Etching Techniques

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Metal-assisted catalytic etching techniques – e.g., metal-assisted chemical etching (MacEtch) and inverse metal-assisted chemical etching (I-MacEtch) – are novel methods of fabricating high aspect-ratio silicon and III-V micro- and nano-structures, which utilize cost-effective, simple, and common lithography and benchtop processes. These structures have potential applications in electronics, photonics, optoelectronics, energy conversion, and energy storage. Metal-assisted catalytic etching techniques have the unique ability to generate three-dimensional nano-structures using macro-scale planar processes, and exhibit high levels of versatility, adaptability, and tunability. Additionally, these methods have advantages over other top-down techniques, such as deep reactive ion etching (DRIE) or the Bosch process, and bottom-up techniques, such as selective area epitaxy (SAE) and vapor-liquid-solid (VLS) growth, in that they do not require hazardous gases, high vacuum, or high temperature conditions. Moreover, non-uniform sidewall scalloping inherent to conventional Bosch etching and ion-beam-induced damage from RIE are mitigated. Fundamentally, these methods are top-down, wet-etching techniques relying on catalytic oxidation of a semiconductor substrate beneath a patterned noble metal layer, and preferential dissolution of the oxidized regions. To date, we have demonstrated successful MacEtch of Si and GaAs, and I-MacEtch of InP and InGaP. Here we provide examples of structures generated with MacEtch and I-

MacEtch, details on the mechanisms of each technique, and example process flows for structure generation and device fabrication of state-of-the-art asymmetric heterojunction solar cell devices using each method.

34. Selective-Area Epitaxy of III-V Semiconductor Nanowires on Monolayer Graphene, h-BN, and MoS2

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Direct integration of vertically aligned III-V nanowires (NWs) with two-dimensional (2-D) monolayer substrates provides a valuable platform for emergent low-cost, flexible optoelectronics applications that can simultaneous access the unique advantages of both nanomaterials systems. Here, we present a comprehensive comparison between the growth conditions of vertical $InAs_yP_{1-y}$ NW arrays on single layer graphene (SLG), hexagonal boron nitride (h-BN), and molybdenum disulfide (MoS_2) monolayer sheets via seed-free direct van der Waals epitaxy (vdWE) by metal-organic chemical vapor deposition (MOCVD). The morphology, areal density, and crystal structure of $InAs_yP_{1-y}$ NWs within the $1 \leq y \leq 0.8$ range are quantitatively analyzed by mapping a wide growth parameter space as a function of growth temperature, V/III ratio, total precursor flow rate, and molar flow ratio of hydride precursors. While an overall reduction of precursor flow rate favors enhancement of NW density and aspect ratio, as well as simultaneous mitigation of parasitic island formation, we note that distinct optimal growth conditions are found for NW synthesis on each of the aforementioned 2-D substrates. Through manipulation of growth kinetics we demonstrate selective-area vdWE of III-V NWs on 2-D monolayers, and highlight pattern-free positioning of single NWs on isolated MoS_2 islands with one-to-one NW-to-island placement. The results of this work are expected to inform future III-V on 2-D nanomaterials integration toward substrate-free NW-based optoelectronics.

35. Fabrication of Silicon Micropillar Arrays by Carbon-Nanotube-Assisted Chemical Etching

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Metal-assisted chemical etching (MACE) is a solution-based, room-temperature, and anisotropic etching technique that is routinely used for fabrication of semiconductor nano-/micro-structures. In the conventional MACE process, a semiconductor is interfaced with a patterned noble metal film, which acts as a catalyst to promote local oxidation of the semiconductor when introduced into an etching solution containing an oxidant and an acid. The locally oxidized semiconductor phase is then

preferentially etched by the acid in the MACE solution, allowing the catalyst layer to sink into the semiconductor to generate nano-/micro-features along its path. Here, patterned carbon-nanotube (CNT) films are used for the first time as an alternative to noble metal catalysts in an anisotropic etching method for the fabrication of Si micropillar arrays, referred to as carbon-nanotube-assisted chemical etching (CNT-ACE). Vertical and lateral etching trends are analyzed as a function of oxidant concentration, dimensions of the patterned CNT catalytic layer, and duration of the etching process. Chemical analysis of the resultant Si micropillars is performed using Raman spectroscopy, Auger electron spectroscopy, and energy-dispersive X-ray spectrometry. A physical model is provided to demonstrate an interpretation of the etching trends. It is concluded that CNT films do not degrade over time in the etch solution and that they can serve as effective alternatives to conventional MACE catalysts. Based upon these observations, the CNT-ACE process can be employed for fabrication of semiconductor nanostructures with applications in electronics, optoelectronics, and photovoltaics.

Data Science

36. When Fashion Meets Big Data: Discriminative Mining of Best Selling Clothing Features

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With the prevalence of e-commence websites and the ease of online shopping, consumers are embracing huge amounts of various options in products. Undeniably, shopping is one of the most essential activities in our society and studying consumer's shopping behavior is important for the industry as well as sociology and psychology. Indisputable, one of the most popular e-commerce categories is clothing business. There arise the needs for analysis of popular and attractive clothing features which could further boost many emerging applications, such as clothing recommendation and advertising. In this work, we design a novel system that consists of three major components: 1) exploring and organizing a large-scale clothing dataset from an online shopping website, 2) pruning and extracting images of best-selling products in clothing item data and user transaction history, and 3) utilizing a machine learning based approach to discovering fine-grained clothing attributes as the representative and discriminative characteristics of popular clothing style elements. Through the experiments over a large-scale online clothing shopping dataset, we demonstrate the effectiveness of our proposed system, and obtain useful insights on clothing consumption trends and profitable clothing features.

37. Pose-Based Action Recognition for Personalized Body Language Understanding

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Understanding human body language is potentially useful in many areas including medical, business meeting and surveillance. Despite the popularity of low-level feature based action recognition, we argue the importance of fusing high-level information like human pose. Based on the idea, we propose a two-stream pose-based ConvNet architecture. Further, to guarantee the high accuracy and stability of estimated joints information, we propose a personalized model with a specially designed ConvNet structure and a visual similarity based iteration step. This model consists of: 1) a fully convolutional network with spatial fusion architecture, 2) optical flow-based refinement to incorporate motion and temporal information, and 3) iterative personalized annotation to boost the reliability of the joint predictions. For benchmarking, our model outperforms the state-of-the-art on the public datasets. Moreover, our model performs the best on a new psychiatric conversation dataset for computer vision based body language and emotion study.

38. Image Based Appraisal of Real Estate Properties

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Real estate appraisal, which is the process of estimating the price for real estate properties, is crucial for both buys and sellers as the basis for negotiation and transaction. Traditionally, the repeat sales model has been widely adopted to estimate real estate price. However, it depends the design and calculation of a complex economic related index, which is challenging to estimate accurately. Today, real estate brokers provide easy access to detailed online information on real estate properties to their clients. We are interested in estimating the real estate price from these large amounts of easily accessed data. In particular, we analyze the prediction power of online house pictures, which is one of the key factors for online users to make a potential visiting decision. The development of robust computer vision algorithms makes the analysis of visual content possible. In this work, we employ a Recurrent Neural Network (RNN) to predict real estate price using the state-of-the-art visual features. The experimental results indicate that our model outperforms several of other state-of-the-art baseline algorithms in terms of both mean absolute error (MAE) and mean absolute percentage error (MAPE).

39. Skin Lesion Morphology Characterization and Disease Classification

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The diagnosis of skin diseases is challenging. To diagnose a skin disease, a variety of visual clues may be used such as the individual lesional morphology, the body site distribution, color, scaling and arrangement of lesions. When the individual elements are analyzed separately, the recognition process can be quite complex. Unlike the diagnosis by human experts, which depends essentially on subjective

judgment and is not always reproducible, a computer aided diagnostic system is more objective and reliable. In this research, we developed a skin disease classification system using deep convolutional neural network. Through the development of the proposed system, on one hand, we showed that a more reliable approach to skin disease classification is using lesion-targeted classifiers instead of disease-targeted classifiers. On the other hand, we also demonstrated that better skin lesion classification can be achieved through the joint learning of body site identification and lesion morphology characterization. We built a deep multi-task learning (MTL) framework to jointly optimize skin lesion classification and body location classification (the later is used as an inductive bias). Our MTL framework uses the state-of-the-art ImageNet pretrained model with specialized loss functions for the two related tasks. Our experiments show that the proposed MTL based method performs more robustly than its standalone (single-task) counterpart.

40. Change Detection with Deep Learning and Data Augmentation

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Change detection deals with the identification of important differences across images. Change detection is important in various applications, particularly for the US Air Force, but it is challenging due to background variation, illumination differences, weather conditions, camera movement, etc. In this project, we utilize deep learning techniques to detect important changes in satellite imagery. There are two approaches to this task: (a) Supervised change detection, where the target of interest is known, e.g. vehicles, and (b) Unsupervised change detection, where the type of change is unknown. We explore supervised change detection by training deep networks to detect targets of interest across images and comparing the detection maps. Training these deep networks requires a large amount of training data which is typically not available. In this project we utilize RIT's DIRSIG simulator to generate realistic chips of targets that are used to train our networks. We present preliminary results of our work and plans for future research.

41. Annotating ECG Signals using Recurrent Neural Networks

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In-Hospital cardiac arrest (I-HCA) is a significant health problem. There are approximately 200,000 treated I-HCAs annually in the United States, and the rate of survival to hospital discharge is less than 25%. A recent scientific statement of the American Heart Association (AHA) stated that there is a gap in knowledge as to

which patients are at greatest risk for I-HCA. Electrocardiogram (ECG) is a measurement of the electrical activity of the heart over a period of time, obtained with electrodes placed on the skin of patients. ECGs are critical for recognizing the point at which clinicians should respond to a life threatening situation or cardiac arrest at hospitals. However, patterns of ECG data are not being studied at hospitals in order to predict and/or prevent I-HCA. The purpose of our study is to identify patterns of ECG prior to I-HCA. Neural Networks are known to be able to automatically learn patterns from data in order to perform classification or regression tasks. In this project, we developed a recurrent neural network based on Long Short-Term Memory (LSTM) cells to automatically annotate ECG signals. We trained the network on 40 hours of synthetic ECG signals with various morphologies resembling to human ECG. The trained network was able to annotate unseen synthetic signals with 100% accuracy in a leave-one-subject-out cross evaluation experiment. For future work, we plan to extend the experiment on real human ECGs. Also, ECG from hospitalized patients will be collected in order to provide large data set to train a neural network and discover the patterns of ECG prior to I-HCA.

42. Computing with the Community: Engaging Local Intelligence to Promote Public Health Innovation

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Community engaged research infuses local expertise into every phase of science, with the goal of promoting research that expedites community impact. However, barriers exist to creating equitable community involvement in science, including differences in educational histories and the intentionality of cultural responsiveness within research processes. Computing with the Community is a sponsored activity of the University of Rochester's Center of Excellence in Data Science. This program supports undergraduate student engagement in a series of projects, co-led with community partners, to address these barriers to the conduct of data science activities and to increase student preparation for collaboration with community members.

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