Hydrophobic metal, treated with femtosecond laser pulses, floats in distilled water at the lab of University of Rochester professor Chunlei Guo.
We are pleased to present our 2017-18 CEIS Annual Report, a summary of the activities and accomplishments of CEIS over the past year in our ongoing efforts to contribute to the expansion of the New York State economy through university–industry collaborations. Employing the state-defined metrics, this year CEIS activities accounted for more than $47 million of New York State economic impact, including 30.25 new jobs and 45.25 retained jobs for the region. We are grateful to NYSTAR, Empire State Development, and Governor Andrew Cuomo for the resources that afford us this opportunity, and all of us at CEIS are working hard with the hope that our programs will have a long-term positive impact on the economy and quality of life in Rochester, the Finger Lakes region, and the state.

An annual publication such as this one reporting facts, figures, and success stories fails to relay the entire impact of an organization, and we want to take the opportunity here to talk about CEIS’s overarching strategy and aspirations for the region.

The Finger Lakes region has many remarkable assets: two top research universities, a highly skilled and innovative workforce, a high quality of life, world-class cultural assets in the musical and visual arts, and an engaged and supportive government at all levels. Our goal at CEIS is to add more “buzz” and excitement that clearly is part of the culture in hotbeds of technology innovation and entrepreneurship such as Silicon Valley, Seattle, and Austin. An atmosphere of optimism and excitement encourages audaciousness and risk-taking, and we subscribe to the belief that the mindset of a community can indeed be a self-fulfilling prophecy.

With this motivation, CEIS initiated the Light and Sound Interactive Conference in 2017 to bring together our region’s creative and artistic community and technology community to inform and inspire. We are now working with a broader consortium of universities, industry, and government to perpetuate this highly successful event, and LSI is due to return in coordination with the Rochester International Jazz Festival in June 2019. We also are taking a leading role in organizing an augmented and virtual reality initiative that spans the University of Rochester and RIT campuses. Our latest “town hall” AR/VR meeting attracted more than 75 faculty and 100 attendees in total from both universities and several local companies. This initiative already has led to a multimillion-dollar research and development funding commitment to our local universities from a major West Coast technology company working in the AR/VR space. We will work to deepen these connections and reach other similar agreements, but our ultimate goal is to contribute to building an AR/VR industry in the Finger Lakes that will leverage our regional strengths in optics, imaging, audio, games and media, publishing, and other elements of an emerging AR/VR industry. Another project on the CEIS drawing board is a Film and Media Music and Sound Festival in which CEIS is working with the Eastman School of Music’s Beal Institute for Film Music and Contemporary Media to bring together composers, filmmakers, sound designers, audio technologists, and movie enthusiasts for a week of talks, workshops, screenings, and live performances in the fall of 2019.

These all have to be community efforts, so we encourage anyone and everyone who is reading this annual report and is inspired by this vision for our region and wants to reach out to us. We would love to hear from you.

Sincerely,

Mark F. Bocko, Director
Paul H. Ballentine, Executive Director

CEIS TEAM

CEIS staff prides itself on its commitment to fostering industry-university partnerships that lead to economic development for our region.

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CEIS ADVISORY BOARD

CEIS leadership meets with the advisory board to develop action-oriented plans to keep innovative technologies in the pipeline, connecting academic research with corporate product development. CEIS acknowledges and applauds its advisory board members for their leadership, expertise, and forward-thinking ideas.

Bob Naum
Chair

Bob Fiete
Harris Corporation

Ryne Raffaele
AIM Photonics

Mark F. Bocko, Director
Paul H. Ballentine, Executive Director

Cathy Adams
Nicholas Drogo
Mark Bocko
Vitumbiko Kambilonje
Paul Ballentine

Ian Cox
KIC Consulting Group

Elen Kousik-Williams
Corning, Inc.

Ed White
AIM Photonics

John Strong
Oliver Ostriker
Margaret Urzetta

Boo Naum
Bob Fiete
Ryne Raffaele
Ed White

Paul H. Ballentine and Mark F. Bocko
THE OPI CLUSTER

This map depicts the cluster of optical, photonics, and imaging (OPI) companies in the greater Rochester region—one of the oldest, largest, and most important industrial clusters in the country.

SUPPORTERS

The accomplishments of CEIS would not be possible without the partnerships and support of the many local, state, and federal agencies and organizations listed here.

OUTREACH INITIATIVES

This past academic year, CEIS has supported or led a number of outreach activities that have helped grow optics, photonics, and imaging companies as well as companies associated with these industries. Our annual University Technology Showcase, held in April, featured 46 posters highlighting some of the applied research at the University of Rochester and Rochester Institute of Technology that is relevant to local industry. Many of those posters were about collaborations supported by CEIS, while others were presented to spark new interest on the part of industry. More than 175 people attended the event.

In September 2017, CEIS put on the first Light and Sound Interactive* Conference. LSI highlights two areas for which Rochester is most well known: imaging and music. There were eight tracks, including virtual and augmented reality, games, music, film, imaging, phonics, and the use of light- and sound-based technologies in health care. There also happen to be the basis for some of the fastest-growing markets in the world and great opportunities for local economic development. There were also entertainment events at the four major local museums, a trade show, screenings of major motion pictures, and a keynote address by two-time Academy Award–winning director Ang Lee. LSI is designed to shine the international spotlight on Rochester's strength in these areas and raise local awareness of light and sound resources and programs. The idea is to inspire people to take advantage of local assets, including starting new companies. The ultimate goal of LSI is to expand the local economy by incubating, growing, and attracting companies. LSI is also a great example of cooperation among the University of Rochester, RIT, local industry, and the state.

More than 1,000 people attended the inaugural LSI, and the feedback received through a follow-up survey indicated that 95 percent of the attendees were likely to attend again. At least one company, Velaxy/vRcade, was started as a result of presentations and networking at LSI 2017. The company now employs five people. Another important outcome of LSI 2017 grew out of a networking event hosted by AIM Photonics, the American Institute for Manufacturing Integrated Photonics. AIM Photonics is headquartered in Rochester and is where the Test, Automation, and Packaging Facility (TAP) is located. New York State is investing $250 million into the TAP facility, and there is a major effort to get local companies involved with AIM. The LSI Photonics event helped AIM set up one-on-one follow-up meetings with 28 local companies to discuss becoming members of the consortium. Given this success and broad-based interest, CEIS has handed over management of LSI to a community coalition of industry, university, and state leaders. The next LSI is being planned for June 25–27, 2019, to coincide with the CGI Rochester International Jazz Festival.

The virtual and augmented reality market is expected to exceed $100 billion by 2022*. To help Rochester capture some of this growth, CEIS, in collaboration with the University of Rochester’s College, organized a VR/AR conference in October of this year. This was the second of what is planned to be an annual event. The conference focused on the research and capabilities in VR/AR at the University of Rochester and RIT and drew more than 100 people from the two universities and industry. This effort is already paying off. As of October, Facebook Reality Lab has entered into collaborative research agreements with both the University of Rochester and RIT and is funding projects in the areas of optics, visual neuroscience, and optical materials and metamaterials. We hope that this is a sustained and productive relationship between the University of Rochester and one of the leaders in the emerging area of virtual and augmented reality.

Other outreach activities included CEIS’s support for the New York Photonics Calendar, shown on this page, which helps promote the 100-plus photonics companies in the region and is considered to be the cluster’s number one marketing tool. And CEIS was successful in helping a team of semiconductor designers find a new home with a major international consumer electronics company.

In the coming year we look forward to continuing such initiatives that bring our academic and industry communities together to inspire and enable creative activities that will help to grow the economy of the Finger Lakes region and the entire state of New York.

*Source: Average forecast by Market Research Engine, Markets and Markets, and Statistica.

CEIS University Technology Showcase (top)
Light and Sound Interactive* Conference (middle)
New York Photonics Calendar (left)
For the fiscal year July 1, 2017, to June 30, 2018, the total documented dollar value of the economic impact of CEIS-supported research and outreach was more than $47 million. This self-reported data (new and retained jobs, increased sales, cost savings, capital investments, and additional funds acquired) from 24 of our partners provides a snapshot of the region’s economic successes.

A shout-out goes to the AIM Photonics initiative, which led the way in non-job impacts, reporting close to $30 million in monetary gains. The local start-up company Clerio Vision reported nine new jobs and six retained jobs along with more than $2.2 million in non-job impacts. Special recognition goes as well to VeRacity VRcade, a virtual reality arcade that was conceptualized as a direct result of the first-ever Light and Sound Interactive conference! In its first year, VeRacity reported five new jobs as well as non-job impacts.

### Economic Impact

**TOTAL CUMULATIVE ECONOMIC IMPACT**

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**FIVE-YEAR SUMMARY OF ECONOMIC IMPACT**

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**CAT PROGRAM FINANCIAL INFORMATION**

July 1, 2017 – June 30, 2018

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<td>Non-Personnel Related</td>
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A YEAR IN REVIEW

JULY 2017

CEIS awarded 29 faculty researchers more than $570,000 for CAT projects with 14 NYS companies, including 6 new researchers and 4 new company partners.

SEPTEMBER 2017

Light and Sound Interactive (LSI) conference held at the Rochester Riverside Convention Center. More than 1,000 people attended the 2-1/2 day event featuring 150 presenters and 45 exhibitors representing 9 areas of interest: VR/AR, Games, Cinema, Music/Audio, Imaging, Displays, Healthcare, Optics & Photonics, and Start-ups. Film critic Jack Garner and his wife enjoying the 3-D action (on left).

NOVEMBER 2017

Carestream joined Zebra Medical Vision’s AI1 campaign. This collaboration allows radiologists to access Zebra-Med’s AI algorithms through the Diagnostic Carestream Workstation. Zebra-Med’s engine can automatically detect various medical findings in imaging scans, and the deep-learning engine will help radiologists deliver a more comprehensive quantitative and consistent reporting in an effort to improve patient care.

DECEMBER 2017

VisualDx expanded operations in Rochester’s Downtown Innovation Zone. The innovative medical diagnostic company added 5,000 square feet to its current lease with plans to create up to 21 new jobs and retain 39 jobs. Art Papier, VisualDx CEO, stated, “We believe Rochester is an ideal spot for technical innovation and are proud to bring two of the city’s best assets together — imaging and health care—to improve medical decision making. We appreciate the support to expand our operation and retain the local talent available.”

DECEMBER 2017

CEIS partner Professor Wayne Knox elected as a fellow of the National Academy of Inventors. Professor Knox has been awarded 50 US patents and another 150 worldwide.

MARCH 2018

The first Carestream OnSight 3D Extremity System was installed at Cobalt Health’s Imaging Centre in Cheltenham, UK. This first installment will allow professionals to use a cone beam technology, which will provide 3-D images at the point of care. There are minimal site and installation requirements, which will allow faster and more convenient imaging and therefore enabling more timely diagnosis and treatment.

FEBRUARY 2018

VeRacity VRcade opened its doors. The business idea was born when the founder attended the 2017 Light and Sound Interactive conference. VeRacity VRcade offers a VR experience that is fun and affordable.

MAY 2018

Harris Corp awarded a five-year, up to $130 million contract with the US Air Force for Hand Held Video Data Link (HH-DVL) radios.

APRIL 2018

Forty-six posters touting an array of technologies were presented at the University Technology Showcase. J. Mikael Tottorman, CEO of Clerio Vision, was given the CEIS Partner Appreciation Award. Kaithin Wnaduk won the poster prize for the presentation of Clerio Vision-related research: “Scattering properties of ultrafast laser-induced refractive index shaping lenticular structures in hydrogels.”

JANUARY 2018

Molecular Glasses received a patent for “Charge-transporting molecular glass mixtures, luminescent molecular glass mixtures, or combination thereof or organic light-emitting devices and other organic electronics and photonics applications.”

MAY 2018

Renovations began on a hands on AR/VR lab to be located in the Carlson Science and Engineering Library. The new lab will give students and faculty the opportunity to create and explore with augmented and virtual reality.

JUNE 2018

Google partners with MCC to offer a new IT Support Professional Certificate program. The eight-month course will prepare students to enter this well-paying high-tech field. Google reports there are approximately 150,000 open IT jobs that do not require a college education but do require experience.

Luminate NY announced Double Helix Optics as the winner in its first round of competition. CEIS partners Molecular Glasses, Inc., Positive Science LLC, and LighTopTech Corporation were finalists in the OPI competition.

VeRacity VRcade opened its doors. The business idea was born when the founder attended the 2017 Light and Sound Interactive conference. VeRacity VRcade offers a VR experience that is fun and affordable.

Harris shipped its 50,000th PRC-117G Falcon III manpack radios—a groundbreaking technology developed with the University of Rochester’s Professor Wendi Heinzelman. The 117G was introduced in 2007 and allowed soldiers to connect a screen to the manpack to send email, images, and videos. It has provided soldiers with enhanced battlefield situational awareness capability and has increased Harris’s market share to 85 percent.

Harrjs frog at LSI 2017 event

Award recipient Mike Tottorman (right) with CEIS director Mark Bocko

Luminate’s first cohort pose at NextCorps offices in the Sibley Building.
2018–2019 ABSTRACTS

2018–19 PROJECT ABSTRACTS

Improved Mathematical Modeling and Computer Simulation of Contact Lens Dynamics
David S. Ross and Kara L. Maki
Rochester Institute of Technology
Bausch & Lamb

We propose to advance the modeling of contact lens dynamics. We have established the model of asymmetric lens motion, and we have developed a computer simulation of such motion based on the model. Over the next year we plan to improve the model's representations of lid pressure, blinking, tear film shape and rheology, and toric lens shapes. In addition, we plan to transfer the established lens centration model to Bausch & Lomb researchers; in collaboration with B&L, we will tailor the existing computer code to their requirements.

Peripheral Visual Quality and Its Impact on Myopia Development and Control
Geunyoung Yoon
University of Rochester
Bausch & Lamb

The population of myopia (or nearsightedness) patients has been booming worldwide. Although myopia can be corrected with optical and surgical interventions, pathologic myopia is known to occur in the region of eye diseases such as cataracts, glaucoma, and macular degeneration, which cause large socioeconomic burden worldwide. The genesis of myopia remains uncertain but is generally considered to have a multifactorial origin: component of optical, genetic, and environmental factors. The hypothesis to be tested in the proposed study is that peripheral optical and visual quality of the eye influences myopia development, i.e., eye elongation. This hypothesis will be tested by characterizing the impact of bifocal contact lens designs, attempting to reduce myopia progression by increasing myopic defocus and depth of focus in the peripheral visual field. We will use the state-of-the-art wide-field scanning ocular wavefront sensor to quantify aberration profiles at the peripheral retina eccentricities, which will then be used to simulate retinal image quality.

Defining and Modeling LIRIC Writing Modalities
Paul D. Funkenbusch and Amy Lerner
University of Rochester
Clerio Vision, Inc.

We propose to continue and extend current research on Laser Induced Refractive Index Change (LIRIC) to better define, model, and control the process. In addition to changing the refractive index to produce gradient index optical corrections, LIRIC can also subtly alter the cornea shape, providing a potential second modality for producing optical corrections. The proposed work includes two elements. First, differentiating process conditions that produce primarily refractive index change from those that also provide significant shape change. Second, enabling controlled use of the shape change effect by modeling the effects of LIRIC on shape.

Power-efficient LIRIC Scaling and Study of Limits
Wayne H. Knox
University of Rochester
Clerio Vision, Inc.

We propose to expand current studies of Laser Induced Refractive Index Change (LIRIC) into new regimes of low-laser repetition rates (5–15 MHz) and wavelength simultaneously (810 and 405 nm). A newly developed theoretical model for LIRIC writing predicts that LIRIC structures can be written at much lower average powers than currently. For development of eye-safe procedures, these factors are most critical. These studies are being made possible with a new custom fiber laser. Furthermore, we will study damage limits to the LIRIC writing process in cornea and hydrogels with a newly developed high-resolution confocal Raman microscope.

Developing a Brillouin Scattering Microscope to Quantify Mechanical Properties
Geunyoung Yoon
University of Rochester
Clerio Vision Inc.

The human cornea exhibits a relatively simple geometric structure, exposed primarily to stable intraocular pressure. However, the optical and biomechanical behaviors are highly sensitive to variations in individual geometry such as the diameter and thickness as well as the three-dimensional distribution of material properties such as extracellular matrix modulus and fibril organization. The organization and density of the collagen fibrils within the extracellular matrix contribute to highly complex material properties, which are nonlinear, anisotropic, and nearly incompressible and viscoelastic. The overarching goal of the project is to model the biomechanical behavior of the cornea and its influence on optical quality based on individual patient's anatomic geometry, material characteristics, and loading conditions. Such a model, once validated, could be used to investigate responses to refractive surgery, risk for disease, and, potentially, responses to treatment. To achieve this goal, here we propose to develop a Brillouin scattering microscope as a potential ex-vivo imaging modality that can quantify the three-dimensional distribution of material properties of cornea and soft contact lens material with and without optical manipulations.

Efficacy of Visual Training for Recovering Sight in Stroke Patients
Steven Feldon
University of Rochester
Envision LLC

Every year, half a million stroke patients become cortically blind in the US. This blindness impairs the ability to read, drive, and navigate, impacting other rehabilitation efforts and the capacity to live independently. Yet, there is a complete lack of validated vision rehabilitation treatments available to those afflicted. Here, we propose to continue the first randomized, blinded, placebo-controlled study to test the efficacy of a visual discrimination training treatment developed at the University of Rochester for eliciting visual recovery in the blind field of stroke patients. Validating this treatment in the proposed trial is a critical first step for deploying this technology clinically.
Support for Distributed Computing and Network Management on Mobile Ad Hoc Networks
Wendy Heinzelman and Cristiano Tapparello
University of Rochester
Harris Corporation

The goal of this research is to develop technologies and approaches for achieving robust data connections in heterogeneous network platforms using a mixture of ad-hoc and hierarchical networks. Techniques that will be investigated include combining the advantages of point-to-multipoint access systems such as Wi-Fi and/or commercial cellular systems with mobile ad-hoc networking (MANET) technology. Network hierarchy, heterogeneous assets, and cognitive networking will be considered in the solution space.

Smart Sensors for Classical and Quantum Data Links
Roman Sobolewski
University of Rochester
HYPRES, Inc.

The project is devoted to development of the new-generation photon smart sensors, based on superconducting single photon detectors (SSPDs) integrated with Josephson-junction-based, mixed-signal circuits to provide readout, tuning, and control of the detector. These digitally-assisted detectors will have performance characteristics far surpassing traditional, analogue-type SSPDs and will unlock their scalability into large SSPD arrays. We will target high-value applications in optical quantum networks and quantum information applications, including high data rate quantum key-distribution schemes. We will also pursue SSPD applications by interfacing optics with digital superconducing electronics as well as study novel SSPDs based on superconductor/ferromagnet bilayer nanostripes.

Global Surveillance Augmentation for Deep Learning
Andreas Savakis and John Kerekes
University of Rochester
Ovitz Corporation

In this project, we will continue to explore deep learning algorithms for global surveillance applications, focusing on change detection in satellite imagery. During the first two phases of the project, we generated a dataset of vehicle and helicopter images using DIRSIG and used them to train deep convolutional neural networks (CNNs) as object detectors and two channel Siamese networks for change detection. In the third year of the project, we will focus on generating more realistic DIRSIG imagery for training our algorithms, and we will test our change detection methods on real data.

Integrated Optical Frequency Detection and Weak Value Amplification
Jaime Cardenas
University of Rochester
Leondro DRS

We will collaborate to design, fabricate, and test an integrated optical chip. This chip’s purpose will be precise optical frequency measurement using a combination of dispersive elements and weak value-based phase readout. Funds provided by the CEBs will be used to support a graduate student in our group and to buy time and materials for the Cornell nanofabrication facility. This effort is part of the larger effort in collaboration with Leondro DRS, a defence-related company with a national scope.

Fluorescence Gabor-Domain Optical Coherence Microscopy (GD-OCM)
Jarrett Rolland
University of Rochester
LightFormTech Corporation

A multimodal instrument for simultaneous, noninvasive structural and functional assessment of biological environments will be developed. Coupling the high-definition imaging capability in 3D of Gabor-Domain Optical Coherence Microscopy (GD-OCM) with the capability of studying biochemical evolution with laser scanning confocal fluorescence microscopy is unprecedented.

Custom Anterior Surfacing of Scleral Lens Prosthetic Devices for Vision Quality Improvement in Patients with Corneal Ectasia
Tara Vaz
University of Rochester
Ovitz Corporation

Corneal ectasia is a group of ophthalmic conditions involving severe degradation of a patient’s visual acuity and quality of life. We propose a double blinded clinical study for evaluating visual performance of custom anterior surface wavefront correction in ectasia patients wearing scleral lens prosthetic devices. Previous research conducted by the Flaum Eye Institute and Boston Light show improvements in visual performance using this method when performed with research-grade diagnostics. A similar method will be evaluated using a commercial prototype wavefront sensor developed by Ovitz Corporation. This study would demonstrate the effectiveness of the improved technique using a diagnostic setup that could be made available to standard clinics.

Computational Models of Nanomembrane Fouling
James McGrath
University of Rochester
SiMpare Inc.

The emergence of oncolytic viruses that target and kill cancers has profound implications for health care. A major cost driver in the production of viruses as medical products is titer losses as high as 80 percent during sterile filtration. SiMpare’s precise slot-pore membranes can sterile filter oncolytic viruses without loss; however, they have only been tested in small formats. In this project, we will use computational models of membrane clogging by viruses to understand the area requirements and flow conditions needed to meet the demands of industrial production. Results will be used in an NIH Phase II SBIR application to development tangential flow nanomembrane devices for oncolytic virus production.

Development of Quantum Dot Coated Detector Arrays
Zoran Ninkov
University of Rochester
Thermo Fisher Scientific

Improving the sensitivity of silicon-based CMOS and CCD in the deep-UV is an area of interest. Lumogen has been previously used for this purpose but has limitations in its use in both vacuum and radiation harsh environments. Quantum Dots (QD) offer a robust alternative to Lumogen. The fluorescence wavelength of QDs is tunable and can match the peak sensor quantum efficiency. Aerosol jet printing (AJP) is being used at Rochester Institute of Technology to meet the demands of industrial production. Results will be used in an NIH Phase II SBIR application to development tangential flow nanomembrane devices for oncolytic virus production.
**Phased: 2017-2018 PROJECT ABSTRACTS**

**Phase 1: Black Metals and Superwicking Surfaces**

Chenlei Guo  
University of Rochester  
Bausch & Lomb

This project will develop techniques to mass-produce black metals for broad band solar energy absorbers and superwicking superhydrophobic materials for the cold end of thermoelectric generators (TEG) is projected to enhance current module efficiency and extend field service life, which represents a breakthrough in the renewable energy generation and waste heat management. Superwicking surfaces will be produced by manipulating the surface topography of a polymer material through a newly developed imprinting technique.

**Development of Novel Topical Antimicrobial Therapeutics**

Paul Dunman  
University of Rochester  
Acure Therapeutics, Inc.

We are facing a catastrophic health care crisis—antibiotic resistance has jeopardized the use of drugs that have previously cured deadly bacterial infections. Current antibiotics are no longer working. Acure Therapeutics Inc. has developed agents for therapeutic intervention of the most problematic bacterial species that physicians encounter. The current proposal will extend the preclinical development of one of those products and directly create job growth in Rochester, New York.

**Mathematical Model and Computer Simulation of the Motion of a Tordoidal Contact Lens**

Kari L. Maki  
David Ross  
University of Rochester  
Bausch & Lomb

In recent work with Bausch and Lomb, we have developed and applied models of the coupled fluid mechanics and solid mechanics of a contact lens on an eye: a model of action previously performed by a radically symmetric lens conformed to a rigid eye and a model of concentration of a perturbed contact lens. Here we propose to develop a model of the stresses the eyelid exerts on a rigid contact during a blink. We will couple this model with the concentration model and simulate the displacement of a lens and its recentering under the influence of suction pressure gradients.

**Understanding On-Eye Performance of Presbyopia Correcting Contact Lens**

Geungyoon Yoon  
University of Rochester  
Bausch & Lomb

Presbyopia is a visual condition that is faced by all adults over the age of approximately 40 years. Individuals with presbyopia lose the ability to focus on objects up close with significantly impact 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 worn by patients improves our ability to predict its performance and moreover to develop advanced designs. The project is aimed toward the evaluation through in vivo performance of multifocal contact lens designs in which these realistic factors such as deformation and decorrelation of presbyopia-correcting contact lenses imaged by a real-time pupil camera and high resolution optical coherence tomography.

**Deep Learning for High Resolution 3D Cone ARIA and AAR Analytical Imaging Analyses**

Jiebo Luo  
University of Rochester  
Cleno Vision Inc.

Traditional approaches in medical imaging analysis rely on handcrafted features that are robust and reliable when the image analysis task is complicated. In contrast, deep learning, which has made significant progress in recent years, can learn feature representations automatically. For this reason, deep learning has recently gained much attention in the medical image analysis community. In this study, we investigate a deep learning approach to analyzing images of multiple medical imaging modalities, ranging from CT and X-ray to 2D and 3D ultrasound. In particular, we intend to demonstrate the effectiveness of deep learning through a number of sub problems that involve different medical imaging modalities. To ensure that the algorithms will be robust for diverse clinical sources, we will rely on large-scale and diverse datasets with detailed annotations in collaboration with Carestream Health. The developed algorithms will be integrated with the existing Carestream systems, when possible, to validate the benefit of deep learning-driven image analysis.

**Towards Automated Clinical Evaluation of Tendon through Shear Wave Elastography**

Staphanie Heavy  
Mark Buckley  
University of Rochester  
Cleno Vision Inc.

We propose a Comprehensive Parallel-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 constructs 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 greatly increased frame rates. The proposed system uses ultrasound imaging of the target medium via a binary-coded aperture, which gives much improved spatial resolution and reduces the sideband artifacts commonly seen in traditional ultrasound systems, and allows a significant speed-up of image acquisition. This method could have a profound impact on health and quality of life for humans by providing a compact, portable, and easy-to-use ultrasound imaging system with improved performance.

**Plane Wave and Elastic Wave Imaging of ARIA and AAR Arteries**

Michael S. Richards  
Mark Buckley  
University of Rochester  
Cleno Vision Inc.

The continuing goal of the proposed research is to improve the patient-specific assessment of the pathological severity associated with the onset of cardiovascular diseases such as atherosclerosis and aneurysms. The recent development of clinical ultrasound (US) based tissue mechanical property measurements (e.g., elastography) has motivated the use of these technologies to measure the spatial variations of in vivo vascular mechanical properties in real time or pseudo real time. This patient-specific information gathered in a diagnostic or screening mode can then be used to improve treatment recommendations for a variety of life-threatening vascular diseases. This second year will expand upon our previous work in which we developed computational tools that allowed us to accurately measure pulse velocities and material properties in vessel-mining phantoms. In year two, our goal is to test our methods in a limited patient population and construct more quantitative model-based approaches to estimating the material properties of vessels with complicated geometries.

**Assessing the Link between Refractive Changes and Mechanical Properties in IRIS Contact Lenses**

Paul Furkenbusch  
University of Rochester  
Cleno Vision Inc.

Our long-term goal is to use femtosecond micromachining as a noninvasive method of custom-correcting refractive error in human cornea and intraocular lenses (IOLs). The proposed experiments will investigate new regimes of low repetition rate (10–40 MHz), wavelengths of 1030 nm and 1515 nm, and high-power scaling (<10 W) to achieve ultrafast writing speeds in ophthalmic materials such as hydrogels and cornea.

**Biological Impact of LIRIC in the Cornea**

Krystel R. Hughes  
University of Rochester  
Cleno Vision Inc.

LIRIC (Laser-Induced Refractive Index Change) is being developed as a new method for refractive correction in humans and a less-damaging alternative to traditional laser in situ keratomileusis (PRK, LASIK and LASIK). The proposed preclinical study will assess the safety of LIRIC at 405 nm in living rabbit corneas. Aim 1: use optical coherence tomography and in vivo confocal imaging to assess how LIRIC alters the maco-scopic structure of the cornea and the lens. Aim 2: assess whether LIRIC induces inflammation or other cellular/tissue of ocular health (e.g., transparency, intraocular pressure, epithelial integrity). These aims are critical to translate this technology beyond corneal refractive correction and revolutionize the field of refractive correction.

**High-Power Femtosecond Ytterbium-Doped Fiber Laser-Based System for Optimization of Femtosecond Micromachining Ophthalmic Devices**

Wayne H. Knox  
Envision Solutions LLC  
Cleno Vision Inc.

Our ultimate goal is to use femtosecond micromachining as a nondamaging method of custom-correcting refractive error in human cornea and intraocular lenses (IOLs). The proposed experiments will investigate new regimes of low repetition rate (10–40 MHz), wavelengths of 1030 nm and 1515 nm, and high-power scaling (<10 W) to achieve ultrafast writing speeds in ophthalmic materials such as hydrogels and cornea.

**Computer Modeling of Telecom Signals in Metallic and Multimode Fibers**

Govind P. Agrawal  
University of Rochester  
Cleno Vision Inc.

In this project my research group will work with Dr. William Wood of Comming Inc. to develop a comprehensive computer model for studying transmission of optical pulses through multimode and/or multimode fibers capable of supporting several optical modes. A computer model will be developed in stages and tested through experimental verification whenever possible. This work is important because multimode and multicom mode fibers are likely to be used in the near future for implementing the technique of space-division multiplexing.
Developing THz Detector Technology for Inspection Applications
Zoran Ninkov
Rochester Institute of Technology
Harris Space and Intelligence Systems

The THz region provides a means of using nonionizing radiation to perform a variety of noninvasive sensing tasks. Commercial cardiac monitors are available that use THz microbolometer or pyroelectric detectors (e.g., from Gentec and IMO), but these devices lack sensitivity, stability, or readout speed. The proposed collaborative development by Harris/UMR seeks to design, fabricate, and test suitable CMOS-based devices that, through iteration, will result in a commercial product marketed by Harris. The CMOS devices are fabricated in commercial foundries using standard chip manufacturing techniques to keep costs low. The ultimate goal of this multiyear effort is to develop a room temperature, compact, inexpensive THz imaging system that our sponsor (Harris) can market to commercial (e.g., package inspection, crowd monitoring) and military (e.g., on aerial drones for short-range-imaging) customers.

Further Development of THz Detector Arrays and Extension to the IR
Judith L. Pipher
University of Rochester
Harris Space and Intelligence Systems

In collaboration with RIT PI Ninkov, ECE PI Ignjatovic, and Harris Space and Intelligence Systems, our group in PAS has been developing THz and long-wave IR arrays exploiting thermionic emission in CMOS Si arrays. Currently, Generation 6 designs and parameter have been submitted to MOSIS foundry by the ECE group, the first of “smart” chips with memory, an A/D converter and S/H circuitry on-chip. We will concentrate on noise reduction of the more recent generation chip deliverables, IR characterization of the ~10,000 devices, and on conducting the necessary experiments on the new Gen 6 arrays. Our group gives specialise in array technology and has pre-exposure with responsivities that far exceed that of more expensive and less scalable pyroelectric detectors. During the 2017-18 academic year, we will begin tests on the CMOS THz prototype imager fabricated during 2016–17. The results of this analysis will be used to model and optimise noise performance of our THz focal plane arrays, which will be fabricated and tested subsequently.

Smart Sensors for Classical and Quantum Data Learning
Roman Sobolewski
University of Rochester

dwyer Inc.

The project is devoted to developing new optical smart sensors, based optical, superconducting single photon detectors (SPDs) integrated with the Josephson junction-based mixed-signal circuits to provide readout, tuning, and control of the detector. These digitally assisted detectors will have performance characteristics far surpassing those of the traditional analogue-type SPDs and will unlock their scalability to larger SPD arrays. We will target high-value applications in quantum networks for quantum information applications including high data rate key distribution, quantum teleportation, and applications in interfacing optics with digital superconducting electronics and study novel SPDs based on superconducting/ferromagnet nanolayer striper.

High-Frequency Quantitative Ultrasound Systems for Tissue Engineering
Dane Dalecki
University of Rochester
Imaginant

Technologies for monitoring engineered tissues quantitatively are critically needed to advance the field of tissue engineering. The overall goal of this project is to develop and implement high-frequency, quantitative ultrasound systems for noninvasive characterization of engineered tissue constructs. The ultrasound technologies will (i) provide important quantitative tools for monitoring the functionality of tissue engineered products, (ii) offer rapid feedback for optimizing construction design and fabrication parameters, and importantly (iii) circumvent destructive testing in imaging, a world leader in high frequency, nondestructive ultrasound instrumentation. This project will unite experts in biomedical ultrasound and tissue engineering (Dalecki and Hocking) with Imaginant’s technical expertise.

Global Surveillance Augmentation for Deep Learning
Andreas Savakis
John Kerekes
Harris Space and Intelligence Systems

Kivano Inc.

In this project we will continue to explore deep-learning algorithms for global surveillance applications, including object detection and change detection in satellite imagery. Our goal is to train various architectures of deep networks and compare them with graph-based change detection methods. To that end, we will generate additional datasets of augmented data that are sufficiently large and diverse to train our deep networks. We will develop, test, and compare both supervised and unsupervised change detection methods to identify important changes in panchromatic or color satellite imagery taken at different times.

Nondestructive/Noninvasive Three-Dimensional Imaging with Gabor-domain Data Links
Jannick Rolland
University of Rochester
LightTapTech Corporation

Real-time, high-resolution nondestructive, inspection methods are needed to characterize materials through their depth, including plastics, glass, and human tissue. Fast, accurate metrology brings value to the manufacturing industry by improving quality, increasing productivity, and reducing costs. This project will supplement the development of Gabor-domain optical coherence microscopy (GD-OCM) instrument, the Explo3D, to explore a longer working distance for industrial and medical imaging applications.

Host/Emitter Interactions in OLED Emitter Layers
Lee H. Rothberg
University of Rochester
Molecular Glasses

Molecular Glasses, Inc. is developing a novel class of noncrystalline organic semiconductors for use in OLED devices. We have already demonstrated significant increase in OLED device lifetime in yellow phosphorescent OLEDs using our material as a host. One key OLED problem is the short life of high-efficiency blue emitters. Our materials have the potential to help solve this problem. This project will help us develop the necessary hosts for long-life blue emitters. Photophysical characterization of hosts/emitters interaction is essential for choosing the most promising host candidates.

Augmented Reality Display Exploiting Advanced Ad Hoc Networking
Jannick Rolland
Nick Vamivakas
University of Rochester
Oculus

We work on compact hemodialysis devices that revealed an unexpected benefit: the ability of nanomembranes to capture 90–100 nm vesicles that naturally occur in biological fluids. These vesicles, called exosomes, are powerful diagnostic markers for cancers and other disease. We wish to develop a robust exosome capture system and propose that transmembrane electrical resistance (TMER) can be used as a real-time measure of the capture process. We will first develop a nanomembrane capture device with integrated electronics. We will then test the hypothesis that TMER increases in proportion to the fraction of pores occupied by exosomes.

Development of Quantum Dot Coated Detector Arrays
Zoran Ninkov
Rochester Institute of Technology
Thermo Fisher Scientific

Improving the sensitivity of silicon-based CMOS and CCD in the deep-UV is an area of interest. Lumogen has been previously used for this purpose but has limitations in its use in both vacuum and radiation harsh environments. Quantum Dots (QD) offer a robust alternative to Lumogen. The fluorescence wavelength of QDs is tunable and can match the peak sensor quantum efficiency. Aerosol jet printing (AJP) is being used at RIT for the deposition of QDs on substrates and commercial sensor arrays. Insights obtained and improvements in the equipment will permit commercialising ready devices to be fabricated and tested this year.

Electrical Monitoring of Exosome Capture on Nanomembranes
James McGrath
University of Rochester
SWiFre Inc.

This project will unite experts in biomedical technology, characterization and develop design methodologies for THz focal plane arrays in support of Harris’s (formerly ITT Exelis, Inc.) THz imaging initiative. The proposed work is a continuation of our current efforts with Harris. Preliminary experimental results indicate that our technology shows a great deal of promise in detecting THz and IR to THz with high responsivity that far exceed that of more expensive and less scalable pyroelectric detectors. Other devices to be fabricated and tested subsequently:

Data Links

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At the Corning Museum of Glass in Corning, New York, visitors can learn about the science and technology of glass and optics through hands-on exhibits.

ALCHLIGHT
www.alchlight.com
Alchlight, based in Rochester, New York, is the leading developer and distributor of advanced and proprietary laser-fabricated materials. Acclaimed by the New York Times as “optical alchemy,” Alchlight uses femtosecond laser processing to etch proprietary nanostructures on materials. The procedure doesn’t coat the materials; instead, it changes the intrinsic properties of the materials. Alchlight’s topographies can change the color of titanium to blue, make silicon attract water, or even make water bounce off brass.

ARCUM THERAPEUTICS
www.arcumtherapeutics.com
Arcum is developing an antibiotic platform for the prevention and elimination of resistant bacterial infections. Arcum’s mission is to save lives and prevent a return to the days when simple infections were a common cause of death. We create combination drugs that target the Arcum proprietary resistance pathway, utilizing the FDA 505b2 accelerated approach to bring products to market faster with less risk for our investors.

BAUSCH AND LOMB
www.bausch.com
Bausch & Lomb offers one of the world’s most comprehensive portfolios of eye-health products. B+L markets five broad categories of products: contact lenses, lens care, pharmaceuticals, cataract and ophthalmic surgery, and refractive surgery.

CARESTREAM
www.carestream.com
Carestream is a dynamic global company with more than 100 years of leadership. In today’s rapidly changing global health care environment, where the mandate to provide better outcomes has never been greater, we add value by delivering personalized, affordable, and practical options to help our customers advance. Medical providers large and small, from clinics and single hospitals to large networks and even entire countries, are upgrading their radiology and IT systems using Carestream’s latest solutions.

CLERIO VISION
www.cleriovision.com
Clerio Vision is developing a novel vision correction procedure based on technology licensed from the University of Rochester. Instead of changing the shape of the cornea, as current LASIK-based approaches do, its approach is to use a femtosecond laser to change the refractive index of the cornea with small pulses to “write” a corrective prescription onto the cornea noninvasively. Because this approach doesn’t thin the cornea, it can be repeated as needed to correct vision changes over a person’s lifetime. The approach, called LIRIC, is being commercialized by some of the original architects of the world’s first LASIK systems. Clerio’s core technology has been in development for over a decade and is based on more than 40 issued and pending patents.

CORNING INCORPORATED
www.corning.com
Corning, Inc. is a diversified technology company that develops breakthrough technologies that significantly improve people’s lives. Corning pursues innovation and focuses on high-impact growth opportunities in the telecommunications, flat panel display, environmental, life sciences, and semiconductor industries.
ENVISION SOLUTIONS LLC
Envision Solutions, LLC is a company that has been working to build efficacy of visual training for recovering sight in stroke patients.

FLINT CREEK RESOURCES
www.flintcr.com
Flint Creek Resources is a unique company that offers services to make used rare earth and zirconia glass polishing compounds better than new. Spent polishing compounds are processed through a proprietary system that removes glass, polishing pad fragments, and contamination from the slurry. The resulting clean polishing particles are then custom formulated to produce excellent stock removal, surface finish, suspension, and cleanability.

FLUXDATA, INC.
www.fluxdata.com
FluxData develops and manufactures multispectral and polarimetric imaging systems for aerospace, defense, industrial, medical, and scientific markets. FluxData is a privately held, women-owned company located in Rochester, New York. FluxData’s imaging and system integration expertise helps guide customers from camera specification to delivery of the final system. Our staff of imaging experts works with customers to frame problems and deliver optimized systems based on a broad suite of options. Every product comes with FluxData’s commitment to first-rate customer support.

HARRIS CORPORATION
www.harris.com
Harris provides advanced technology-based solutions that solve government and commercial customers’ mission-critical challenges. The company has approximately 58 billion in annual revenue and about 23,000 employees—including 9,000 engineers and scientists—supporting customers in more than 125 countries. Harris Corporation is a top-10 defense contractor providing mission-critical solutions through its Communication Systems, Critical Networks, Electronic Systems, and Space and Intelligence Systems segments.

HYPRES, INC.
www.hypres.com
HYPRES, Inc manufactures superconducting microelectronics, including superconducting Integrated Circuits (ICs). Its products include voltage standard circuits and systems, wide bandwidth semiconductor-based amplifiers, and superconducting circuit foundry service. The company was founded in 1983 and is based in Elmsford, New York.

IMAGINANT
www.jnjultrasonics.com
Imaginant is a manufacturer of high-resolution digital cameras, ultrasonic NDT instruments, and handheld and robotic coating thickness measurement systems.

KITWARE
www.kitware.com
Kitware, Inc. is a leader in the creation and support of open-source software and state-of-the-art technology. Through our long-standing commitment to open source, detailed in our open source mission statement, we have become one of the fastest growing software companies in the country. By fostering extended collaborative communities, Kitware is able to provide flexible, cost-effective visualization, computer vision, medical imaging, data publishing, and quality software process solutions to a variety of academic and government institutions and private corporations worldwide.

KODAK ALARIS
www.kodakalaris.com/en-us
We’re a company born from one of the world’s most iconic brands. A company that is passionate about using technology to transform organizations and improve people’s lives across the planet. From our digital scanners and intelligent state-of-the-art software services that power some of the world’s largest companies to our photographic paper production, printing kiosks, and suite of consumer apps, we help people capture and connect with the emotional moments that define all our lives. Kodak Alaris is on a mission to unlock the power of images and information for the world. We work behind the scenes, making the connections, pushing the boundaries of technology, and helping you make sense of and exploit the ever-expanding volume of data that is the hallmark of the 21st century.

LIGHTOPTTECH
www.lightoptech.com
LightOptTech Corporation is a women-owned optical technology company founded in 2013 and based in Rochester, New York. Our goal is to build innovative optical instruments to improve noninvasive imaging in medical and manufacturing fields.

MOLECULAR GLASSES, INC.
www.molecularglasses.com
Molecular Glasses, Inc. focuses on proprietary NONcrystallizable™ molecular glasses for stable and long-lived OLED and other organic electronics. Their unique technology enables them to design NONcrystallizable™ molecular glasses for superior performance. They have the ability to take their clients’ favorite material sets and convert them to NONcrystallizable™ and soluble materials without affecting their original photophysical properties.

OCULUS
www.oculus.com
Oculus Rift and the Oculus-powered Samsung Gear VR provide the most immersive VR experiences and environments available, from games and movie scenes to exotic destinations and beyond. Founded in July 2012 by Palmer Luckey, Brendan Iribe, Nate Mitchell, and Michael Antonov, Oculus began as a Kickstarter campaign that raised $2.4 million in the first month and was acquired by Facebook in 2014.
CORPORATE PARTNERS

OPTIPRO SYSTEMS LLC
www.optipro.com
OptiPro was founded on one revolutionary, yet simple, concept: optical fabricators deserve more. In the past 30 years since we introduced the first affordable CNC machine designed specifically for the optics industry, we have consistently built a culture that cares—a culture of employees who live and breathe by our strong OptiPro values and a culture of best-in-breed customers who are collectively on a relentless pursuit of process efficiencies, design improvements, capability enhancements, and marketplace superiority.

OVITZ
www.o-vitz.com
Ovitz Corporation is an exciting medical device company specializing in developing, manufacturing, and marketing novel and portable ophthalmic equipment and accessories that facilitate the delivery of ophthalmic care in eye doctors’ and primary care physicians’ offices, and in schools, rural areas and developing nations.

SIMPORE INC.
www.simpore.com
SiMPore is a Rochester, New York–based nanotechnology company that designs and produces membranes and membrane-enabled products based on its unique patent-pending platform technology—the NanoBarrier™ ultrathin nanoporous silicon membrane. The NanoBarrier™ membrane is the world’s first membrane to offer both tunable nanometer-scale thickness and pore size. SiMPore is developing products that take advantage of these one-of-a-kind features, including filters for separating and concentrating biological molecules and nanoparticles, cell culture substrates for growing cells, and electron microscopy grids for preparing and imaging samples at the nanoscale.

SOLID CELL
www.solidcell.com
Solid Cell is a developer of stationary and portable solid-oxide fuel cell technologies for residential, commercial, industrial, and other critical off-grid applications. The company’s headquarters is located in New York City; its principal product development and manufacturing center is in Rochester, New York. Solid Cell’s products provide clean energy using state-of-the-art fuel cell technology at commercially competitive costs. The company has targeted several specific applications to satisfy a wide variety of global power requirements. Widespread use of Solid Cell’s fuel cells will reduce reliance on scarce natural resources like natural gas and oil.

SYNAPTICS INC.
www.synaptics.com
We are the pioneers and leaders of the human interface revolution, bringing innovative and intuitive user experiences to intelligent devices. From usability and R&D to supply chain and support, we collaborate with our partners to invent, build, and deliver human interface solutions that integrate seamlessly and optimize system value. The improved ease of use, functionality, and aesthetics of Synaptics-enabled products help make the digital lives of people more productive, secure, and enjoyable.

THERMO FISHER SCIENTIFIC INC.
www.thermofisher.com
Thermo Fisher Scientific Inc. (NYSE: TMO) is the world leader in serving science, with revenues of $17 billion and 50,000 employees in 50 countries. Our mission is to enable our customers to make the world healthier, cleaner, and safer. We help our customers accelerate life sciences research, solve complex analytical challenges, improve patient diagnostics, and increase laboratory productivity. Through our four premier brands—Thermo Scientific, Life Technologies, Fisher Scientific, and Unity Lab Services—we offer an unmatched combination of innovative technologies, purchasing convenience, and comprehensive support.

UR VENTURES
www.rochester.edu/ventures
UR Ventures develops University of Rochester innovations into valuable products and services to make the world a better place. Technology transfer functions are mandated by federal law. Even if they weren’t, we would still do it because it’s the right thing to do. Not only does the transfer of technologies make the world a better place, but the revenues generated are unrestricted and support the amazing research of the future. By rewarding our inventors, we also motivate them to solve real-world problems. Finally, the relationships we create help to attract and maintain industrial support for research.

VISUALDX
www.visualdx.com
UR Ventures develops University of Rochester innovations into valuable products and services to make the world a better place. Technology transfer functions are mandated by federal law. Even if they weren’t, we would still do it because it’s the right thing to do. Not only does the transfer of technologies make the world a better place, but the revenues generated are unrestricted and support the amazing research of the future. By rewarding our inventors, we also motivate them to solve real-world problems. Finally, the relationships we create help to attract and maintain industrial support for research.
This year, CEIS partner Professor Wane Knox of the University of Rochester was elected as a fellow of the National Academy of Inventors.

**Govind Agrawal**

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**Education**

PhD, Indian Institute of Technology, Physics, 1974; MS, Indian Institute of Technology, Physics, 1971; BS, University of Lucknow, Physics and Statistics, 1969

**Research Interests**

Quantum electronics, Nonlinear photonics, Fiber-optic communications

**Recent Research Projects**

Transmission of optical pulses, Semiconductor lasers, Nonlinear fiber optics, Optical communications

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**Education**

PhD, University of Rochester, Physics, 1984; MS, University of Rochester, Physics and Astronomy, 1980; BS, Colgate University, Physics and Astronomy, 1978

**Research Interests**

Multimedia signal processing, Imaging microelectronics, Wireless sensors

**Recent Research Projects**

Digital audio watermarking and steganography, Image sensors with built-in image compression, Digital CMOS image sensor read-out circuits

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**Thomas Brown**

Professor of Optics, University of Rochester

**Education**

PhD, University of Rochester, Optics, 1987; BS, Gordon College, Physics, 1979

**Research Interests**

Optical polarization and metrology, Optoelectronic modeling, Integrated optoelectronics

**Recent Research Projects**

Focusing and coherence properties of polarization vortex beams, Stress-engineered optical elements, Polarization properties of nanostructures, Waveguide mode resonances in SOI waveguides

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**Education**

PhD, Cornell University, Physics, 2010; BS, Haverford College, Physics, 2001

**Research Interests**

“Viscoelastic” soft biological tissues; Soft tissue aging, disease, and repair

**Recent Research Projects**

Diseases of the musculoskeletal system, Plane wave and elastographic imaging

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Recent Research Projects Integrated optical frequency detection and weak value amplification, Photonic needles for light delivery in deep-tissue-like media
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Earl W. Brinkman Professor of Industrial and Systems Engineering and Director of AMPrint Center (CAT), Rochester Institute of Technology
Research Interests Additive manufacturing and multifunctional printing
Recent Research Projects Integration of 10 printed lens with InGaN light-emitting diodes with enhanced light extraction efficiency, Cu ink adhesion solutions
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Education PhD, University of Rochester, Electrical Engineering, MS, University of Rochester, Electrical Engineering; BS, University of Rochester, Chemical Engineering
Research Interests Diagnostic ultrasound imaging, Therapeutic applications of ultrasound, Low-frequency underwater sound fields
Recent Research Projects Mechanisms for wound healing with ultrasound, Ultrasound technologies for tissue engineering, Effects of underwater sound on biological tissues
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Education Diagnostic Radiology, Siemens Medical, New York, 1999; MD, Medicine, St. Vincent Medical Center, 1994; MD, Medicine and Surgery, Jawaharlal Institute (India), 1977
Research Interests MR, CT, and GU radiology, Ultrasound
Recent Research Projects In-vivo photoacoustic and ultrasound imaging probe for human thyroid cancer detection
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Research Interests Novel strategies for the therapeutic intervention of bacterial infections, Modulation of mRNA turnover
Recent Research Projects Light-diffusing fiber as a disinfectant or antimicrobial agent, Efflux pumps and inhibitors of serum-grown Acinetobacter baumannii, Identifying new antimicrobial agents against Mycobacterium tuberculosis, Tefendine as a new S. aureus antibiotic
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Research Interests Computer graphics, Digital imaging, Data visualization, Visual perception, Low vision, Assistive technologies
Recent Research Projects Effects of image dynamic range on apparent surface gloss
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Recent Research Projects Thyroid-associated eye disease
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Research Interests Relationships among microstructure, properties, and processing of materials
Recent Research Projects Optical probing for freeform optics metrology
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Recent Research Projects Light-diffusing fiber as a disinfectant or antimicrobial agent, Efflux pumps and inhibitors of serum-grown Acinetobacter baumannii, Identifying new antimicrobial agents against Mycobacterium tuberculosis, Tefendine as a new S. aureus antibiotic
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Recent Research Projects Effects of image dynamic range on apparent surface gloss
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Recent Research Projects Optical probing for freeform optics metrology
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Recent Research Projects
Cellular co-culture screening assays

Research Interests
Multimedia communication, Wireless sensor networks, RFID systems, Cloud computing,
Electrical and Computer Engineering, 2004; BS, Cornell University, Biological and Environmental Engineering, 1998

Education
PhD, University of Rochester, Electrical and Computer Engineering, 2000; MS, Rochester Institute of Technology, Electrical Engineering, 1998, BS, Rochester Institute of Technology, Biomedical Engineering, 1996

Research Interests
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Electrical and Computer Engineering, 2004; BS, Cornell University, Biological and Environmental Engineering, 1998

Education
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Research Interests
Multimedia communication, Wireless sensor networks, RFID systems, Cloud computing,
Electrical and Computer Engineering, 2004; BS, Cornell University, Biological and Environmental Engineering, 1998

Education
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Research Interests
Multimedia communication, Wireless sensor networks, RFID systems, Cloud computing,
Electrical and Computer Engineering, 2004; BS, Cornell University, Biological and Environmental Engineering, 1998

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Research Interests
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Electrical and Computer Engineering, 2004; BS, Cornell University, Biological and Environmental Engineering, 1998

Education
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Research Interests
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Electrical and Computer Engineering, 2004; BS, Cornell University, Biological and Environmental Engineering, 1998

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Research Interests
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Electrical and Computer Engineering, 2004; BS, Cornell University, Biological and Environmental Engineering, 1998

Education
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Research Interests
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**Education**
- PhD, Purdue University, Electrical Engineering, 1989
- MS, Purdue University, Electrical Engineering, 1986
- BS, Purdue University, Electrical Engineering, 1983

**Research Interests**
- Remote sensing, system modeling, and analysis
- Pattern recognition
- Digital imaging
- Image processing

**Recent Research Projects**
- Global surveillance augmentation for deep learning

### WAYNE KNOX

**Professor of Optics, of Physics, of Materials Science, and in the Center for Visual Science, University of Rochester**

**Education**
- PhD, University of Rochester, Optics, 1984
- BS, University of Rochester, Optics, 1979

**Research Interests**
- Ultrafast laser physics and prototyping
- Femtosecond micromachining and applications in vision science
- Dispersion micromanagement in holey and photonic crystal fibers
- Ultra-short pulse lasers
- Novel fiber components based on fiber tapering
- Dispersion compensation devices
- High nonlinearity fiber devices
- Ultrafast mid-infrared sources
- Dispersion—limits, measurements, compensation schemes
- Biomedical optics

**Recent Research Projects**
- Femtosecond micromachining of ophthalmic polymers

### JIEBO LUO

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**Education**
- PhD, University of Rochester, Electrical Engineering, 1995
- MS, Electrical Engineering, University of Science & Technology (China), 1992
- BS, Electrical Engineering, University of Science & Technology (China), 1989

**Research Interests**
- Computer vision
- Machine learning
- Social media
- Data mining
- Human computer interaction
- Biomedical informatics
- Mobile and pervasive computing
- Computational photography
- Ubiquitous and mobile computing

**Recent Research Projects**
- Fine-grained user profiling from multiple social multimedia platforms
- Wine recommendation for grocery shoppers

### KARA MAKI

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**Education**
- PhD, University of Delaware, Applied Mathematics, 2005
- MS, University of Delaware, Applied Mathematics, 2002
- BS, University of New Hampshire, Mathematics, 2001

**Research Interests**
- Physical systems and industrial problems pertaining to flows of biological and complex fluids
- Modeling
- Ordinary and partial differential equations
- Scientific computing

**Recent Research Projects**
- Effect of contact lens distortion on exchange of tears, Model for suction pressure under a contact lens

### STEPHEN MCALEAVEY

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**Education**
- PhD, University of Rochester, Electrical and Computer Engineering, 2002
- MS, University of Rochester, Electrical and Computer Engineering, 1998
- BS, University of Rochester, Electrical and Computer Engineering, 1996

**Research Interests**
- Use of motion tracking techniques to enhance the contrast of ultrasound images,
- Acoustic Radiation Force Impulse (ARFI), Magnetically induced vibration of brachytherapy seeds

**Recent Research Projects**
- Development of novel, clinically applicable ultrasound imaging techniques,
- Acoustic radiation force imaging techniques,
- Spatially Modulated Ultrasound Radiation (SMURF) imaging,
- Single tracking location

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### JAMES McGRATH

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**Education**
- PhD, Division of Health Sciences and Technology, Harvard/MIT, 1998
- BS, Massachusetts Institute of Technology, Mechanical Engineering, 1994
- BS, Arizona State University, Mechanical Engineering, 1991

**Research Interests**
- Nanoparticle and molecular separations, Nanotechnology, MEMS and micro fabrication, Cell culture technologies, Biological tissue models, Small-format hemodialysis, Biosensors, Electrokinetic devices

**Recent Research Projects**
- Interaction of nanoparticles with cells and protein mixtures
- Ultrathin silicon-based nanomembranes for filtration of molecules and nanoparticles
- Ultrathin silicon-based nanomembranes for bioculture

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**Education**
- PhD, Rensselaer Polytechnic Institute, Physics, 1998
- BS, Clarkson University, Physics, 1991

**Research Interests**
- Investigation of physical and geophysical processes and properties through analysis of remotely sensed data and image exploitation
- Advanced mathematical approaches for spectral image processing
- Target detection in hyperspectral imagery

**Recent Research Projects**
- Spatial segmentation of multispectral imagery by fusion of spectral-gradient textural attributes, Knowledge-based automated road network extraction system using multispectral images

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### BENJAMIN MILLER

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**Education**
- PhD, Stanford University, Organic Chemistry, 1994
- BS, Chemistry, BA, Mathematics, German, Miami University, 1988

**Research Interests**
- Biomedical nanotechnology, Combinatorial chemistry, Biophysical methods, Biosensors

**Recent Research Projects**
- Control of biomolecular interactions through the synthesis of new small-molecule probes and the observation of biomolecular interactions through the development of novel optical sensing technologies

**Contact Information**
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Education PhD, University of British Columbia, Geophysics and Astronomy, 1985; MSc, Monash University, Physical Chemistry, 1980; BS, University of Western Australia, Physics, 1977
Research Interests Novel 2-D CMOS detector arrays, Fundamental limitations of visible and IR arrays, Miniaturized multispectral systems
Recent Research Projects Development of novel two-dimensional detector arrays, Development of image processing techniques for optimal analysis of such two-dimensional astronomical image data
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Research Interests Critical care translational research, Epidemiology of critical care medicine, Noninvasive measurements of microvascular function
Recent Research Projects Hyperspectral imaging for noninvasive, comprehensive measurement of microvascular function in humans, Protocols and hospital mortality in critically ill patients: the United States Critical Illness and Injury Trials Group Critical Illness Outcomes Study
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JUDITH PIPHER
Professor Emeritus of Physics and Astronomy, University of Rochester
Education PhD, Astronomy, Cornell University, 1971; MS, Astronomy, Cornell University, 1970; BS, Physics and Astronomy, University of Toronto, 1962
Research Interests Infrared observations of star-forming regions, Infrared detector array development and applications to astronomy and to persistent surveillance
Recent Research Projects Teledyne HgCdTe 10 micron cutoff detector arrays for use in future space experiments, with particular emphasis on NEOCam (Near Earth Object Camera), Characterization of Raytheon long wavelength HgCdTe detector arrays, FIRE spectrometer development, Persistent surveillance driven projects
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Research Interests Machine learning, Computer vision and robotics, Embedded control
Recent Research Projects Computer vision algorithms for portable vision diagnostic devices
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Research Interests Optical metrology, Optical instrumentations, Adaptive and active optics, Segmented large-scale optics alignment and testing, Pulse compression, ultrafast laser systems and applications, Optical system design and performance evaluation
Recent Research Projects Development and investigation of an integrated laser-based optics polishing and manufacturing technology, Laser polishing for additive manufacturing
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Research Interests Biomechanics of soft tissues and measuring the change in mechanical properties of diseased tissues using clinical imaging modalities
Recent Research Projects Development, validation, and implementation of elasticity imaging, or elastography, for diagnosing vascular diseases
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Research Interests Optical system design for imaging and nonimaging optics, Physics-based modeling, Image quality assessment
Recent Research Projects Gabor domain optical coherence microscopy for detection of defects in manufacturing, Optical coherence tomography for quantification of contact lens properties
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Research Interests Statistical physics of protein mixtures, Cell signaling dynamics, Fluid mechanics and solid mechanics of contact lenses and tear films
Recent Research Projects Effect of contact lens distortion on exchange of tears, Model of suction under contact lens
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Research Interests Organic electronics, Organic device science, Metal nanoparticle enhanced spectroscopy and imaging, Bio-molecular sensing
Recent Research Projects Molecular glasses, Novel optical technologies for sensing of nuclear acids and proteins, Mechanistic studies of electronic polymers used in Luminescent devices, Plasmonic enhancements of molecular absorption and luminescence, Small fragment removal for next-generation sequencing
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Research Interests Three-dimensional geometry extraction from multiview imagery, Material optical properties measurement and modeling, Still and motion image processing for various applications, Thermal infrared phenomenology, exploitation, and simulation
Recent Research Projects Signatures Modeling, Derivation, and Exploitation, RT Immersive Living Room, START-X ESP Signatures and WVR Measurement Support
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Research Interests Real-time computer vision, Multimedia systems, Medical imaging
Recent Research Projects Global surveillance: augmentation for deep learning, Real-time systems for object tracking and activity recognition, Algorithms and systems for robust scene categorization and object classification in consumer photographs, Document processing algorithms for thresholding, compression, and rendering in high-speed scanners
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Research Interests Ultrasonic optoelectronics, Quantum optoelectronic and spintronic devices, Ballistic transport in electronic nanodevices, Quantum communication and information
Recent Research Projects Quantum key distribution using polarized infrared single photons for practical quantum cryptography and deep space optical communications, Subpicosecond electro- and magnetooptic characterization of electronic, optoelectronic, and spintronic materials and systems, Smart sensor for classical and quantum data links
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Research Interests Wireless communication and networking, Mobile cloud computing, Smart and connected healthcare solutions, Stochastic modeling and optimization, Design of novel techniques to facilitate the development and diffusion of smart and connected healthcare solutions
Recent Research Projects Design and optimization of large ad-hoc networks
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Education PhD, Boston University, Electrical Engineering, 2008; BS, Boston University, Electrical Engineering, 2001
Research Interests Light-matter interaction at the nanoscale, Quantum optics, nano-photronics and condensed matter physics
Recent Research Projects Solid-state and photonic approaches to quantum science
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TARA VAZ
Assistant Professor of Ophthalmology, University of Rochester
Education Fellowship, SUNY College of Optometry, 2002; OD, SUNY College of Optometry, 2001; BS, McMaster University, Biochemistry, 1996
Research Interests Contact lenses, Lens selection, Ophthalmic drops
Recent Research Projects High- and low-contrast visual acuity measurements in spherical and aspheric soft contact lens wearers, Continued development of portable low-cost wavefront sensors
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Research Interests Adaptive optics and in-vivo ocular surface and intracocular imaging, Customized vision correction, Presbyopic correction
Recent Research Projects Large stroke adaptive optics for correcting highly aberrated eyes, Investigation of accommodation and presbyopic lens (multifocal and accommodative intraocular lens)
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yoon@cv.rochester.edu
This microdialysis prototype is printed from ABS plastic and contains layers of silicone and nanomembrane filters for use in portable hemodialysis. It was developed by University of Rochester associate professor of biomedical engineering James L. McGrath.
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