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Conferences + Courses: 2-4 February 2020

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AR|VR|MR 2020

AUGMENTED, VIRTUAL, AND MIXED
REALITY CONFERENCE

2-4 February 2020

The Moscone Center, San Francisco, California, USA

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SPIE.

SPIE is the international society for optics and photonics, an educational not-for-profit organization founded in 1955 to advance light-based science, engineering, and technology. SPIE provided more than \$5 million in support of education and outreach programs in 2019.

SPIE would like to express its deepest appreciation to the symposium chairs, conference chairs, program committees, session chairs, and authors who have so generously given their time and advice to make this symposium possible.



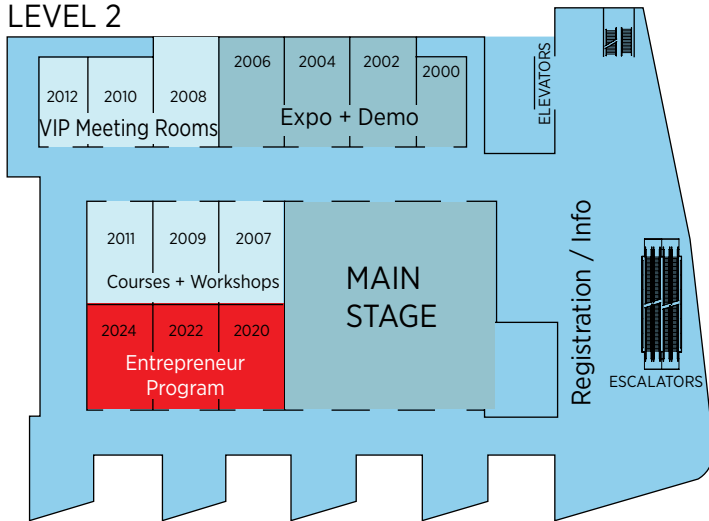
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THE MOSCONE CENTER WEST • 2ND FLOOR (LEVEL 2)

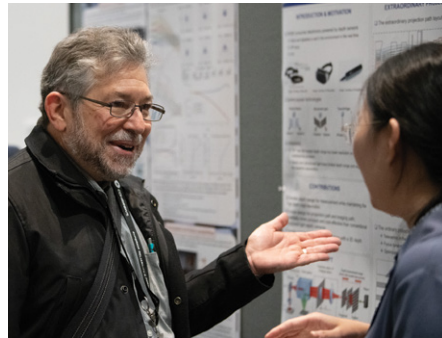
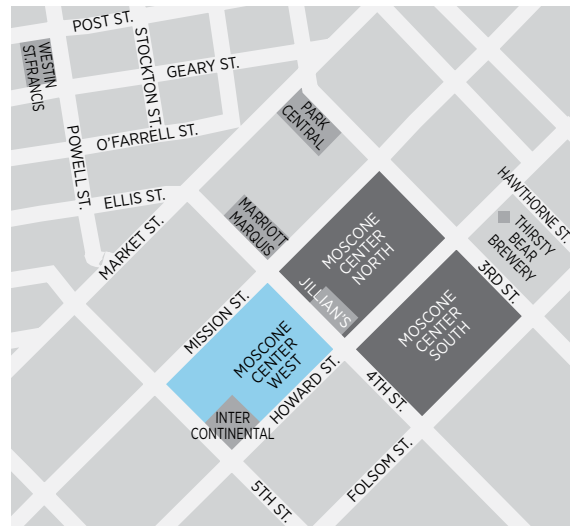


SPIE.AR|VR|MR MOSCONE WEST

LEVEL 2



STREET MAP



SUNDAY TECHNICAL PRESENTATIONS

CONFERENCE 11310

Sunday 2 February 2020 • Proceedings of SPIE Vol. 11310

Optical Architectures for Displays and Sensing in Augmented, Virtual, and Mixed Reality (AR, VR, MR)

Conference Chairs:



Bernard C. Kress,
Microsoft Corp. (USA);



Christophe Peroz,
Magic Leap, Inc. (USA)

Program Committee:

- Martin S. Banks,** Univ. of California, Berkeley (USA)
- Pablo Benítez,** Univ. Politécnica de Madrid (Spain)
- Julie L. Bentley,** Univ. of Rochester (USA)
- Michael P. Browne,** SA Photonics, Inc. (USA)
- Weichuan Gao,** Facebook Technologies, LLC (USA)
- Andreas G. Georgiou,** Microsoft Research Cambridge (United Kingdom)
- Hong Hua,** Wyant College of Optical Sciences, The Univ. of Arizona (USA)
- Mary Lou Jepsen,** Openwater (USA)
- Fernando Mendoza-Santoyo,** Centro de Investigaciones en Óptica, A.C. (Mexico)
- Jannick P. Rolland,** The Institute of Optics (USA)
- Zhujun Shi,** Harvard Univ. (USA)

SUNDAY 2 FEBRUARY

SESSIONS 1A - 1D RUN CONCURRENTLY.

SESSION 1A
LOCATION: ROOM 2007
(LEVEL 2 WEST)
SUN 8:10 AM TO 10:10 AM

Optical Design Challenge Presentations

Session Chair: **Weichuan Gao,**
Facebook Technologies,
LLC (USA)

Optical Design Challenge contestants will present their cutting-edge research as one of three required components of the challenge. The three components are: (1) abstract and manuscript submission; (2) on-site poster presentation (reviewed and scored); and (3) on-site "pitch" presentation (reviewed and scored).

The Student Optical Design Challenge consists of authors who are full-time students registered at an academic or research institute, performing their work either in an academic lab, a research institute or as an internship in an external company.

8:10 am: **A retinal-scanning-based near-eye display with diffractive optical element,** Chao Ping Chen, Wenbo Zhang, Yifan Lu, Jie Chen, Nizamuddin Maitlo, Shanghai Jiao Tong Univ. (China); Lantian Mi, Shanghai Jiao Tong Univ (China) [11310-1]

SESSION 1B
LOCATION: ROOM 2009
(LEVEL 2 WEST)
SUN 8:10 AM TO 10:10 AM

Human Factors in AR/VR

Session Chair: **Martin S. Banks,**
Univ. of California, Berkeley (USA)

8:10 am: **Eyebox centering using chromatic aberrations of virtual reality head mounted displays,** Ryan Beams, Aldo Badano, Andrea S. Kim, U.S. Food and Drug Administration (USA) [11310-7]

8:30 am: **Method for evaluating 3D display systems based on perceived retinal image,** Mohan Xu, Hong Hua, The Univ. of Arizona (USA) [11310-8]

8:50 am: **Clearing key barriers to mass adoption of augmented reality with computer-generated holography,** Andrzej Kaczorowski, Alfred J. Newman, Alden O. Spiess, Omer A. Tastemur, Darran F. Milne, VividQ (United Kingdom) . . . [11310-9]

9:10 am: **Contributions of foveal and non-foveal retina to accommodation,** Vivek Labhishetty, Steven A. Cholewiak, Agostino Gibaldi, Martin S. Banks, Univ. of California, Berkeley (USA) . [11310-10]

9:30 am: **Augmented reality and human factors regarding the neurosurgical operating room workflow,** Nhu Q. Nguyen, Jillian Cardinell, Joel M. Ramjist, Dimitrios Androutsos, Victor X. D. Yang, Ryerson Univ. (Canada) [11310-11]

SESSION 1C
LOCATION: ROOM 2011
(LEVEL 2 WEST)
SUN 8:10 AM TO 9:50 AM

Improvement of Waveguide Combiners for AR

Session Chair: **Zhujun Shi,**
Harvard Univ. (USA)

8:10 am: **Eye box expansion using waveguide and holographic optical element for augmented reality head-mounted display,** Bongsu Shin, Sunil Kim, Samsung Advanced Institute of Technology (Korea, Republic of); Vladislav Druzhin, Polina Malinina, Sergey Dubynin, German Dubinin, SAMSUNG R&D Institute Russia (Russian Federation); Sergey Kopenkin, Andrey Putilin, P. N. Lebedev Physical Institute of the RAS (Russian Federation); Wontaek Seo, Chang-Kun Lee, Geeyoung Sung, Yun-Tae Kim, Samsung Advanced Institute of Technology (Korea, Republic of); Juwon Seo, Samsung Advanced Institute of Technology (Kosovo, Republic of); Jae-Seung Chung, Hong-Seok Lee, Sung-Hoon Hong, Samsung Advanced Institute of Technology (Korea, Republic of) [11310-13]

8:30 am: **Waveguide-based see-through near-eye display with two-dimensional exit pupil expansion,** Wenbo Zhang, Shanghai Jiao Tong Univ. (China) [11310-14]

SESSION 1D
LOCATION: ROOM 2008
(LEVEL 2 WEST)
SUN 8:00 AM TO 9:00 AM

Technology Trends in AR/VR

Session Chair: **Hong Hua,** Wyant College of Optical Sciences (USA)

8:00 am: **Electronic see-through head mounted display with minimal peripheral obscuration,** Michael P. Browne, SA Photonics, Inc. (USA); Stan Larroque, SL Process (France) [11310-45]

8:20 am: **Birds do it. Bees do it. A bio-inspired look at wayfinding and navigation tools for augmented reality,** James E. Melzer, Richard W. Madison, Thales Visionix, Inc. (USA) [11310-42]

8:40 am: **Laser packaging architecture which overcomes challenges in AR imaging,** Ann Russell, OSRAM (USA) [11310-79]

SUNDAY TECHNICAL PRESENTATIONS

SESSIONS 1A - 1D RUN CONCURRENTLY.

SESSION 1A CONTINUED SUN 8:10 AM TO 10:10 AM

Optical Design Challenge Presentations

8:30 am: **Planar optics enables chromatic aberration correction in immersive near-eye displays**, Tao Zhan, Junyu Zou, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA); Xiaomin Liu, Zhengzhou Univ. (China) and CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA); Hao Chen, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA) and NanoScience Technology Ctr., Univ. of Central Florida (USA); Jilin Yang, Sheng Liu, Goertek Electronics, Inc. (USA); Yajie Dong, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA) and NanoScience Technology Ctr., Univ. of Central Florida (USA); Shin-Tson Wu, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA). [11310-2]

8:50 am: **Design of foveated contact lens display for augmented reality**, Jie Chen, Lantian Mi, Jinghui Jiang, Haowen Liu, Chao Ping Chen, Wenbo Zhang, Nizamuddin Maitlo, Shanghai Jiao Tong Univ. (China). [11310-3]

9:10 am: **Variable zoom using rotating Toroidal lenses for AR glasses**, Megan M. Art, Michigan State Univ. (USA); Hossein Shahinian, Micro-LAM, Inc. (USA) [11310-4]

9:30 am: **Computing high quality phase-only holograms for holographic displays**, Praneeth Kumar Chakravarthula, The Univ. of North Carolina at Chapel Hill (USA). [11310-5]

9:50 am: **A portable projection mapping device for single-stage cranioplasty**, Shuya Liu, Wei-Lun Huang, Austin Shin, Johns Hopkins Univ. (USA); Chad Gordon, Johns Hopkins University School of Medicine (USA); Mehran Armand, Johns Hopkins Univ. (USA) . [11310-6]

Coffee Break. Sun 10:10 am to 10:40 am

SESSION 1B CONTINUED SUN 8:10 AM TO 10:10 AM

Human Factors in AR/VR

9:50 am: **Evaluation of the effects of field-of-view in augmented reality for marine navigation**, Thomas Butkiewicz, Andrew H. Stevens, The Univ. of New Hampshire (USA). [11310-12]

Coffee Break. Sun 10:10 am to 10:40 am

SESSION 1C CONTINUED SUN 9:10 AM TO 9:50 AM

Improvement of Waveguide Combiners for AR

9:10 am: **Innovative systematic design approach for lightguide devices for XR-applications**, Christian Hellmann, Wyrowski Photonics GmbH (Germany); Stefan Steiner, Roberto Knoth, Site Zhang, LightTrans International UG (Germany); Frank Wyrowski, Friedrich-Schiller-Univ. Jena (Germany) [11310-16]

9:30 am: **Wide field of view multiplexed photopolymer consumer AR displays**, Jonathan D. Waldern, Alastair J. Grant, DigiLens Inc. (USA); Milan M. Popovich, Creative Physics Ltd. (United Kingdom). [11310-17]

Coffee Break. Sun 10:10 am to 10:40 am

SESSIONS 2A - 2C AND 3A RUN CONCURRENTLY.

SESSION 2A
LOCATION: ROOM 2007 (LEVEL 2 WEST)
SUN 10:40 AM TO 11:00 AM

Novel AR Optical Architectures

Session Chair: **Weichuan Gao**, Facebook Technologies, LLC (USA)

10:40 am: **Design and fabrication of a lightweight AR headset demonstrator using a buried Fresnel mirror combiner**, Axel Bodemann, Dirk Michaelis, Peter Schreiber, Torsten Harzendorf, Stephanie Fischer, Ralf Rosenberger, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany) [11310-19]

SESSION 2B
LOCATION: ROOM 2009 (LEVEL 2 WEST)
SUN 10:40 AM TO 12:00 PM

Visual Comfort in AR

Session Chair: **Hong Hua**, Wyatt College of Optical Sciences (USA)

10:40 am: **Image analysis of varifocal geometrical lightguide head mounted display**, Miaomiao Xu, Hong Hua, The Univ. of Arizona (USA) [11310-20]

11:00 am: **How many views are required for an effective light field display?**, Steven A. Cholewiak, Emma Alexander, Vivek Labhishetty, Agostino Gibaldi, Laura Waller, Austin Roorda, Martin S. Banks, Univ. of California, Berkeley (USA) . [11310-21]

11:20 am: **Screen door effect reduction using mechanical shifting for virtual reality displays**, Jilian Nguyen, Facebook Technologies, LLC (USA) and The Univ. of Arizona (USA); Jasmine Sears, Clinton Smith, Ziv Magoz, Facebook Technologies, LLC (USA) [11310-22]

11:40 am: **Adjustable lenses: how to overcome the vergence accommodation conflict**, Prashanthan Ganeswaran, Nick Rimmer, Graeme MacKenzie, Adlens Ltd. (United Kingdom); Caterina Ripamonti, Robert Lee, Cambridge Research Systems, Ltd. (United Kingdom); Eamonn O'Neill, Christof Lutteroth, Michael Proulx, Univ. of Bath (United Kingdom); Rob Stevens, Adlens Ltd. (United Kingdom) [11310-23]

Lunch Break Sun 12:00 pm to 12:50 pm

SESSION 2C
LOCATION: ROOM 2011 (LEVEL 2 WEST)
SUN 10:40 AM TO 11:40 AM

AR/VR Display Optics Measurements and Analysis

Session Chair: **Jannick P. Rolland-Thompson**, The Ctr. for Freeform Optics (USA)

10:40 am: **Standardized display image measurement methods for AR, VR, MR and comprehensive metrology tools for precise, repeatable and reproducible results**, Richard Austin, Bruce Denning, Monirul Hassan, Sonika Obheroi, Gavin Cook, Gamma Scientific (USA); John Penczek, Univ. of Colorado Boulder (USA). [11310-24]

11:00 am: **Measuring and qualifying optical performance of AR/VR/MR device displays and addressing the unique visual requirements of transparent AR/MR displays**, Eric Eisenberg, Jens Jensen, Radiant Vision Systems, LLC (USA) [11310-25]

Lunch Break Sun 11:20 am to 12:50 pm

SESSION 3A
LOCATION: ROOM 2007 (LEVEL 2 WEST)
SUN 11:00 AM TO 11:40 AM

Sensors for AR/VR Headsets

Session Chair: **Weichuan Gao**, Facebook Technologies, LLC (USA)

11:00 am: **Eye-tracking for human-centered mixed reality: promises and challenges**, Aaron L. Gardony, U.S. Army Combat Capabilities Development Command Soldier Ctr. (USA) and Ctr. for Applied Brain and Cognitive Sciences, Tufts Univ. (USA); Robert W. Lindeman, Univ. of Canterbury (New Zealand); Tad T. Brunyé, U.S. Army Combat Capabilities Development Command Soldier Ctr. (USA) and Ctr. for Applied Brain and Cognitive Sciences, Tufts Univ. (USA) [11310-27]

11:20 am: **Qualitative and quantitative visual information detected by portable eye tracking technology**, Nuno Alão, Univ. de Lisboa (Portugal) [11310-28]

Lunch Break Sun 12:00 pm to 12:50 pm

Optical Design Challenge Pitches
LOCATION: ROOM 2003 (LEVEL 2 WEST) • 12:50 PM TO 1:50 PM
 Optical Design Challenge contestants will give 10-minute pitches on their cutting edge research.

POSTER SESSION
LOCATION: ROOM 2003 (LEVEL 2 WEST) • SUN 1:50 PM TO 2:50 PM

Conference attendees are invited to attend the AR, VR, MR poster session on Sunday afternoon. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field.

Poster Setup: 8:00 AM - 12:00 PM • View guidelines and set-up instructions at <http://spie.org/AVRposter>

Optical Design Challenge contestant posters

A retinal-scanning-based near-eye display with diffractive optical element, Lantian Mi, Chao Ping Chen, Wenbo Zhang, Yifan Lu, Jie Chen, Nizamuddin Maitlo (China) [11310-1]

Planar optics enables chromatic aberration correction in immersive near-eye displays, Tao Zhan, Junyu Zou, Hao Chen, Jilin Yang, Sheng Liu, Yajie Dong, Shin-Tson Wu, (USA) and Xiaomin Liu (China) [11310-2]

A foveated intraocular display on contact lens for augmented reality, Jie Chen, Lantian Mi, Jinghui Jiang, Haowen Liu, Chaoping Chen, Wenbo Zhang, Nizamuddin Maitlo (China) [11310-3]

Variable zoom using rotating Toroidal lenses for AR glasses, Megan Arlt and Hossein Shahinian (USA) [11310-4]

Computing high quality phase-only holograms for holographic displays, Praneeth Kumar (USA) [11310-5]

A portable projection mapping device for medical augmented reality, Shuya Liu, Wei-Lun Huang, and Mehran Armand (USA) . [11310-6]

Holographic AR display based on the cylindrical holographic optical element for wide viewing zone, Yusuke Sando, Kazuo Satoh, Osaka Research Institute of Industrial Science and Technology (Japan); Daisuke Barada, Toyohiko Yatagai, Utsunomiya Univ. (Japan) . [11310-49]

Ultrapact eye and pupil tracking device using VCSEL arrays and position sensitive detector, Suguru Sangu, Tatsuya Shimokawa, Shu Tanaka, Ricoh Co., Ltd. (Japan) [11310-50]

Virtual scalpel simulation in the VR and AR environments, Larisa A. Zherdeva, Independent Researcher/ Developer (Russian Federation); Konstantin V. Cherepanov, Samara Univ. (Russian Federation); Denis A. Zherdev, Image Processing Systems Institute of the RAS (Russian Federation) and Samara Univ. (Russian Federation) [11310-51]

Eyeball camera based calibration and system performance verification for spatial computing systems, Zhiheng Jia, Hyunsun Chung, Jeffrey Daiker, Sina Sedighi, Daniel Dominguez, Jeremy Grata, Hudson Welch, Magic Leap, Inc. (USA) [11310-52]

SUNDAY TECHNICAL PRESENTATIONS

SESSIONS 4A - 4D RUN CONCURRENTLY.

SESSION 4A
LOCATION: ROOM 2007
(LEVEL 2 WEST)
SUN 3:00 PM TO 5:00 PM

AR Display Building Blocks

Session Chair: **Bernard C. Kress**, Microsoft Corp. (USA)

3:00 pm: **Utilisation of micron scale LED arrays as display projection light sources**, Kat Vinden, Samir Mezouari, Plessey Semiconductors Ltd. (United Kingdom) [11310-29]

3:20 pm: **Holographic near-eye 3D display based on amplitude-only wavefront modulation**, Chenliang Chang, Wei Cui, Liang Gao, Univ. of Illinois (USA) [11310-30]

3:40 pm: **Angular and spatial light modulation by single digital micromirror device for display applications**, Brandon Hellman, Ted Lee, Yuzuru Takashima, Wyant College of Optical Sciences (USA) [11310-31]

4:00 pm: **High dynamic range near eye displays**, Yang Zhao, Nathan Matsuda, Xuan Wang, Marina Zannoli, Douglas Lanman, Facebook Reality Labs. (USA) [11310-32]

4:20 pm: **A novel micro LED microdisplay platform for AR/MR that offers both high brightness and high efficiency with manufacturing scalability**, Vikas R. Dhurka, Vincent Lee, Brian R. Tull, Lumiod, Inc. (USA) [11310-33]

4:40 pm: **Monolithic and heterogeneous integration of RGB micro-LED arrays with pixel-level optics array and CMOS image processor to enable small form-factor display applications**, Kameshwar Yadavalli, Chih-Li Chuang, Hussein S El-Ghoroury, Ostendo Technologies Inc (USA) [11310-78]

SESSION 4B
LOCATION: ROOM 2009
(LEVEL 2 WEST)
SUN 3:00 PM TO 5:00 PM

Fabrication Processes, Materials, and Design Tools for AR

Session Chair: **Christophe Peroz**, Magic Leap, Inc. (USA)

3:00 pm: **Nanoimprint lithography for AR waveguides manufacturing**, Martin Eibelhuber, EV Group (Austria) [11310-34]

3:20 pm: **Index-matched polymers for augmented reality applications**, Patrick Heissler, Markus Brehm, Isabel Pilottek, DELO Industrie Klebstoffe GmbH & Co. KGaA (Germany) [11310-35]

3:40 pm: **High refractive index glass wafers for augmented reality – review of recent innovations enabling the ecosystem to implement the industry roadmap**, Ruediger Sprengard, Peter Nass, Frederik Bachhuber, Clemens Ottermann, Stefan Weidlich, Volker Dietrich, Berthold Lange, Volker Plapper, SCHOTT AG (Germany); Dirk Apitz, Ulf Brauneck, Alo Lo, SCHOTT Suisse SA (Switzerland); Helen Fang, Alex Wang, SCHOTT Glass Technologies Co., Ltd. (China) [11310-36]

4:00 pm: **ALLVAR alloys for smaller and lighter optics**, James A. Monroe, Jay Zgarba, Jeremy S. McAllister, David Content, ALLVAR (USA) [11310-37]

4:20 pm: **Physical-optics analysis of lightguides for augmented and mixed reality glasses**, Christian Hellmann, Wyrowski Photonics GmbH (Germany); Stefan Steiner, Roberto Knoth, Site Zhang, LightTrans International UG (Germany); Frank Wyrowski, Friedrich-Schiller-Univ. Jena (Germany) [11310-38]

4:40 pm: **Fabrication of polymeric freeform lenses by magnetically assisted printing of liquid molds**, Mojtaba Falahati, Washington State University (USA) [11310-76]

SESSION 4C
LOCATION: ROOM 2011
(LEVEL 2 WEST)
SUN 3:00 PM TO 4:20 PM

Applied AR/VR

Session Chair: **Rubén Mohedano**, Limbak 4PI S.L. (Spain)

3:00 pm: **VR archaeological museum with applying at student education processes**, Denis A. Zherdev, Image Processing Systems Institute of the RAS (Russian Federation) and Samara Univ. (Russian Federation); Evgeniy Y. Minaev, Samara Univ. (Russian Federation); Vladimir A. Fursov, Samara Univ. (Russian Federation) and Image Processing Systems Institute of the RAS (Russian Federation) [11310-39]

3:20 pm: **The impact of color coding in Virtual Reality navigation tasks**, Yiran (Thea) Wang, Univ. of Alberta (Canada) [11310-40]

3:40 pm: **XR methodology on precision imaging optimized in vivo system**, Hua Liu, Science and Technology on Electro-optic Control Lab. (China) [11310-41]

4:00 pm: **Development tools with augmented reality (AR) for the industry**, Carlos Alberto Orta, Miguel Martin Cardenas Lopez, Luis Valentin Coronado, Gustavo Acevedo Ramirez, Centro de Investigaciones en Óptica, A.C. (Mexico) . . [11310-43]

SESSION 4D
LOCATION: ROOM 2008
(LEVEL 2 WEST)
SUN 3:00 PM TO 4:20 PM

New Technologies in VR

Session Chair: **Pablo Benítez**, Univ. Politécnica de Madrid (Spain)

3:00 pm: **Lynx: an untethered video see-through head-mounted display for mixed reality**, Stan Larroque, SL Process (France) [11310-44]

3:20 pm: **Enhancing immersive experience through smart apparel**, Amir Servati, Zenan Jiang, Harishkumar Narayana, Texavie (Canada); Ayumi Imaizumi, Su Thida Htun, Sapna Srinivasan, Texavie (Canada); Saeid Soltanian, Frank Ko, Peyman Servati, The Univ. of British Columbia (Canada) [11310-46]

3:40 pm: **Portal to knowledge: a virtual library using marker-less augmented reality system for mobile devices**, Yashas Joshi, Immersive & Creative Technologies Lab, Concordia University (Canada); Charalambos Poullis, Concordia Univ. (Canada) [11310-48]

4:00 pm: **Universal electro-optically tunable metasurfaces for wavefront control**, Harry A. Atwater Jr., Caltech (USA) [11310-77]

Optical Design Challenge Awards and Reception

5:00 PM TO 6:30 PM • LOCATION: ROOM 2003 (LEVEL 2 WEST)

All conference attendees are welcome to enjoy refreshments and network with colleagues. Optical Design Challenge winners will be awarded: 1st, 2nd, and 3rd prizes.



2020 Student Optical Design Challenge

Pitches, Networking, Awards | Sunday 2 February

Join in and watch this exciting competition to see the latest research and see who wins the cash. The challenge provides a unique opportunity for students to demonstrate their design and creativity to top AR, VR companies.

Pitches • 1:00 - 2:00 PM | Posters • 2:00 - 3:00 PM | Awards & Reception • 6:00 PM

OPTICAL DESIGN
CHALLENGE AWARDS
AND RECEPTION

LOCATION: ROOM 2003 (LEVEL 2 WEST)



Bernard Kress
Microsoft HoloLens



Christophe Peroz
Magic Leap



Andreas Georgiou
Microsoft



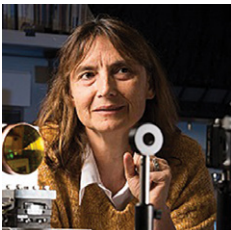
Jerry Carollo
Google



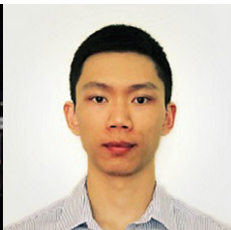
Zhujun Shi
Harvard



Kaan Akşit
Nvidia



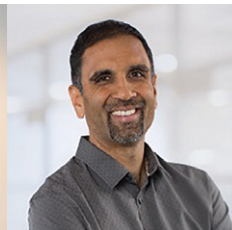
**Jannick Rolland
Thompson**
Institute of
OpticsLabs



Weichuan Gao
Facebook
Technologies



**Frank-Oliver
Karutz**
tooz technologies



**Sanjay
Gangadhara**
Zemax



**Jessica DeGroot
Nelson**
Optimax



Jinxin Fu
Applied Materials



Katsumoto Ikeda
Zemax



Hong Hua
Univ. of Arizona



**Bharathwaj
Narasimhan**
Agilent Technologies

SEE WHO WINS SUNDAY AT 6:00 PM

1st Prize: \$5,000

2nd Prize: \$2,500

3rd Prize: \$1,500



2020 Optical Design Challenge Sponsors

NOTES:



2020 Invited Industry Talks

Hear more than 40 keynotes providing the latest insights from the from the biggest names in consumer electronics and up-and-coming XR companies. These are the two most important days of the year for AR/VR hardware.













INDUSTRY TALKS AND PANELS

LOCATION: ROOM 2003 (LEVEL 2 WEST)

Monday 3 February 2020
8:30 AM TO 6:30 PM












Tuesday 4 February 2020
8:30 AM TO 6:30 PM





Monday Invited Industry Talks and Panels

8:30 AM		Bernard Kress Microsoft HoloLens Opening address	10:30 AM		Marty Banks UC Berkeley Are Leads and Lags of Accommodation Real?
8:50 AM		Omkaram Nalamasu Applied Materials Innovations in Materials Engineering for Enabling the AR Industry	10:50 AM		Jonghyun Kim Nvidia ModuAR: AR-convertible prescription glasses
9:10 AM		Edgar Auslander Facebook Perspectives on the role of AI in AR and VR	11:10 AM		Nataliya Kosmyna MIT AttentivU: a Wearable Pair of EEG and EOG Glasses for Real-Time Physiological Processing
9:30 AM		Gordon Wetzstein Stanford University Computational Eyeglasses and Near-eye Displays with Focus Cues	11:30 AM		Darran Milne VividQ Unlocking the key technical drivers needed to advance AR consumer wearables
9:50 AM		Ilmars Osmanis LightSpace Technologies Multi focal near eye AR display architecture to solve the vergence-accommodation problem	PANEL SESSION , See p. 12 MONDAY 3 FEBRUARY • 11:50 AM to 12:30 PM What is the Potential Market for the AR, VR Industry? Tom Emrich , 8th Wall, AR/Wearables Pioneer		
10:10 AM		Kevin Zhong DreamWorld Vision Laser safety Considerations in Laser-related Head Mounted Displays	12:35 PM		Mikio Iwamura NTT Docomo A New Paradigm Begins with 5G and XR

INDUSTRY TALKS AND PANELS





Monday Invited Industry Talks and Panels continued

12:55 PM		Stefan Alexander North Smartglasses vs Mixed Reality: Hardware, Use Cases, and Convergence
1:15 PM		Chi Xu nreal Advancing AR's Future, One Step at a Time
1:35 PM		Kai Jens Ströder tooz technologies Are Consumers Ready for Smart AR Glasses Mass adoption?
1:55 PM		Hiroshi Mukawa SONY Latency Compensation for Optical See-Through AR Headsets
2:15 PM		Michael Klug Magic Leap Optical Needs and Challenges for Emerging Spatial Computing Applications
2:35 PM		Stan Larroque Lynx Lynx: First Standalone Device for Video See-through Mixed Reality
2:55 PM		David Fattal LEIA The Beauty of Lightfields
3:15 PM		Nigel Burton Realmax Using Augmented Reality Glasses in Multi-User Shared Experiences
3:35 PM		Robert Schultz Vuzix Exceeding Expectations in AR Design
3:55 PM		Eugene Panich Almalence Achieving Eye-Clean Visual Fidelity: How Eye Tracking and Digital Lens Correction Enable a Breakthrough in VR/AR HMD Picture Clarity
4:15 PM		Ed Tang Avegant Foveation is Coming












4:35 PM		Osku Sahlsten Varjo Immersive Mixed Reality
4:45 PM		Doug Lanman Facebook Reality Labs Display Systems Research at Facebook Reality Labs
5:00 PM		Mark Bolas Microsoft Design to Immersion
PANEL SESSION , See p. 12 MONDAY 3 FEBRUARY • 5:15 to 6:00 PM How do we build the AR, VR World with Hardware?		 Svetlana Samoilova , NewSight Reality



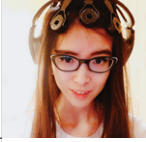






Reception to follow - Moscone West, Level 2 Lobby

Tuesday Invited Industry Talks and Panels

8:30 AM		Bernard Kress Microsoft HoloLens Opening Address
		AWARD PRESENTATION Pablo Benitez LIMBAK SPIE A. E. Conrady Award in Optical Engineering
8:50 AM		Mikihiko Sano AGC High Refractive Index Glass Substrates and Optical Components for AR/MR Devices
9:10 AM		Xavier Lafosse Corning High-Index Glass Substrates for Augmented Reality Displays
9:30 AM		Rüdiger Sprengard SCHOTT Guiding and Harnessing Light: High Index Waveguides and Optical Materials Enabling AR Devices
9:50 AM		Thomas Glinsner EV Group Enabling High Volume Manufacturing for AR Applications Using Nanoimprint Lithography
10:10 AM		Donna Qin HOYA CANDEO HOYA's Solutions for Wave-guide Related Market

Tuesday Invited Industry Talks and Panels continued

10:30 AM		Jerry Carollo Google HMD Optical Architectures: "Avoiding the Cliff"
10:50 AM		Antti Sunnari Despelix Mass-Manufacturable Diffractive Waveguide Displays for AR and MR
11:10 AM		Phil Greenhalgh WaveOptics Diffractive and Reflective Waveguides: A Game of Trade-Offs
PANEL SESSION , See p. 12 TUESDAY 4 FEBRUARY • 11:30 AM to 12:15 PM What It's Like to be a Start-Up in 2020 Christina Ingwolson, Health Scholars		
12:25 PM		Iginio Padovani BOSCH Smartglasses - How the Puzzle Fits Together
12:45 PM		Harry Atwater California Institute of Technology Electronically Tunable Metasurfaces for Reconfigurable Wavefront Control
1:05 PM		Soon-gi Park LetinAR PinMR: From Concept to Reality
1:25 PM		Jonathan Waldern DigiLens Electro-Optic Photopolymer Waveguide Technology for Compact Wide Field of View MR Glasses
1:45 PM		Zheng Yu LingXi AR Perspectives on Microdisplay Technology in AR Waveguide Optical Solutions
2:05 PM		Hakan Urey CY Vision Computational Holographic Displays for AR Glasses and AR-HUDs
2:25 PM		Rich Madison Thales Visionix Head Tracking for Roving AR

2:45 PM		Ronald Azuma Intel Progress in Occlusion and FOV
3:05 PM		Caitlin (CK) Kalinowski Facebook VR at Facebook
3:25 PM		Kelly Peng Kura AR Gallium: High-Performance AR Through Multi-Disciplinary Inventions on Displays, Optics, and More
3:45 PM		Marcus Duelk EXALOS Progress on RGB Superluminescent LEDs for AR/MR Display Applications
4:05 PM		Vincent Lee Lumiode Lumiode: Ultra High Brightness Micro-LED Displays for AR/MR
4:25 PM		Srinivasa Banna Lumileds MicroLED Technology for AR/VR Displays
4:45 PM		Mike Stover Jasper Display JDC Paving the Way for MicroLED Microdisplays to Get to Market
5:05 PM		Mike Browne SA Photonics
PANEL SESSION , See p. 12 TUESDAY 4 FEBRUARY • 5:25 to 6:10 PM Micro-LEDs: The Hot, New, Vital Building Blocks of AR, VR Brian Schowengerdt, Magic Leap		

Reception to follow - Moscone West, Level 2 Lobby

PANEL SESSIONS

What is the Potential Market for the AR, VR Industry?

Monday 3 February 2020 • 11:50 AM - 12:30 PM

Location: Room 2003 (Level 2 West)

Attend the panel on potential markets moderated by Tom Emrich



MODERATOR:
Tom Emrich
8th Wall,
AR/Wearables Pioneer (USA)

PANELISTS:



John Ludwig
Lead Product Manager
HP



Silka Miesniek
Head of Emerging
Design,
Adobe (USA)



Amy Peck
Sr. Director Enterprise
Content,
HTC Vive (USA)

How Do We Build the AR, VR World with Hardware?

Monday 3 February 2020 • 5:15 PM - 6:00 PM

Location: Room 2003 (Level 2 West)

Do you think that optical solutions are developed with serious consideration of all relevant product needs and not just optical/display metrics?

Do you think that every big company will get their own homegrown optical solution (like Microsoft and ML) for better integration and production? If not - what viable combo of display and optics solutions you see down the road for easy integration?

What optical features/metrics you are willing to compromise to deliver best comfortable and battery sufficient device?



MODERATOR:
Svetlana Samoilova
VP of Product,
NewSight Reality,
Former Microsoft HoloLens (USA)

PANELISTS:



Stefan Alexander
Vice President
Advanced R&D,
North (USA)



Phil Greenhalgh
CTO of Wave Optics,
(USA)



Jeri Ellsworth
CEO at Tilt Five and
founder,
CastAR (USA)



Paul Greco
SVP of Hardware,
Magic Leap (USA)



John Haddick
Distinguished
Engineer at Lenovo,
Former CTO of ODG
(USA)



Mark Bolas
Microsoft (USA)

[Monday Evening Reception to follow](#)

What It's Like to Be a Start-Up in 2020

Tuesday 4 February 2020 • 11:30 AM - 12:15 PM

Location: Room 2003 (Level 2 West)

Join us live for our start-up-focused panel, where we will be looking at what it's like to grow a business in the current XR climate and the challenges start-ups have to overcome.



MODERATOR:
Christina Ingwolson
VP Marketing & Communications
Health Scholars (USA)

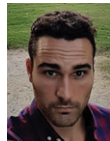
PANELISTS:



Marryam Chaudry
CEO,
XR2Lead (USA)



Jeff Meador
Founder,
JMXR.pro (USA)



Joe Connolly
Founder,
Sketchbox (USA)



Amy Hedrick
CEO,
CleanBox Technology
(USA)

Micro-LEDs: The Hot, New, Vital Building Blocks of AR, VR

Tuesday 4 February 2020 • 5:00 PM - 6:00 PM

Location: Room 2003 (Level 2 West)

Lots of people are interested today in iLED arrays (Mini and Micro), but no one really seems to know which implementation will be best suited for AR, and when it will be ready for primetime (2022, 2023 or beyond?). Should they be on silicon backplane or rather on glass LTPS backplane? What about plastic backplane? Brian will ask these questions and more.



MODERATOR:
Brian Schowengerdt
co-founder
Magic Leap (USA)

PANELISTS:



Saket Chadda
CEO,
GLO (USA)



Paul Martin
Vice President,
Mojo Vision (USA)



Srinivasa Banna
Vice President,
MicroLED R&D,
Lumileds (USA)



Robert Visser
Vice President,
Applied Materials
(USA)



Vincent Lee
Founder and CTO
Lumiode (USA)



Eric Virey
Senior Analyst,
Yole (France)

[Tuesday Evening Reception to follow](#)

Student Optical Design Challenge Pitches

Sunday 2 February 2020 • 12:50 PM - 1:50 PM
Location: Room 2003 (Level 2 West)

Watch students from a variety of institutions present their cutting-edge research aimed at improving any aspects of the optics in virtual reality (VR), augmented reality (AR), and mixed reality (MR).

Poster Session

Sunday 2 February 2020 • 1:50 PM - 2:50 PM
Location: Room 2003 (Level 2 West)

Conference attendees are invited to attend the poster session on Sunday afternoon. Come view the posters, enjoy beverages, and ask questions. Authors of poster papers and Optical Design Challenge participants will be present to answer questions concerning their posters. Attendees are required to wear their conference registration badges to the poster session.

Poster Set-Up: 8:00 AM - 11:50 AM

Extended Poster Viewing: 8:00 AM - 11:50 AM and 2:00 PM - 5:30 PM

Optical Design Challenge Awards and Reception

Sunday 2 February 2020 • 5:00 PM - 6:30 PM
Location: Room 2003 (Level 2 West)

All conference attendees are welcome to enjoy refreshments and network with colleagues. Optical Design Challenge winners will be awarded: 1st, 2nd, and 3rd prizes.

AR, VR, MR Reception: Monday Evening

Monday 3 February 2020 • 6:30 PM - 7:00 PM
Location: Lobby (Level 2 West)

Network after the panel session.

2020 SPIE A.E. Conrady Award in Optical Engineering

Tuesday 4 February 2020 • 8:30 AM - 8:40 AM
Location: Room 2011 (Level 2 West)

The SPIE A. E. Conrady Award in Optical Engineering is presented in recognition of exceptional contributions in design, construction, testing and theory of optical and illumination systems and instrumentation.

Pablo Benitez, Universidad Politécnica de Madrid and LIMBAK, Madrid, Spain, is the 2020 recipient of the SPIE A.E. Conrady Award in Optical Engineering in recognition of pioneering discoveries in both Nonimaging and Imaging optics, including the simultaneous multiple surface (SMS) method of optical design for freeform surfaces.

The award will be presented by Bernard Kress, Microsoft HoloLens and SPIE President, John Greivenkamp.



AWARD WINNER:

Pablo Benitez

Universidad Politécnica de Madrid;
co-founder and CTO, LIMBAK (Spain)

Meet the Authors Event

Monday 3 February 2020 • 2:00 PM - 3:00 PM
Location: Moscone West, Level 2 Lobby

Come and meet Joseph Goodman, father of modern Fourier Optics, a field which enabled many of the optical technologies used today in AR/VR. SPIE will be publishing Joe's new edition of "Speckle Phenomena in Optics". This is a unique opportunity to get to chat with Joe and have all of your previous "Goodman Books" autographed. Bernard Kress, for whom Joe was a terrific mentor, will be signing also his own new book on "Optical Architectures for AR,VR and MR headsets".



Bernard Kress

Partner Optical Architect
Microsoft / HoloLens (USA)

Over the past two decades, Bernard Kress has made significant scientific contributions as an engineer, researcher, associate professor, consultant, instructor, and author. He has been instrumental in developing numerous optical sub-systems for consumer and industrial products, generating IP, teaching and transferring technological solutions to industry. Application sectors include laser materials processing, optical anti-counterfeiting, biotech sensors, optical telecom devices, optical data storage, optical computing, optical motion sensors, digital displays systems, and eventually HUD and HMD displays (smart glasses, AR/MR/VR). Bernard has been specifically involved in the field of micro-optics, wafer scale optics, holography and nano-photonics. He has published half a dozen books and has more than 35 patents granted. He is a short course instructor for the SPIE and has been chair of various SPIE conferences. He is an SPIE fellow since 2013 and has been elected to the board of Directors of SPIE (2017-19). Bernard has joined Google [X] Labs in 2011 as the Principal Optical Architect on the Google Glass project, and is since 2015 the Partner Optical Architect at Microsoft on the HoloLens project.



Joe Goodman

Emeritus Professor of Electrical Engineering
Stanford University (USA)

Joseph W. Goodman received an A.B. Degree from Harvard, an M.S degree and Ph.D. degree, both from Stanford University in Electrical Engineering. After 4 years on the research staff at Stanford, he joined the faculty of the Department of Electrical Engineering. He chaired the department from 1989 to 1996, following which he served as Senior Associate Dean of Engineering until 1999. He retired from Stanford in January of 2001. Dr. Goodman is the author of the books Introduction to Fourier Optics (now in its 4th edition), Statistical Optics (now in its 2nd edition), Speckle Phenomena in Optics (now in its 2nd edition), and co-author of Fourier Transforms: An Introduction for Engineers. He is the author of more than 200 scientific and technical papers, and has been primary research supervisor for 49 Ph.D.s. He has received numerous awards from the I.E.E.E., the A.S.E.E., the O.S.A., the S.P.I.E., including the highest awards given by the latter two societies. Goodman was a co-founder of Optivision, Inc., ONI Systems (now part of Ciena), and served as a member of the board of directors of E-TEK Dynamics (now part of JDS Uniphase).

AR, VR, MR Reception: Tuesday Evening

Tuesday 4 February 2020 • 6:30 PM - 7:00 PM
Location: Lobby (Level 2 West)

Network after the panel session.




AR, VR, MR Expo with hands-on demos of the latest XR gear

NETWORK, CONNECT, AND SEE THE LATEST GEAR

Come to the Expo to meet with the biggest names in consumer electronics and up-and-coming XR companies. Whether you are looking for a job, want to talk about the next research developments, or just try out the latest AR, VR, MR hardware, this is the place you want to be.

2020 EXHIBITORS

EXPO + DEMOS

LOCATION: ROOM 2004 (LEVEL 2 WEST)

Monday 3 February 2020
10:00 AM TO 5:00 PM

Tuesday 4 February 2020
10:00 AM TO 5:00 PM



Courses and Workshops— A Week of Learning and Networking

PERSONAL INSTRUCTION FROM LEADING EXPERTS

Take a course, or join a workshop, and get face-to-face instruction on some of the most popular sessions in optical design for AR, VR, and MR. Courses range from 2-hour to two-day formats. Workshops range from 30 minutes to 2 hours. Join your colleagues, meet new contacts, and learn from the best in the industry.

COURSES—Additional Fees Required

Head-Mounted Display Requirements and Designs for Augmented Reality Applications

SC1096 • Course Level: Introductory • CEU: 0.7
\$695 Members • \$401 Student Members • \$815 Non-Members USD
Sunday 8:30 am to 5:30 pm

Introduction to VR, AR, MR and Smart Eyewear: Market Expectations, Hardware Requirements and Investment Patterns

SC1234 • Course Level: Introductory • CEU: 0.2
\$270 Members • \$193 Student Members • \$295 Non-Members USD
Sunday 8:30 am to 10:30 am

Optical Technologies and Architectures for Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) Head-Mounted Displays (HMDs)

SC1218 • Course Level: Intermediate • CEU: 0.7
\$685 Members • \$397 Student Members • \$805 Non-Members USD
Wednesday 8:30 am to 5:30 pm

Design Techniques and Applications Fields for Digital Micro-optics

SC1125 • Course Level: Intermediate • CEU: 0.7
\$685 Members • \$397 Student Members • \$805 Non-Members USD
Thursday 8:30 am to 5:30 pm

SUNDAY-THURSDAY
COURSES AND WORKSHOPS

REGISTER FOR COURSES
AT THE SPIE CASHIER

COURSES AT PHOTONICS WEST THAT MIGHT ALSO INTEREST YOU

Additional registration and fees required

- Wednesday, 8:30 AM - 12:30 PM: Meta-Lenses
- Wednesday, 8:30 AM - 12:30 PM: Designing and Specifying Digital Cameras

View the complete list of courses online.

WORKSHOPS—Included with your badge

Spatial Mapping of Refractive Index Modulation for Improved AR Holographic Waveguide Manufacture

Monday 3 February 2020 • 10:00 AM - 11:00 AM

Location: Room 2009 (Level 2 West)

Come hear the CTO of DigiLens talk about their holographic waveguide display technology for augmented reality applications.



SPEAKER:

Jonathan Waldern

Founder, Chairman & CTO
DigiLens

WORKSHOPS

Building a Mass Manufacturing Capability for Augmented Reality Waveguides

Monday 3 February 2020 • 1:30 PM - 2:45 PM
Location: Room 2009 (Level 2 West)

WaveOptics patented diffractive waveguides have the broadest range of fields of view and can be readily customised for augmented reality smart glasses and headsets. WaveOptics' technology was designed with mass manufacture in mind. Our waveguides enable crisp, clear imagery, that can be manufactured affordably, at scale, even with a custom design. Striking this balance is key to unlocking the potential of augmented reality for the mass market. Our joint workshop with Goertek Optoelectronics, a leading manufacturer in the AR/VR industry, will focus on the core processing principles of WaveOptics technology and how WaveOptics and Goertek provide a volume manufacturing capability to meet the demands of any customer.

SPEAKERS:



Phil Greenhalgh
CTO,
Wave Optics. (USA)



Frank Rao
General Manager of
Optoelectronics
Goertek (China)

Systematic Design Approach for Lightguide Devices for AR/VR Applications in VirtualLab Fusion

Monday 3 February 2020 • 3:00 PM - 4:15 PM
Location: Room 2009 (Level 2 West)

Lightguides in combination with gratings are one beneficial approach to combine the virtual image with the light impinging from the real-world environment. The design and modeling of such lightguides is very different from traditional lens design and there is still a lot of room for new ideas and innovation. Such devices are quite complex due to the unavoidable handling of a large field of view and different wavelengths and, consequently, numerous parameters must be considered in order to obtain a functional device which provides good image quality. We present a systematic approach to design lightguide devices which combines the benefits of functional and parametric design and optimization strategies. We will discuss typical design tasks, with emphasis on the trade-off between uniformity and system efficiency in different examples.

LEARNING OUTCOMES:

- Construction and modeling of lightguide devices with grating regions for in- and out-coupling of light.
- Systematic design workflow for lightguide devices, from functional design to parametric optimization.
- Evaluation of the performance of the complete lightguide device for different fields of view.

INTENDED AUDIENCE: Optical engineers, designers, researchers and students interested in lightguide devices for AR/VR applications.

INSTRUCTORS:



Stefan Steiner
LightTrans
International UG
(Germany)



Site Zhang
LightTrans
International UG
(Germany)

SPONSORED BY:



Smart Goggles for Swimming: Bringing AR into the Water

Monday 3 February 2020 • 4:30 PM - 5:30 PM
Location: Room 2009 (Level 2 West)



SPEAKER:

Reynald Hoskinson
VP Technology at FORM (USA)

Wearable fitness trackers have become ubiquitous, due in part to their low cost and simple use case. The predominant form factor for these trackers has been a band around the wrist. There are situations such as swimming, however, where a wrist-worn device is not very convenient because it requires you to stop your activity to consult the display. A near-to-eye display is an elegant solution to this problem, as almost all swimmers already wear eyewear in the form of goggles. Unlike fitness trackers, however, commercially available augmented reality displays are relatively expensive.

Google glass is above \$1000, Focals by North is currently \$599 USD, and more-feature rich platforms such as Microsoft HoloLens and Magic Leap One are more expensive still. Since swimming goggles are a relatively narrow application, consumers are unlikely to be very receptive to paying the kind of prices normally charged for gear designed for all occasions. On the other hand, focusing on a specific use case means that as augmented reality eyewear designers, we can pare down the functionality of the device to only what is needed to support our use cases. This talk will present work on a lower-cost (\$200 consumer price) augmented reality system for swimming.

Design Considerations for Rapid Prototype Freeforms for AR/VR Applications

Tuesday 4 February 2020 • 8:00 AM - 9:00 AM
Location: Room 2009 (Level 2 West)



SPEAKER:

Jessica DeGroote Nelson
Director of Technology and Strategy
Optimax Systems (USA)

Being first to market is critical in the commercial sector. This presentation will overview optical design considerations for freeform optics that can make a difference when trying to get rapid prototype optics for AR/VR applications.

SPONSORED BY:



Market Outlook & Implications for Sales & Marketing

Tuesday 4 February 2020 • 9:30 AM - 12:30 PM
Location: Room 2007 (Level 2 West)



INSTRUCTOR:

Michele Nichols
Launch Team Inc. (USA)

Join this session to learn drivers in the industries you serve, and how you can position your company and capabilities to meet the needs of emerging customer needs. Launch Team president Michele Nichols will address market outlook, regulatory and customer requirements that will impact sales and marketing, and today's winning strategies for companies from start-up to global market leaders. Bring your questions and specific challenges for actionable take-aways.

Computer Generated Holography for AR: from Star Wars dream to commercial applications

Tuesday 4 February 2020 • 10:30 AM - 11:45 AM
Location: Room 2009 (Level 2 West)



SPEAKER:
Aleksandra Pedraszewska
COO
VividQ (United Kingdom)

3D display systems based on Computer Generated Holography have been kept in a state of perpetual research for decades. Sci-fi franchises like Star Wars have brought to life holography's potential to change the nature of human-machine interaction, but how do we get this technology out of imagined scenarios or academic circles and into consumer use. With the rise of AR applications and scientific breakthroughs in reducing the computing requirements of holographic systems, CGH is now a topic of major industry interest. Co-founder and COO Aleksandra Pedraszewska brings her first-hand experience in commercialising breakthrough software solutions for CGH and building a holographic display ecosystem. She discusses the benefits of CGH for different AR applications and shows how recent hardware developments enable the system-level integrations of CGH, using VividQ's ecosystem as a case study.

From Virtual to Indistinguishable: How Disruptive Technologies will Enhance our Simulated Experiences

Tuesday 4 February 2020 • 12:00 PM - 1:30 PM
Location: Room 2009 (Level 2 West)

Seeing the invisible, feeling the untouchable, experiencing the impossible. The only limits to AR, VR and XR will be the ones set by our imagination. Because the technologies for truly immersive adventures are rapidly becoming available. Imec allows you a window into the future of VR/AR/XR by demonstrating the latest advancements in:

- IR and 3D imagers for AR/VR applications
- Novel on-glass processing techniques
- Haptic feedback

SPEAKERS:



Denis Marcon
Senior Business Development Manager,
imec (Belgium)



Jiwon Lee
Senior Image Sensor Pixel Designer,
imec (Belgium)



Xavier Rottenberg
Scientific Director and Group Leader
Wave-based Sensors and Actuators,
imec (Belgium)

SPONSORED BY:



You Can Have It All: A Novel Waveguide Technology

Tuesday 4 February 2020 • 1:45 PM - 3:00 PM
Location: Room 2009 (Level 2 West)



SPEAKER:
Yaakov Amitai
Founder and CTO,
Oorym (Israel)

The technology of substrate-guided optical element, which is recently has been extensively used in many AR products, has many advantages, such as compactness, low weight, and the potential to materialize AR systems having eyeglasses configurations. The existing relevant technologies, however, suffer from many drawbacks. Mainly, achieving the requested characteristics of one parameter usually comes with the penalty of weakening those of another one. A novel waveguide technology that has been developed in Oorym has the unique property of combining those seemingly contradicting features. That is to say, extensive pupil expansion along with very high brightness efficiency, extremely wide FOV along with a simple embodiment, and excellent image quality along with an uncomplicated and non-expensive fabrication process that can be easily accommodated for mass production.

The Future of Traditional is Virtual: AR/VR/MR Technologies Moving into the Mainstream

Tuesday 4 February 2020 • 3:15 PM - 4:30 PM
Location: Room 2009 (Level 2 West)



SPEAKER:
Andy Cochran
The AV Club (USA)

Invention to Impact

Tuesday 4 February 2020 • 4:15 PM - 5:15 PM
Location: Room 2009 (Level 2 West)



SPEAKER:
Anna Brady-Estevez
Program Director for Blockchain, DAGs, Chemical, and Environmental Tech, National Science Foundation SBIR (USA)

Innovation programs at the National Science Foundation (NSF) advance ideas from the lab to the marketplace to strengthen America's economy, health, and security. The Division of Industrial Innovation and Partnerships (IIP) in the Engineering Directorate leads several programs to translate fundamental research into market solutions. IIP supports researchers with promising technologies, as well as funding high-tech startups. Learn about the NSF's central role in accelerating the growth of the national ecosystem and hear about specific funding opportunities.

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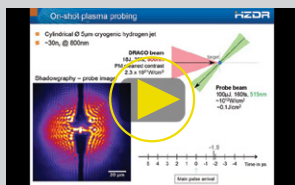
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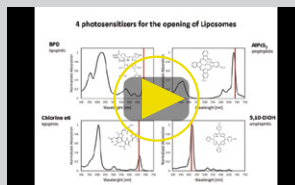
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16 August 2019

Frontiers of applications of petawatt laser physics (Conference Presentation)

[Ulrich Schramm](#)



23 August 2019

Light-induced permeabilization of liposomes

[Paula Enzian, et al.](#)



22 April 2019

Chromatic line confocal technology in high-speed 3D surface-imaging applications

[Karri Niemelä](#)

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