

LDC

Monday, 19 April

[LDC-Opening] 13:00-13:10

Opening Remarks

Chairs: Kazuo Kuroda
Utsunomiya University
 Fergal Shevlin
Dyoptyka

[LDC-1] 13:10-14:40
Keynote

Chairs: Sunao Kurimura
NIMS
 Fergal Shevlin
Dyoptyka

LDC-1-01 13:10 *Invited*

Laser Light Sources for Specialty and Automotive Lighting Applications

Paul Rudy
KYOCERA SLD Laser

We provide a description on the rapidly expanding capabilities of laser light technology, including 1000 lumen sources with luminance above 1000 cd/mm², more than 10x that of LEDs, from surface mount device components.

LDC-1-02 13:55 *Invited*

Laser Technologies in Novel Medical Imaging

Albert P Heberle
Openwater

We are devising a new generation of portable medical imaging technologies for improved access to medical diagnoses and treatments. Our breakthrough systems use opto-electronics and holography together with novel lasers to enable low cost equipment that rivals the resolution and image quality of multi-million dollar medical imaging scanners.

[LDC-2] 14:55-16:10
AR, MR, VR, ... XR Technologies 1 - Aerial & Aquatic Display -

Chairs: Frank Fischer
Bosch Sensortec GmbH
 Norihiro Ohse
Sony Group Corporation

LDC-2-01 14:55 *Invited*

3D Interface by Parity Mirror and Its Applications

Yuki Maeda
Parity Innovations Co., Ltd.

An optical imaging device for air floating image display and its applications are introduced in this paper. An observer can see the air floating image by the naked eye and manipulate it by touching the air floating image using non-contact sensor.

LDC-2-02 15:25

Subjective Super-Resolution Display on Aerial LED Signage Formed with Aerial Imaging by Retro-Reflection

Kojiro Matsushita¹, Akinori Tsuji²,
 Toyotaro Tokimoto³, Hirotsugu Yamamoto^{1,4}
¹*Utsunomiya University*, ²*Tokushima University*,
³*XAix, LLC*, ⁴*JST ACCEL*

We have realized a novel aerial display that features higher resolution than the light-source LED. We have realized subjective super-resolution display, which makes viewers perceive finer resolution than the actual number of pixels, on aerial LED signage by use of our designed high-speed LED display circuit and aerial imaging optics.

LDC-2-03 15:40

Multiple Aquatic Image Formation with Faced Mirror Structure and Polarized AIRR

Kazunari Chiba¹, Masaki Yasugi^{1,2},
 Hirotsugu Yamamoto^{1,2}
¹*Utsunomiya University*, ²*JST ACCEL*

This paper proposes a new way of 3D display application. Multiple aquatic images were formed using the principle of infinity mirror and Aerial Imaging by Retro-Reflection (AIRR). We have successfully improved the brightness of aquatic images by use of polarization modulation.

LDC-2-04 15:55

Influence of Diverging Angle of the Light Source on the Image Spot Formed in Water by Use of Retro-Reflection

Daiki Kudo¹, Kazunari Chiba¹, Masaki Yasugi^{1,2},
 Nao Ninomiya¹, Hirotsugu Yamamoto^{1,2}
¹*Utsunomiya University*, ²*JST ACCEL*

The aquatic display has been realized with aerial imaging by retro-reflection (AIRR). We confirmed that the spread of a point image formed in water from a point source placed in the air changes depending on the divergence angle of the light from the source.

Tuesday, 20 April

[LDC-3] 10:00-11:30
AR, MR, VR, ... XR Technologies 2 - Viewing Angle in AR/VR Display and Devices -

Chairs: Hidekazu Hatanaka
Ushio
 Tetsuya Yagi
NICHIA CORPORATION

LDC-3-01 10:00 *Invited*

Expanding Field-of-view in Head-mounted Displays Considering Characteristics of Vision

Wataru Yamada, Hiroyuki Manabe
NTT DOCOMO, INC.

Field of view (FOV) is one of the key parameters for the performance of head-mounted displays. Focusing on the differences between central vision and peripheral vision, we developed a technique for expanding the FOV of a head-mounted display at low cost by using lenses with different levels of magnification.

LDC-3-02 10:30

Analysis on Viewing Angle in Aerial Display by Use of an LED Panel Covered with Apertured Retro-Reflector

Daiki Nishimura¹, Masaki Yasugi^{1,2},
 Hirotsugu Yamamoto^{1,2}
¹*Utsunomiya University*, ²*JST, ACCEL*

This paper proposes an analytical model on the viewing angle of the aerial image formed over an LED panel. Our optical system forms aerial signage over a specially fabricated LED panel. A half mirror is placed in front of the LED panel that is covered with retro-reflector with square-shaped holes.

LDC-3-03 10:45

Increasing Luminance of Aerial Image Formed with AIRR by Use of Dual Transparent Spheres

Kengo Fujii¹, Satoshi Maekawa²,
 Hirotsugu Yamamoto^{1,3}
¹*Utsunomiya University*, ²*Parity Innovations Co., Ltd.*, ³*JST ACCEL*

We propose a method to form aerial display by installing two transparent spheres in the light path of AIRR. By proposed method, we confirmed by simulation that the luminance of the aerial image was increased.

LDC-3-04 11:00 *Invited*

Compact Full-color Laser Beam Projectors Based on Waveguide-type RGB Multiplexers

Toshio Katsuyama¹, Akira Nakao¹,
 Shoji Yamada¹, Osamu Kawasaki²,
 Kazuki Iwabata², Koichi Horii², Akira Himeno^{1,2}
¹*University of Fukui*, ²*SEIREN KST Corp.*

Compact full-color laser sources and laser beam scanning modules are demonstrated. Those are based on waveguide-type RGB multiplexers. In principle, their output laser beams are perfectly aligned, which inevitably leads to clear projection images. Thus, compact imaging projectors are constructed, which are applicable to a variety of imaging fields.

[LDC-4] 15:15-17:00
AR, MR, VR, ... XR Technologies 3 - xR Concepts -

Chairs: Ray-Hua Horng
National Chiao Tung University
 Masafumi Ide
Lambda Works

LDC-4-01 15:15 *Invited*

Introduction of xR Use Case at Toyota

Koichi Kayano
TOYOTA MOTOR CORPORATION
 In general, there have been many examples of engineering using xR technology. However, unfortunately, there are few examples of its use in the customer service field. Toyota is currently demonstrating the use of HoloLens 2 in dealerships. This presentation will explain the case study, results, and points to keep in mind.

LDC-4-02 15:45 *Invited*

Introducing KDDI's Activities in XR and Spatial Computing Towards 5G

Katsuhiko Kozuki
KDDI CORPORATION
 The presentation will explain about KDDI's recent activities in VR, AR and MR(collectively XR) enhanced by its 5G system, mobile edge computing and AR cloud technologies with 5G smartphone and tethered AR glasses products. Introducing from PoC level promotional events to commercially available products and services on 5G networks.

LDC-4-03 16:15

Deforming Aerial Image by Use of Deflection of Beam Splitter in See-Through AIRR

Kosuke Inoue¹, Masaki Yasugi^{1,2},
 Hirotsugu Yamamoto^{1,2}
¹*Utsunomiya University*, ²*JST, ACCEL*

This paper proposes a novel aerial display optics to display a three-dimensional aerial image by intentionally creating irregular deflection. Irregular deflection is occurred by pulling the acrylic plate forward with a piano wire and partially raising it. We succeeded in forming aerial images that appear differently depending on the viewpoint.

LDC-4-04 16:30 *Invited*

Why Lasers are Key to Make Smart and AR Glasses the Next Big Thing

Lucas Ginzinger
Bosch Sensortec GmbH
 The world has been waiting for the big bang in consumer smart glasses not only since Google Glass. Besides use case readiness, the tech maturity is playing a major role in the delayed market of smart/AR glasses for consumers. In his presentation, Lucas Ginzinger, Head of Product Area Optics, talks on the major levers to overcome the hurdles for a successful market entry - the role of laser beam scanning projectors as the key enablers to high volume smart and AR glasses.

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Wednesday, 21 April

[LDC-5] 10:00-11:45
Imaging / Lighting
 Chairs: Hirotsugu Yamamoto
Utsunomiya University
 Hisashi Masuda
Oxide Corporation

[LDC-6] 13:00-14:30
Light Sources and Components
 Chairs: Paul Rudy
KYOCERA SLD Laser
 Hiroyuki Matsumoto
Iwasaki Electric

LDC-7-02 15:15
Improvement of Color LiDAR with RGB Visible Single-Mode Laser Diodes
 Masato Ishino, Tomoyuki Ohashi, Hiroshi Fuji, Kana Fujioka, Kazuhisa Yamamoto
Osaka University

LDC-8-03 16:45
High Power Laser Phosphor Light Source Using Tilted Rotating Mirror
 Kenneth Li¹, Y. P. Chang², Lion Wang², Andy Chen², Stark Tsai²
¹*Optonomus Technologies Inc.*, ²*Taiwan Color Optics, Inc.*

LDC-5-01 10:00 *Invited*
Laser TV Progress with Visible Laser Improvement
 Xianrong Liu
Hisense
 Laser TV progress with visible laser improvement will be presented.

LDC-6-01 13:00 *Invited*
Nanowire LEDs with Ultrastable Emission Characteristics and Monolithically Integrated Multicolour Emission
 Zetian Mi, Xianhe Liu, Yi Sun, Yakshita Malhotra, Yuanpeng Wu
University of Michigan

We report on the performance improvement of a color LiDAR with RGB visible laser diodes (LD). By using LDs with single lateral mode as the light sources, a short pulse driver, and a high-sensitivity detector, distance and color evaluations with small deviations and a low LD-operation power have been achieved.

This paper describes a stationary phosphor plate system excited by a scanning laser focused spot on the phosphor increasing the excitation area, while keeping the same etendue. Such scanning is created by using a tilted rotating mirror reflecting the input laser beam towards the phosphor plate and reflecting the output beam towards the direction of the input laser beam maintaining the small etendue of a single focus spot.

LDC-5-02 10:30 *Invited*
Large-Scale Full-Parallax Full-Color Computer-Generated Holograms Reconstructed by Laser/LED Lighting
 Kyoji Matsushima
Kansai University

We report on the design and demonstration of monolithically integrated InGaN/GaN micro-LEDs with multi-colour emission using selective area molecular beam epitaxy, which exhibit unique properties including ultrastable operation, extremely narrow linewidth, and highly directional emission.

LDC-7-03 15:30
Thermal Property of AlN-Ce:YAG Composite Ceramics Phosphor for Laser Lighting
 Takuya Sawada, Hiroshi Huiji, Kenta Yagasaki, Hisashi Minemoto, Yukio Manabe, Kana Fujioka, Kazuhisa Yamamoto
Institute of Laser Engineering, Osaka University

We have developed AlN-Ce:YAG composite ceramics in order to suppress thermal quenching, and measured thermal property when the ceramics were irradiated with a high-power laser.

Recently, full-color computer-generated holograms (CGH) are created by several techniques. These CGHs can be reconstructed using an LED or RGB laser light source. The creation and lighting techniques are introduced for promoting development of light sources for computer holography.

LDC-6-02 13:30 *Invited*
Emission Characteristics of Random Lasers and Their Control
 Takashi Okamoto
Kyushu Institute of Technology
 Random lasers are mirrorless lasers comprising scatterers and an active medium. Multiple scattering of light provides the feedback mechanism for lasing. In this talk, I will present the mechanisms and properties of a random laser and emission control methods.

We have developed AlN-Ce:YAG composite ceramics in order to suppress thermal quenching, and measured thermal property when the ceramics were irradiated with a high-power laser.

[LDC-8] 16:00-17:00
Laser Technology for Automotive Applications 2
 Chairs: Abdelmalek Hanafi
BMW
 Tatsushi Hamaguchi
Sony Group Corporation

LDC-5-03 11:00
Improvement of Color Rendering Index of BGYR Laser Illuminants
 Yoshio Manabe, Masato Ishino, Hiroshi Fuji, Akira Takamori, Junichi Kinoshita, Kana Fujioka, Kazuhisa Yamamoto
Institute of Laser Engineering, Osaka University

LDC-6-03 14:00 *Invited*
Purcell-Effect-Enhanced Red Emission from Eu Ions in GaN Cavities
 Yasufumi Fujiwara, Dolf Timmerman, Shuhei Ichikawa, Jun Tatebayashi
Osaka University

LDC-8-01 16:00 *Invited*
GaN-based Vertical-Cavity Surface-Emitting Lasers with Lattice-Matched AlInN/GaN DBRs

Tetsuya Takeuchi¹, Satoshi Kamiyama¹, Motoaki Iwaya¹, Isamu Akasaki^{1,2}
¹*Meijo University*, ²*Nagoya University*
 GaN-based vertical-cavity surface-emitting lasers (VCSELs) have been intensively developed, showing high performances toward practical uses. We show in-situ wafer curvature evolutions during the epitaxial growth of AlInN/GaN DBRs and an implementation of nano-height cylindrical waveguides in the VCSELs. Room-temperature continuous-wave operations of the VCSELs with large apertures up to 30 μm diameter have been demonstrated.

We have attempted to improve Color Rendering Index of Blue-Green-Yellow-Red four-color Laser illuminants. As a result, average color rendering index Ra and special CRI (R9) as high as 80 around at 5000 K were obtained by optimizing the BGYR wavelengths and their laser power densities.

Luminescence properties of a Eu-doped GaN microdisk cavity and a two-dimensional photonic crystal nanocavity are demonstrated. The resonant modes are coupled with indirectly excited Eu²⁺ ions and enhance drastically Eu emission, which is due to the Purcell effect.

Room-temperature continuous-wave operations of the VCSELs with large apertures up to 30 μm diameter have been demonstrated.

LDC-5-04 11:15
Color Shift Behavior at Image Pattern Edges of Raster-scan RGB Mobile Laser Projectors
 Junichi Kinoshita¹, Akira Takamori¹, Kazuhisa Yamamoto¹, Kazuo Kuroda², Koji Suzuki³
¹*Osaka University*, ²*Utsunomiya University*, ³*OXIDE Corporation*

[LDC-7] 14:45-15:45
Laser Technology for Automotive Applications 1
 Chairs: Jared Kearns
Sony Group Corporation
 Masaru Kuramoto
STANLEY ELECTRIC CO., LTD.

LDC-8-02 16:30
Freeform Lens Design for High-Efficient LED Low-Beam Headlamp Lens

Zhengbo Zhu, Shili Wei, Wenyi Li, Donglin Ma
Huazhong University of Science and Technology
 We develop a least-squares ray mapping method to design freeform lens for LED-based low-beam headlamp optical system, the produced irradiance distribution conformed to the United Nations Economic Commission for Europe vehicle regulations (ECE) R112. The energy efficiency reaches up to 84% considering the Fresnel loss.

Color shift behavior at image pattern edges of three raster-scan RGB mobile projectors is analyzed. The speckle noise effects are eliminated. Pure color shift is clearly picked up and analyzed.

LDC-7-01 14:45 *Invited*
Laser Crystal Phosphor Automobile Headlight Integrated with Beam Control and LiDAR

This invited paper presents our current research in the subject of integrated Beam Control Headlight and LiDAR, which includes a DMD pixel-based system and a polygon scanning mirror-based system. Single crystal phosphor is used providing high efficiency and reliability to the system. The goal is to provide highly reliable, compact, and low-cost systems to be introduced into the mass market for autonomous vehicles.

LDC-5-05 11:30
Ultra High Resolution and VAC-free N3D Technology and its Applications
 Chin-Yung Hsieh¹, Hao-Yu Liu¹, Ruey-Jer Weng¹, Wei-Yi Lu¹, Naoki Sumi²
¹*Innolux Corporation*, ²*Innolux Japan K.K.*
 In this paper, we introduce the Innolux N3D technology with ultra high resolution and its vergence-accommodation conflict free feature. The N3D technology provide focus cues for nature viewing experience. Lot of 3D display applications can using this technology to improve its display quality.

LDC

Thursday, 22 April

[LDC-9] 13:00-14:30
Smart SystemsChairs: Young-Joo Kim
Yonsei University
Satoshi Ouchi
Hitachi, Ltd.**LDC-10-02 15:00****Colorization of Arc3D using Projector Lighting**Ikuya Saji¹, Masafumi Nakata²,
Yasuhiro Kashihara², Atsushi Hayashi²,
Hirotugu Yamamoto^{1,3}
¹Utsunomiya University, ²NSC Co., Ltd., ³JST,
ACCEL

This paper describes the colorization of Arc3D, which is an autostereoscopic display by use of arc-shaped scratches on a transparent substrate. Directional scattering on an arc changes the position of a bright spot depending on the viewing position. Arc3D has been colorized and switched by use of a projector lighting.

LDC-9-01 13:00 *Invited***Geo-marine science using visible light**Hiroshi Yoshida
JAMSTEC

Geo-marine science using visible light will be presented.

LDC-9-02 13:30 *Invited***Imperceptible Projected Marker Codes with Application to Calibration-Free Projection Mapping**Shingo Kagami
Tohoku University

This paper reviews our recent efforts on Digital Micromirror Device (DMD)-based approaches to embed imperceptible marker codes into video projection. An application to calibration-free projection mapping onto a moving surface is also described.

[LDC-Closing] 15:15-15:25**Closing Remarks**Chair: Sunao Kurimura
NIMS**LDC-9-03 14:00****Scanning RGB Laser Beam Detection for Smart Laser Display System**Takeshi Ebara¹, Hiroshi Murata^{1,2},
Masato Ishino², Junichi Kinoshita²,
Kazuhiisa Yamamoto²
¹Mie University, ²Institute of Laser Engineering,
Osaka University

Interruption of scanning RGB laser beams was detected by use of a high-speed photodiode and high-speed oscilloscope to check a response time for controlling smart laser display operation. Clear electrical pulse train signals were obtained from the photodiode. These results are useful for safety control of smart laser display systems.

LDC-9-04 14:15**Extraction Method of Typical Traffic Lines of Pedestrians**Akinobu Watanabe
Hitachi, Ltd.

We developed the extraction method of typical traffic lines of pedestrians captured by TOF sensor, and grouping method of similar pathways with the typical traffic lines.

[LDC-10] 14:45-15:15
Novel and Emerging TechnologiesChair: Hiroshi Murata
Mie University**LDC-10-01 14:45****Design an Extreme Ultraviolet Illumination System with High Uniformity**Yanqiu Li, Qian Hao, Ke Liu, Xu Yan
Beijing Institute of Technology

In this paper, an extreme ultraviolet illumination system matching an NA 0.33 projection objective is designed. Simulation results show that this illumination system can achieve high uniformity on the mask plane under different illumination modes.