

LDC <Room 211+212>

Tuesday, 18 April

[LDC-OP] 9:50-10:00**Opening Remarks**Chair: Hiroshi Murata
Mie University**[LDC-ST] 10:00-10:30****Special Talk**Chair: Sunao Kurimura
NIMS**LDC-ST-01 10:00** *Special Talk***Human Augmentation Research towards Interverse Services**Masaaki Mochimaru
The National Institute of Advanced Industrial Science and Technology (AIST)

Human augmentation enables to enhance human capability through wearable IT and robot technologies. Human augmentation can circulate the value between the Metaverse and the Universe. It can be called the Interverse.

[LDC1] 10:30-12:00**Keynote**Chairs: Sunao Kurimura
NIMS
Shining Zhu
Nanjing Univ.**LDC1-01 10:30** *Keynote***Laser Beam Scanning for Near-to-Eye Display Applications: Architectural, Optical, Photonic and Systems Considerations**Bharath Rajagopalan
STMicroelectronics

Laser Beam Scanning (LBS) technologies enables small form-factor, light weight, fashionable, all-day wearable AR smart glasses with the ability to scale resolution and field-of-view (FoV) with low power consumption.

LDC1-02 11:15 *Keynote***Lidar and Near-to-Eye AR Display by Angular and Spatial Light Modulation with MEMS SLM**Yuzuru Takashima, Parker Liu,
Ted Liang-tai Lee, Chuan Luo,
Brandon Friedman, Gregory Michael Nero,
Yexin Pei, Tianyao Zhang, Xianyu Deng,
Jeff Ching-Wen Chan, Eunmo Kang,
Chin-I Tang, Jeff Chen, Joshua Rodriguez,
Braden Smith
Wyant College of Optical Sciences, University of Arizona

Beam and image steering by Micro Electro Mechanical System (MEMS) spatial light modulators decouples trade-offs between resolution, field of view and size of displays and optics that solves optical design challenges commonly found in lidar and Augmented Reality display engine.

----- Lunch 12:00-13:00 -----

[LDC2] 13:00-15:00**Light Sources and Components 1**Chairs: Tatsushi Hamaguchi
Sony Group Corp.
Xun Tang
Kyushu University**LDC2-01 13:00** *Invited***Recent Progress of Green and Blue GaN-based Vertical-Cavity Surface-Emitting Lasers**Hitoshi Nagai, Kenichi Terao,
Kazutaka Tsukayama, Takashi Ohara,
Yoshihiro Hara, Ryoma Shimazu, Shingo Masui,
Tomoya Yamamoto, Shin-ichi Nagahama
Nichia Corp.

We present latest development results of nitride blue and green Vertical-Cavity Surface-Emitting Lasers (VCSELs). The wall-plug efficiency of 18.5% and 3.7% were achieved for the blue and green VCSELs, respectively. Furthermore, our VCSELs are lasing with a single-longitudinal and single-transverse mode.

LDC2-02 13:30 *Invited***High power AlGaInP red laser diodes for projection applications**Satoshi Kawanaka, Seiji Kitamura,
Shintaro Miyamoto, Manabu Hashizume,
Kazuaki Yano, Masato Hagimoto
Ushio Inc.

638nm high power AlGaInP laser diodes for display applications have been demonstrated. The optical output power exceeds 4.5W and 3.5W at 25degC and 45degC, respectively. The wall-plug efficiency at 25degC is 43%.

LDC2-03 14:00**Polarization Control of Long-Cavity Vertical-Cavity Surface-Emitting Lasers by Side-Facet Introduction**Tomohiro Makino, Tatsushi Hamaguchi,
Noriko Kobayashi, Kentaro Hayashi,
Maiko Ito, Maho Ohara, Koichi Sato,
Yuki Nakamura, Takumi Watanabe,
Shoetsu Nagane, Yuichiro Kikuchi,
Tatsuro Jyokawa, Yukio Hoshina,
Eiji Nakayama, Rintaro Koda,
Noriyuki Futagawa
Sony Semiconductor Solutions Corporation

We found a simple way to ensure polarization control of the output light without any degradation by creating a facet surface on the side of the substrate using a GaN-based c-plane blue VCSEL.

LDC2-04 14:15**Study on improvement of color rendering properties of phosphor-converted laser illuminants**Yoshio Manabe¹, Hiroshi Fuji¹, Kana Fujioka¹,
Kazuhiya Yamamoto¹, Tsuneo Kusunoki²,
Seika Tokumitsu², Hideo Kawabe²,
Satoshi Makio²
¹Osaka University, ²OXIDE Corp.

We have proposed blue laser-excited phosphor-converted red laser-assisted laser illuminants. As a result, the laser illuminants have a high color rendering index of 80 or higher over a wide color temperature range.

LDC2-05 14:30**Chromaticity coordinates and general color rendering index of a white light from phosphor excited with varying densities of blue laser light**Seika Tokumitsu¹, Satoshi Makio¹,
Tsuneo Kusunoki¹, Hideo Kawabe¹,
Yoshio Manabe², Hiroshi Fuji², Kana Fujioka²,
Kazuhiya Yamamoto²
¹OXIDE Corporation, ²Osaka University

Laser lighting systems represent new energy efficient light sources. However, the phosphors in systems excited by laser light general provide poor color rendering index (Ra). In the present work, the Ra and color temperature of phosphor-type laser-based lighting systems were adjusted by varying the phosphor excitation conditions.

LDC2-06 14:45**Process impact as LED size shrinks and improve the brightness of AlGaInP**Zhen Jin Wang^{1,2,3}, Xin Liang Ye³,
Wei Chen Tu⁴, Chih Chiang Yang²,
Yan Kuin Su^{1,2,4,5}¹Institute of Microelectronics, National Cheng Kung University, ²Green Energy Technology Research Center, Department of Electrical Engineering, Kun Shan University,³Epileds Technologies, Incorporated, Tainan,⁴Department of Electrical Engineering, National Cheng Kung University, ⁵Academy of Innovative Semiconductor and Sustainable Manufacturing, National Cheng Kung UniversityUsing 60x40 um² process parameters to produce 36x18 um² Micro-LEDs, the micro LED shape with a size of 36 x 18 um² has a second-order plane and a waist on the upper surface. Improving Red Micro LED Efficiency by Removing n-GaAs and Distributed Bragg Reflectors. Compared to the untreated reference, the EQE of the micro-LED with n-GaAs removed (an increase of 1%), and the micro-LED with n-GaAs and DBR removed had the best performance with an EQE enhanced of 11.76%.

----- Coffee Break 15:00-15:15 -----

[LDC3] 15:15-15:30**Short Presentation**Chairs: Seika Tokumitsu
Oxide
Tetsuya Yagi
NICHIA CORPORATION**LDC3-01 15:15****Luminescence investigation of chromium-doped cordierite powder phosphor**Mu-Tsun Tsai, Yin-Jun Luo
National Formosa UniversityWe experimentally investigate the luminescence of chromium-doped cordierite (Mg₂Al₂Si₂O₁₂:Cr) phosphor via a sol-gel process. The phosphor powders exhibit significant red-light emission peak at 696 nm under 398 nm excitation, with full width at half maximum of 8 nm, short afterglow, and good red saturation.**LDC3-02 15:18****Monolithic active-matrix micro-LEDs through filamentary interconnection using memristive switches**Seok Hee Hong, Ho Jin Lee, Wanqi Ren,
Na Hyun Kim, Hwi Geun Kim, Tae Geun Kim
School of Electrical Engineering, Korea University

A new active-matrix driving circuitry for microscale light-emitting diode display, using a multilevel GeTe-based memristor, instead of conventional one-transistor and one-capacitor approach, is proposed and demonstrated.

LDC3-03 15:21**Design of Balanced Photodetector for Flash Type FMCW LiDAR System**Eunbin Na^{1,2}, Kwon Soon Wook²,
Roh Cheong Hyun², Soo Jin Kim¹, Junho Lee²
¹Korea University, ²Korea Electronics Technology Institute

Realize a flash-type FMCW-LiDAR-system for fully autonomous vehicles, design and manufacture a 2x2-array balanced-photodetector corresponding to the flash-type that needs to receive 2D-data in free space, and analyze the beat signal to check its performance.

LDC3-04 15:24**Improved Performance of IZO/IGZO:Hf-based Bilayer TFTs with Low-temperature Process.**Hwi Geun Kim, Tae Geun Kim, Ho Jin Lee,
Seok Hee Hong, Kang Min Lee
Korea University

Oxide TFTs are limited in their use as display driving devices due to low mobility, high annealing process, and instability. Here, we propose an IZO/IGZO:Hf bilayer TFT to lower the process temperature and improve performance.

LDC3-05 15:27**3D Images Reconstruction in Front of Existing 2D Display By Edge-Based Depth Fused 3D Display Using Aerial Images**Takahiro Omoto, Kengo Fujii, Masaki Yasugi,
Shiro Suyama, Hirotsugu Yamamoto
Utsunomiya University

We propose an optical system for Edge-Based DFD displays that uses aerial images for the front image in front of conventional 2D display and clarify effectiveness of our optical system as a 3D display.

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Wednesday, 19 April

[LDC4] 9:00-10:30
Light Sources and Components 2
 Chair: Hiroshi Murata
Mie University

LDC4-01 9:00 *Invited*

EO Polymers and High-Speed Manipulation Devices for Visible Light
 Shun Kamada, Kouichi Tanaka, Chiyumi Yamada, Toshiaki Yamada, Akira Otomo
NICT

We developed high-performance EO polymers and modulators for visible light. The modulator's figure of merit, $V_{\pi}L$ is as small as 0.52 V-cm, which is smaller than the typical value of C-band modulators. An optical phased array for manipulating 640 nm laser beam is being prototyped.

LDC4-02 9:30 *Invited*

Compact Full Color Optical Engine Composed of RGB Laser Diodes and Silica Waveguides

Kazuki Iwabata, Yuuta Yabe, Osamu Kawasaki, Tetsufumi Yoshida, Tomoki Kamio, Akira Himeno
SEIREN KST Corp.

We have developed an integrated RGB multi-mode laser module that is compact and has a large optical output power. The coupling efficiency with the laser diodes was maximally 60 % without lenses, and the speckle noise was suppressed to 70 % compared to a single mode laser module.

LDC4-03 10:00

Analysis of high-speed electro-optic deflection devices for visible lasers
 Shohei Uomi, Takashi Ebara, Yui Otagaki, Hiroshi Murata
Mie University

We have been investigating a high-speed optical deflection device using the electro-optic effect for visible laser application. In this paper, we report a new electro-optic deflection device for multi-colored laser beams with BPM analysis results.

LDC4-04 10:15

Temporal Domain Analysis of Laser Beam Signal from Raster Scanning Laser Projectors -Colour Shift-

Takashi Ebara¹, Hiroshi Murata^{1,2}, Junichi Kinoshita², Kazuhisa Yamamoto²
¹Mie University, ²Osaka University

Temporal delays were observed corresponding to the colour shift in the projected pattern. The obtained results are useful for control and design of smart laser display systems.

----- Coffee Break 10:30-10:45 -----

[LDC5] 10:45-12:15
Smart Systems

Chairs: Masafumi Ide
Lambda Works
 Muneharu Kuwata
Mitsubishi Electric Corp.

LDC5-01 10:45 *Invited*

Interstellar Probes Enabled by Gigawatts of Diodes

Wesley A. Green¹, Álvaro de Miguel², Andreas M. Hein³, Nicolas Appel²
¹Breakthrough Initiatives, ²Technical University of Munich, ³SnT, University of Luxembourg

A 200 GW terrestrial coherent phased array of lasers is required to propel lightsails to Alpha Centauri. The cost of such a system is untenable today, but we find an exponential decrease in cost over time, resulting in just 1-10 cents per watt in 2050. This follows from a 77% learning curve. These laser prices make interstellar travel economically viable.

LDC5-02 11:15 *Invited*

Development of Underwater LiDAR for Visualizing Underwater Environment

Ken-ichi Suzuki, Hiroki Okuzawa, Chihiro Kawabata, Koichi Tezuka
Trimatiz Limited

This paper introduces our effort to develop underwater LiDAR's to visualize underwater environment. This paper also explains the realization of underwater LiDAR's using visible light devices and introduces 3D scanning images using our underwater LiDAR.

LDC5-03 11:45

Development of a Submersible Compact Time-of-Flight Imager for In-situ Characterization of 3D Underwater Targets

Kévin Walcarus¹, Malik Chami², Laurent Hespel¹, Thibault Dartigalongue¹
¹ONERA / DOTA, Université de Toulouse, ²LATMOS, Sorbonne Université, CNRS

The identification of 3D underwater targets is critical for defense and infrastructures monitoring. A prototype is described and tested in controlled immersed conditions with increasing turbidity.

LDC5-04 12:00

Blue laser beam irradiation system for controlling flying pests

Soichiro Nishiguchi, Hiroshi Fuji, Kana Fujioka, Kazuhisa Yamamoto
Institute of Laser Engineering, Osaka University

We propose a pest control system that detects flying pests and irradiates a pulsed beam from a semiconductor blue laser to the detection position. The system tracked the erratically flying pests and shot them instantly.

----- Lunch 12:15-13:30 -----

[LDCp] 13:30-15:00
LDC Poster Session
<Exhibition Hall A>

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Thursday, 20 April

[LDC6] 9:00-10:30
Imaging / Lighting 1

Chairs: Sunao Kurimura
NIMS
 Nan Ei YU
Gwangju Inst. of Science and Technology

LDC6-01 9:00 *Invited*

Robust designable light sources for display and bio-imaging

Sunao Kurimura
National Institute for Materials Science (NIMS)

Optical parametric light sources by quasi-phase matching are reviewed in different wavelength regions. Owing to efficient devices single-pass wavelength conversion becomes feasible with moderate efficiency, leading to robust light sources in commercial mobile imaging system.

LDC6-02 9:30 *Invited*

High-throughput, label-free imaging and analysis of cells and tissues by Raman spectroscopy

Yasuaki Kumamoto^{1,2}
¹Osaka University, ²Kyoto Prefectural University of Medicine

I present Raman spectroscopic techniques accelerating imaging and analysis of cells and tissues. I also discuss potential biomedical applications of the techniques that acquire comprehensive molecular information of a sample without invasive and destructive treatment.

LDC6-03 10:00 *Invited*

Development of second-harmonic-generation microscopy and its application to human skin diagnostics

Eiji Hase, Takeshi Yasui
Tokushima University

Second-harmonic-generation (SHG) microscopy is an attractive imaging modality for the in situ visualizations of collagen fiber in tissues. In this paper, we introduce our recent research progress and discuss the advantages of SHG microscopy in skin diagnostics.

----- Coffee Break 10:30-10:45 -----

[LDC7] 10:45-12:30
Imaging / Lighting 2

Chairs: Hirotsugu Yamamoto
Utsunomiya University
 Atsushi Satou
Iwasaki Electric Co., Ltd.

LDC7-01 10:45

Complex-Amplitude Generation Technique Using Single Phase-Only Spatial Light Modulator and Rhombic Low Pass Filter

Nobuhiro Yamagishi, Atsushi Okamoto, Akihisa Tomita
Hokkaido University

We propose a new complex-amplitude generation technique with a simple optical system. In numerical analysis, the SNRs of the intensity and phase were 10.09 and 3.06 dB higher than the mode shaper, respectively.

LDC7-02 11:00

Laser Speckle Reduction Based on a Fluctuating Mesoscale Optical Pattern Realized in a Liquid Crystal Device

Eriko Fukuda¹, Mitsuhiro Akimoto²
¹Kyushu Sangyo University, ²Sanyo-Onoda City University

We here show that a particular electroconvection pattern realized in a liquid crystal device under appropriate voltage condition can reduce the laser speckle noise with keeping the beam quality of transmitted laser light.

LDC7-03 11:15

Evaluation of Touch Sensation on Aerial Display using Sensory Feedbacks: Tactile by Vibration to Sole of Foot, Visual, and Auditory

Yasunori Terao, Haruki Mizushima, Kenji Yamamoto
Tokushima University

In recent years, contactless aerial display has been attracting attention. One issue of the system is no sensation of touching the screen in air. In this paper, we evaluate improvement of usability on aerial display with visual, tactile and auditory information by Scheffe's method of paired comparisons.

LDC7-04 11:30

Image Processing System for Blur Correction of Aerial Imaging by Retro-Reflection

Hayato Kikuta^{1,2}, Masaki Yasugi², Hirotsugu Yamamoto²
¹Mitsubishi Electric Corp. Advanced Technology R&D Center, ²Utsunomiya University

We propose a processing system that corrects the blurring peculiar to aerial imaging by retro-reflection. We calculate the point spread function from the observed aerial imaging and obtain the inverse function. Image blur can be corrected by deconvolving the inverse function to the displayed image. We perform correction on the simulation and correction on the actual aerial image, and consider the visibility improvement factors in the image processing system.

LDC7-05 11:45

Reconstruction Performance of U-Net in Single-Pixel-Imaging with Random-Dot-Embedded Apparent Images

Hiroki Takatsuka, Masaki Yasugi, Naoya Mukojima, Shiro Suyama, Hirotsugu Yamamoto
Utsunomiya University

Single-pixel-imaging with latent random patterns has a problem that the reconstructed image is influenced by the apparent image. Images reconstructed by single-pixel-imaging were restored by U-Net. The reconstruction performance after U-Net processing has been evaluated based on structural similarity (SSIM). Results shows that 100 patterns are necessary for reconstruction.

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LDC7-06 12:00**Approximate Calculation of Imaging Property in Optical System of AIRR (Aerial Imaging by Retro-Reflection)**Katsunari Ashimine^{1,2}, Shiro Suyama¹, Hirotsugu Yamamoto¹
¹Utsunomiya University, ²ALPSALPINE

We propose a simulation method of an aerial image formed with AIRR system by using an effective point-spread function (PSF) with aperture for blurring due to diffraction. Contrast transfer function (CTF) was calculated using effective PSF, and its effectiveness was confirmed by comparative examination of the observed CTF.

LDC7-07 12:15**Investigation of Femtosecond-Laser-Excited Micro-Cloud Voxels for Volumetric Display**KEISUKE NUMAZAWA, Kota Kumagaki, Yoshio Hayasaki
Center for Optical Research and Education, Utsunomiya University

Volumetric display using micro-cloud is proposed. The micro-cloud composed of small droplets of ethanol for a focused laser pulse excitation remains in the air for a certain time after laser excitation. The fundamental temporal and spatial property is investigated for the pulse energy.

----- Lunch 12:30-13:15 -----

[LDC8] 13:15-15:15**Light Sources and Components 3**Chairs: Tetsuya Yagi
NICHIA CORPORATION
Fergal Shevlin
*Dyoptyka***LDC8-01 13:15***Invited***InGaN-based red emitters: toward lasers**Kazuhiro Ohkawa¹, Pavel Kirilenko¹, Martin Velazquez-Rizo¹, Daisuke Iida¹, Zhe Zhuang², Bao-Ping Zhang³
¹King Abdullah University of Science and Technology (KAUST), ²Nanjing University, ³Xiamen University

The efficiency of InGaN red LEDs has been greatly improved by developments in epitaxy, LED structures, and device fabrication methods. InGaN red (632 nm) micro-LEDs are also efficient, with power densities over five times higher than InGaP ones. InGaN lasers in the yellow and red regions wouldn't be far off considering recent progress.

LDC8-02 13:45*Invited***Molecular Donor-Acceptor Interaction for Realizing Low Threshold Organic Lasers from Visible to Near-Infrared regime**Xun Tang^{1,2}, Chihaya Adachi^{1,2,3}
¹Center for Organic Photonics and Electronics Research (OPERA), Kyushu University, ²Department of Applied Chemistry, Kyushu University, ³International Institute for Carbon Neutral Energy Research (WPI-ICNER), Kyushu University

The manipulation of intramolecular interactions in the donor-acceptor (D-A) type organic molecules is crucial to effectively tune the lasing wavelengths from yellow to near-infrared, and reorganize the wavefunction distribution for lower lasing thresholds.

LDC8-03 14:15**High Crystallinity InGaN Layers Grown on Cleaved ScAlMgO4 Substrates for Yellow and Red Lasers**Mohammed Najmi¹, Pavel Kirilenko¹, Martin Velazquez-Rizo¹, Artem Shushanian¹, Bei Ma², Daisuke Iida¹, Kazuhiro Ohkawa¹
¹King Abdullah University of Science and Technology, ²Chiba University

The crystallinity of an InGaN epitaxial layer has improved by growing on cleaved ScAlMgO4 substrates with atomically flat surfaces. The high crystalline quality of InGaN layers grown on lattice-matched substrates is promising for high In-content InGaN-based lasers in the yellow and red spectral ranges.

LDC8-04 14:30**A novel laser diode fabrication process of 100 μm cavity GaN-based laser diodes on Si substrates**Kentaro Murakawa, Yoshinobu Kawaguchi, Motohisa Usagawa, Akiko Komoda, Mizuki Tonomura, Takeshi Yokoyama, Yuuta Aoki, Kazuma Takeuchi, Takeshi Kamikawa
KYOCERA Corporation

We propose a novel laser diode fabrication process that yields 100 μm cavity GaN-based edge emitting laser diodes on Si substrates. This fabrication process can realize low energy consumption laser diodes for AR glasses.

LDC8-05 14:45**Enhanced Emission of GaN-Based Micro-LEDs using Suspended Structure**Yang Mei¹, Minchao Xie¹, Tao Yang¹, Hao Long¹, Leiying Ying Ying¹, Guoen Weng², Baoping Zhang¹
¹Xiamen University, ²East China Normal University

Suspended GaN-based micro-LEDs are fabricated by transferring epitaxial-layers to micro-metal pillars on a copper plate. The output power exhibits 150% higher than the normal device, benefiting from the improved light-extraction efficiency and the smaller quantum-confined Stark effect. This study provides a new route to fabricate highly efficient micro-LEDs.

LDC8-06 15:00**The analysis of near-infrared signals using multi-wavelength yellow-orange lasers generated by chi(2) chirped nonlinear photonic crystals**Ming Shung Tsai¹, Kai-Hsun Chang^{1,2}, Chia-Chun Fan¹, To-Fan Pan¹, Azzedine Boudrioua², Hiroyuki Yokoyama³, Lung-Han Peng¹
¹National Taiwan University, ²Université Paris Nord, ³Tohoku University

Yellow-orange multi-wavelength laser source is demonstrated by utilizing chi(2) nonlinear photonic crystals cascaded of tri-parallel IR-OPO segments with chirped design for frequency up-conversion. This intra-cavity pump scheme allows 1-3 groups of NIR signal/idler generation depending on the relative beam position onto the crystals, enabling frequency-converting up to 5-peak wavelengths in the 585-595nm band.

----- Coffee Break 15:15-15:30 -----

[LDC9] 15:30-16:30**Metaverse**Chair: Satoshi Ouchi
*Hitachi***LDC9-01 15:30***Invited***Development of a Head-mounted Display Using Light-field technology**Yasutaka Maeda, Daiichi Koide, Kensuke Hisatomi
Japan Broadcasting Corporation
Light-field head-mounted displays (HMDs) reconstruct focus-adjustable three-dimensional images, which resolves the vergence-accommodation conflict. We report the trials in optical design and system development of light-field HMDs using lens arrays to achieve comfortable virtual reality viewing.**LDC9-02 16:00****Increasing Vection Strength by Stretching Image in the Periphery of the Visual Field**Kohsuke Nakanishi, Kenji Yamamoto, Haruki Mizushima
Tokushima University

In this paper, we applied stretch processing to the image at the periphery of the visual field and evaluated the relationship between the processing conditions and vection strength. The experimental results showed that the vection strength was enhanced by stretching left-right direction of the image. In the left-right stretching process, vection was induced most stably and strongly when the unprocessed area was $\pm 10^\circ$ and the magnification of the stretching was 1.43.

LDC9-03 16:15**Astigmatism on 3D Image Position in a Large Aerial Display Measured by Motion Capture**Mayu Adachi, Masaki Yasugi, Shiro Suyama, Hirotsugu Yamamoto
Utsunomiya University

We have clarified the aberration caused by distortion of a beam splitter in a large aerial display by motion capture. The position of the aerial image cannot be determined due to aberrations caused by the distortion. Experimental results show that astigmatism occurs when the focusing distance changes between the vertical and horizontal directions.

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[LDC10] 9:00-10:30**Holographic Display**Chairs: Kenji Yamamoto
Tokushima Univ.
Ryuji Hirayama
*University College London***LDC10-01 9:00***Invited***Development of holographic video displays**Hiroshi Yoshikawa
Nihon University

A direct-view type with a large image and a wide viewing area is still challenging, the horizontal parallax-only method with limited parallax, and the eye-tracking or near-eye type with limited viewing area are approaching practical.

LDC10-02 9:30*Invited***Computation Techniques in Tera-pixel-scale Full-parallax Computer Holography for 3D Display**Kyoji Matsushima, Hirohito Nishi, Ryosuke Katsura, Chang-Joo Lee
Kansai University

Tera-pixel-scale fringe images are required for creating quality CGHs that reconstruct amazing deep 3D scenes. However, it is very difficult to calculate such large-scale fringes in full-parallax. Techniques based on numerical field propagation are summarized for computing object fields by physical simulation and multi-viewpoint images.

LDC10-03 10:00**Demonstration: Holographic Display**K. Matsushima
Kansai Univ.
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----- Coffee Break 10:30-10:45 -----

[LDC11] 10:45-12:15**Novel and Emerging Technologies**Chair: Hidekazu Hatanaka
Ushio
Makio Kurashige
*Dai Nippon Printing***LDC11-01 10:45***Invited***Acoustic mid-air displays in the presence of sound-scattering objects**Ryuji Hirayama, Giorgos Christopoulos, Diego Martinez Plasencia, Sriam Subramanian
University College London

Recent advances in acoustic holography have enabled levitation-based volumetric displays with tactile and audio sensations, but existing methods did not account for the sound scattering of objects' surfaces. We developed a high-speed multi-point levitation technique that accounts for sound scattering and demonstrated a volumetric display that works in the presence of any physical object.

LDC11-02 11:15**Long-Distance Floating of Aerial Images Formed with AIRR by Use of Fresnel lens**Shinya Sakane^{1,2}, Masaki Yasugi², Siro Suyama², Hirotsugu Yamamoto²
¹Seiwa Electric Mfg. Co., Ltd., ²Utsunomiya University

Floating distance of an aerial image has been extended by introducing a Fresnel lens into an optical system based on AIRR (aerial imaging by retro-reflection). Furthermore, for use as a road information provision, two aerial images have been formed by use of a single LED panel and two beam splitters.

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LDC11-03 11:30**Two-Dimensional Multiplication of Aerial Images Using Non-Parallel Two Half Mirrors in AIRR**Kohei Kishinami, Kengo Fujii, Masaki Yasugi, Shiro Suyama, Hirotsugu Yamamoto
Utsunomiya University

This paper proposes an optical system to form two-dimensional multiple aerial images using non-parallel two half mirrors in AIRR. We found that aerial images can be formed in four directions from a single light source.

LDC11-04 11:45**Aerial Imaging by Retro-Reflection (AIRR) Optical System Containing a Transparent Object at Virtually Conjugate Position**Kazuaki Takiyama, Kengo Fujii, Masaki Yasugi, Shiro Suyama, Hirotsugu Yamamoto
Utsunomiya University

We propose an aerial display that contains a transparent object. The aerial image is free from the object shape by placing the object at the virtually conjugate position in the AIRR optics. The effectiveness of the proposed optical design has been confirmed by experiments with a variety of transparent objects.

LDC11-05 12:00**Analyses on Long-range Pop-up Distance Change Caused by Angle Changes of Light Source, Substrate, and Observation in Arc 3D Display**Hiroto Oishi, Kengo Fujii, Masaki Yasugi, Shiro Suyama, Hirotsugu Yamamoto
Utsunomiya University

We have clarified the angle accuracies between light source, substrate, and observation are important for the pop-up distance in arc 3D display. When observer and light source moves simultaneously at distant position, long and constant pop-up image distance can be obtained regardless of distance change in observer and light source.

----- Lunch 12:15-13:30 -----

**[LDC12] 13:30-15:15
Automotive**Chair: Junichi Kinoshita
*Osaka University***LDC12-01 13:30** *Invited***Integrated the Driving Beam Controller and LiDAR sensor into Smart Laser Headlights for Autonomous Cars.**Y. P. Chang¹, Kuo-Yin Huang^{1,2}, Stark Tsai¹, Chun-Nien Liu², Han Pin³, Wood-Hi Cheng⁴
¹Taiwan Color Optics, Inc., ²Department of Electrical Engineering, National Chun Hsing University, ³Graduate Institute of Precision Engineering, National Chun Hsing University, ⁴Graduate Institute of Optoelectronic Engineering

A light detection and ranging (LiDAR) stands for light imaging, detection and ranging. LiDAR has seen extensive use in autonomous vehicles, robotics, aerial mapping, and atmospheric measurements. In this study, we report a new scheme of smart laser headlight module (LHM) integrated with LiDAR sensor and driving beam controller by a single micro-electro-mechanical system (MEMS).

LDC12-02 14:00 *Invited***LiDAR Technologies for Automated Driving**Toshio Ito^{1,2}¹Shibaura Institute of Technology, ²Hyper Digital Twins

Because of its high spatial resolution and ability to create high-resolution environmental maps, LiDAR for highly automated driving has been resurrected. This presentation shows how LiDAR has been treated so far, introduces the principle of LiDAR in the future and discusses new usage of Laser for communication between vehicles and pedestrians.

LDC12-03 14:30 *Invited***Laser signal lighting for road applications**Makio Kurashige
Dai Nippon Printing Co., Ltd.

There have been many proposals of concept regarding the visible laser signal lighting for road applications, which were for the safety purposes. This paper introduced latest achievements, which were not only for the safety applications but for the improvement of operational efficiency of road constructions.

LDC12-04 15:00**Study of Beam Steering using LCoS for Solid-State LiDAR Applications**Seongjin Son, Byeongchan Park, Toijam Sunder Meetei, Nan Ei Yu
Gwangju Institute Science and Technology

We design and study steering at 1550 nm in LCoS for LiDAR. We report an analysis of the steering angles at different periods and measured the steering angle of 15.6° at 3.6 microns pitch.

**[LDC-PD] 15:15-16:05
Post-Deadline**Chair: Tetsuya Yagi
*NICHIA CORPORATION***LDC-PD-01 15:15****Replicative Glass Optics Manufacturing for Laser-based Systems and Applications**Robert Michels¹, Tim Grunwald¹, Thomas Bergs^{1,2}¹Fraunhofer Institute for Production Technology IPT, ²RWTH Aachen University

This paper discusses the development of non-isothermal glass molding (NGM) as a replicative process for producing integrated micro-optical systems. The study identified and overcame technology-related limitations in the NGM. The results demonstrate that features in micrometer scale can be molded using NGM with the potential for large-scale production.

LDC-PD-02 15:25**Molding of Aspheric Glass Lens Arrays for Use in a Compact Time-of-Flight Camera**Marcel Friedrichs¹, Cheng Jiang¹, Tim Grunwald¹, Thomas Bergs^{1,2}¹Fraunhofer Institute for Production Technology IPT, ²RWTH Aachen University

High-resolution compact optical systems are key components in many large-scale markets such as smartphones and automotive industry. In this paper, we present the manufacturing process of aspherical glass lens arrays using precision glass molding for use in a compact Time-of-Flight (ToF) camera.

LDC-PD-03 15:35**Adaptive SNR Controlling Algorithm for 6.2-Gbps Visible Light Communication with low power consumption and high spectral usage efficiency using a Semipolar Blue Single micro-LED**Pin-Wei Ho¹, Chih-Hsien Cheng², Hao-Chung Kuo^{3,4}, Gong-Ru Lin^{1,5}¹National Taiwan University, ²National Institute of Information and Communications Technology, ³Hon Hai Research Institute, ⁴National Yang Ming Chiao Tung University, ⁵Tektronix Inc. and National Taiwan University

Semipolar blue single μ -LED-based VLC with a low power consumption budget of 29 fJ/bit and high spectral usage efficiency of 8.3 bit/s/Hz delivers the 6.2-Gbps bit-loaded DMT by adaptive SNR controlling algorithm.

LDC-PD-04 15:45**Deterministic Formulas for Horizontal and Vertical Triple-View Display**Keitaro Uchida^{1,2}, Hirotsugu Yamamoto¹, Shiro Suyama^{1,3}¹Utsunomiya University, ²NIPPON SIGNAL CO., LTD., ³Tokushima University

We have identified a deterministic formulas for providing different images for three viewing points in horizontal and vertical directions. The proposed display is composed of three liquid-crystal display (LCD) panels. The multiple-views depending on the viewers' positions are generated by information sharing between the LCDs.

LDC-PD-05 15:55**High-Frequency Homogenization of Laser Illumination Through Stationary 0.22 N.A. Multimode Optical Fiber**Fergal Shevlin
DYOPTYKA

Our phase-randomizing deformable mirror technology is shown to be effective for homogenization of illumination intensity, and for minimization of speckle, within a camera exposure period of only 20 μ s when used with 0.22 N.A. multimode optical fiber.

**[LDC-CL] 16:05-16:20
Closing Remarks**Chair: Sunao Kurimura
NIMS

Poster Session

Poster Session <Exhibition Hall A>

Wednesday, 19 April

LDCp 13:30-15:00

LDCp-01

Luminescence investigation of chromium-doped cordierite powder phosphor

Mu-Tsun Tsai, Yin-Jun Luo
National Formosa University

We experimentally investigate the luminescence of chromium-doped cordierite ($\text{Mg}_2\text{Al}_4\text{Si}_5\text{O}_{18}:\text{Cr}$) phosphor via a sol-gel process. The phosphor powders exhibit significant red-light emission peak at 696 nm under 398 nm excitation, with full width at half maximum of 8 nm, short afterglow, and good red saturation.

LDCp-02

Monolithic active-matrix micro-LEDs through filamentary interconnection using memristice switches

Seok Hee Hong, Ho Jin Lee, Wanqi Ren, Na Hyun Kim, Hwi Geun Kim, Tae Geun Kim
School of Electrical Engineering, Korea University

A new active-matrix driving circuitry for microscale light-emitting diode display, using a multilevel GeTe-based memristor, instead of conventional one-transistor and one-capacitor approach, is proposed and demonstrated.

LDCp-03

Design of Balanced Photodetector for Flash Type FMCW LiDAR System

Eunbin Na^{1,2}, Kwon Soon Wook², Roh Cheong Hyun², Soo Jin Kim¹, Junho Lee²
¹Korea University, ²Korea Electronics Technology Institute

Realize a flash-type FMCW-LiDAR-system for fully autonomous vehicles, design and manufacture a 2x2-array balanced-photodetector corresponding to the flash-type that needs to receive 2D-data in free space, and analyze the beat signal to check its performance.

LDCp-04

Improved Performance of IZO/IGZO:Hf-based Bilayer TFTs with Low-temperature Process.

Hwi Geun Kim, Tae Geun Kim, Ho Jin Lee, Soek Hee Hong, Kang Min Lee
Korea University

Oxide TFTs are limited in their use as display driving devices due to low mobility, high annealing process, and instability. Here, we propose an IZO/IGZO:Hf bilayer TFT to lower the process temperature and improve performance.

LDCp-05

3D Images Reconstruction in Front of Existing 2D Display By Edge-Based Depth Fused 3D Display Using Aerial Images

Takahiro Omoto, Kengo Fujii, Masaki Yasugi, Shiro Suyama, Hirotsugu Yamamoto
Utsunomiya University

We propose an optical system for Edge-Based DFD displays that uses aerial images for the front image in front of conventional 2D display and clarify effectiveness of our optical system as a 3D display.