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35th Annual Stereoscopic Displays and Applications Conference - Introduction

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Abstract

This manuscript provides an overview of the 35th annual Stereoscopic Displays and Applications conference and an introduction to the conference proceedings for this conference.

Introduction

The 35th annual Stereoscopic Displays and Applications conference (SD&A XXXV) was held at the Hyatt Regency San Francisco Airport Hotel in Burlingame, California in the San Francisco Bay Area. SD&A 2024 was held in January 2024 as part of the 36th annual Electronic Imaging (EI) Symposium. It was the second in-person meeting held after the COVID lock-downs.

The 2024 EI Symposium was held over the dates Sunday 21 January to Thursday 25 January 2024. The SD&A conference was coordinated with the Imaging for XR workshop 2024 and the Engineering Reality of Virtual Reality 2024 conference to provide a full three-day program of 3D, VR and XR topics from Monday 22 January to Wednesday 24 January 2024.

The final conference program of SD&A 2024 is available on the SD&A conference website:
www.stereoscopic.org/2024

The conference program lists which papers have a published manuscript either as a regular conference presentation, or as a journal article. All of the manuscripts for the SD&A conference and the EI symposium are published open-access, which increases the visibility and accessibility of works presented at the conference and symposium. Published manuscripts from the EI conferences will be available from the IS&T Digital Library:
https://library.imaging.org/ei

The SD&A 2024 conference program page will provide a direct link to each of the published manuscripts:
www.stereoscopic.org/2024

First Day

The first day of the SD&A conference had two technical sessions, plus the first EI Plenary and the EI Highlights session.

Presentations in the first session, titled “Stereoscopic Displays” and chaired by Nicolas Holliman, were:

- Optical Aberration Analysis of Light Field Displays: A Calibration Approach for Enhanced Performance, Qi Zhang, Yuta Miyanishi, Erdem Sahin, and Atanas Gotchev, Tampere University (Finland) [1]
- Vergence-accommodation Conflict: Accommodation-enabled vs. Accommodation-invariant Near-eye Displays, Erdem Sahin, Tampere University, Ugur Akpinar, and Atanas Gotchev, Tampere University (Finland)
- Can Aliens See in 3D? Exploring the Prospect of 3-Channel Stereoscopic 3D, Andrew J. Woods, Curtin University (Australia) [2]

Presentations which also have a matching published manuscript are indicated by a citation indicated by a number in square brackets, and a listing in the References section.

Presentations in the second session, titled “Stereoscopic Camera Systems” chaired by Andrew Woods, were:

- 4K Stereoscopic Visualization of Robotic Microsurgery in Vascularized Free Tissue Transfer for Head and Neck Reconstruction, Justus Ilgner, Stephan Hackenberg, and Thien An Duong Dinh, Universitätsklinikum Aachen (Germany)
- Manipulating Viewing Distance and Camera Toe-in in a Stereoscopic Remote Vision System, Eleanor O'Keefe and Eric Seemiller, KBR, and Marc Winterbottom and Steven Hadley, Air Force Research Laboratory (United States) [3]

This year’s SD&A Keynote was presented by Aaron Parry, President of SDFX Studios on the topic “The Waking Dream: Next Steps Toward Immersion Entertainment” (Figure 1).

Figure 1. *Aaron Parry delivers his SD&A Keynote presentation.*

As president of SDFX Studios, Aaron Parry oversees the creative vision, worldwide production and technology development of the company. Aaron took the audience on a wide-ranging journey through advancements in the cinematic entertainment sector to the new opportunities in immersive entertainment. SDFX Studios has been involved in the post-production of a wide range of movies including the 3D conversion of a large selection of 3D Movies including the following recent titles: Guardians of the Galaxy Vol. 3 (2023), Teenage Mutant Ninja Turtles: Mutant Mayhem (2023), Trolls: Band Together (2023), Aquaman and the Lost Kingdom (2023), and the recent 3D conversion of the classic Jaws (1975).

In the afternoon was the first EI Plenary presentation titled "Seeing and Feeling in Robot-Assisted Surgery" by Professor Allison Okamura from Stanford University.

This was followed by the EI Highlights Session which included preview presentations of one presentation from each of the EI Symposium conferences. The preview presentation for SD&A was from Eric Seemiller who previewed his presentation “The Effect of Stereoscopic Depth Distortion on the Near Oculomotor Response” gave a preview of his presentation to be delivered on Wednesday.

As every regular SD&A attendee anticipates, there was a good supply of a variety of different Tim Tam flavours. This made the many coffee breaks much more enjoyable for SD&A attendees. A few “Tim Tam slams” may have also been undertaken for purely experimental purposes (Figure 2).

Figure 2. *Tim Tams – the before and the after.*

In the evening the Electronic Imaging Reception provided an opportunity for all EI Symposium attendees to enjoy each other’s company in a relaxed atmosphere in the conference hotel’s big open (and enclosed) atrium.

Normally on the Monday evening of the conference we hold the SD&A conference 3D Theater session. Unfortunately, we were unable to run the 3D Theater session this year due to a range of logistical limitations but we’ll try to run it again next year.

Second Day

On the second day, the Imaging for XR workshop provided a full day of activity related to Extended Reality (XR) technologies (Figure 3). The Imaging for XR workshop is chaired by Bennett Wilburn (Google) with support from the workshop program committee Nicolas Bonnier (Apple), Jonghyun Kim (NVIDIA), Susan Lakin (Rochester Institute of Technology) and Abhijit Sarkar (unaffiliated).

Figure 3. *IS&T Executive Director Suzanne Grinnan welcomed attendees.*

This year’s edition of the workshop comprised seven extended technical presentations:

- AI-mediated 3D Video Conferencing with Real-time 2D-to-3D Face Lifting, Jonghyun Kim, NVIDIA (United States)
- Privacy-preserving Visual Sensing with Applications in XR, Vrendan David-John, Virginia Tech (United States)
- The perfect 3D shot: AI-driven Techniques for Stereoscopic Image Capture and Conversion, Nima Zeighami, Leia, Inc. (United States)
- Volumetric Video Technology in Sports and Entertainment: Current Applications and Future Prospects, Tsuyoshi Wakozono, Canon USA (United States)
- The Time for Immersive 6DoF Content is Now, Victor Lempitsky, Cinemersive Labs (United Kingdom)
- Shipwreck Imaging for XR Applications, Andrew Woods, Curtin University HIVE (Australia)
- Perspective-Correct VR Passthrough, Grace Kuo, Meta Reality Labs (United States)

The technical presentations at the Imaging for XR workshop do not include a matching manuscript – you needed to be there!

The workshop also included a dedicated XR-focused demonstration session with the following demonstrations:

- Nima Zeighami and Joe Hill from Leia Inc demonstrated their AI-driven techniques for stereoscopic image capture and conversion on two different Leia 3D displays. (Figure 4)
- Bennett Wilburn assisted Victor Lempitsky to demonstrate a selection of Cinemersive experiences running on Meta Quest 3. (Figure 5)
- Andrew Woods, with assistance from Susan Lakin, showed an Augmented Reality experience from Curtin University HIVE of an Australian shipwreck named ‘Star’ (sunk in 1880) using two Meta Quest 3 headsets. (Figure 6)

Figure 4. *Nima Zeighami (left) and Joe Hill (rear) from Leia Inc demonstrating the Leia SR Pro^2 32".8K autostereoscopic 3D desktop monitor and the Acer ConceptD 7 SpatialLabs Edition laptop with a Leia Inc autostereoscopic display.*

Figure 5. *Bjorn Sommer tries out the Cinemersive 6DoF experience in a Quest 3 headset.*

Figure 6. *Curtin University had two Quest 3 headsets showing an Augmented Reality experience of an 1880 Australian shipwreck named 'Star'.*

After lunch the second EI Plenary presentation titled "Neural Radiance Fields" was presented by Jon Barron from Google Research. Neural Radiance Fields are one of a triad of techniques (along with Photogrammetric 3D reconstruction and Gaussian Spats) aimed at creating a volumetric 3D experience from a sequence of images or video of a real-world object or scene. Of course, the volumetric 3D experience created by these methods, as either a digital 3D model or a point cloud, can be displayed stereoscopically. (Figure 7)

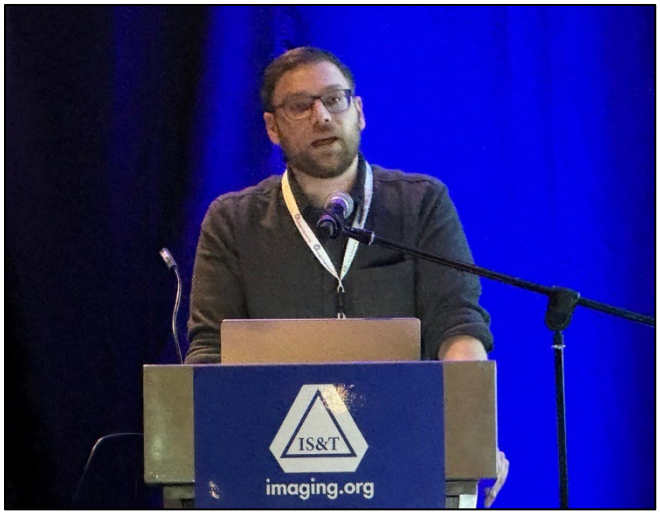

Figure 7. *Jon Baron delivers his EI Plenary presentation on Neural Radiance Fields.*

In the evening was the annual Electronic Imaging Symposium-wide Demonstration Session. There was a wide selection of stereoscopic related demonstrations in the session including:

- **Spatial Video.** Andrew Woods (Curtin University, Australia) presented a comparison of 3D video captured with the Apple iPhone 15 Pro, the Sony HDR-TD10 3D video camera and the Fujifilm W1 3D digital still camera on a Meta Quest 3 headset and a Fujifilm 3D display. (Figure 8)
- **VR Visualization of Avian-Human Perspectives for Co-Design Practices**. Bjorn Sommer (Royal College of the Art, UK) demonstrated work driven by Tori Simpson and Harry Hosker supporting empathy building reflecting on avian-human perspectives. A tethered Meta Quest 2 was used connecting to a computer running UNREAL engine. (Figure 9) **2D to 3D Cinema Content.** Enrique Criado (3d Experiences Iberia, Spain) demonstrated a selection of 2D to 3D converted cinema content using a selection of different 3D display. (Figure 10)
- **CubicSpace.** Nicolas Routhier (CubicSpace, Canada) demonstrated new methods of aligning and correcting stereographs. (Figure 11)
- **Leia Inc.** Nima Zeighami and Joe Hill (Leia Inc, USA) demonstrated different products using Leia's technology: the Leia SR Pro2 32" 8K autostereoscopic 3D desktop monitor, as well as the Acer ConceptD 7 SpatialLabs Edition laptop with an autostereoscopic display. (Figure 12)

- **Vintage Stereoscopic Viewers.** Eric Kurland (3D Space Museum, USA) demonstrated a selection of vintage stereoscopic viewers. (Figure 13)
- **HoloKinect**. Stephen Siemonsma and Tyler Bell (University of Iowa) showed their *HoloKinect* platform for live 3D video conferencing. The system used a Microsoft Azure Kinect to capture 3D of the user and an autostereoscopic Looking Glass Portrait to display the remote user. An alternative VR/AR viewing experience was also offered. (Figure 14)

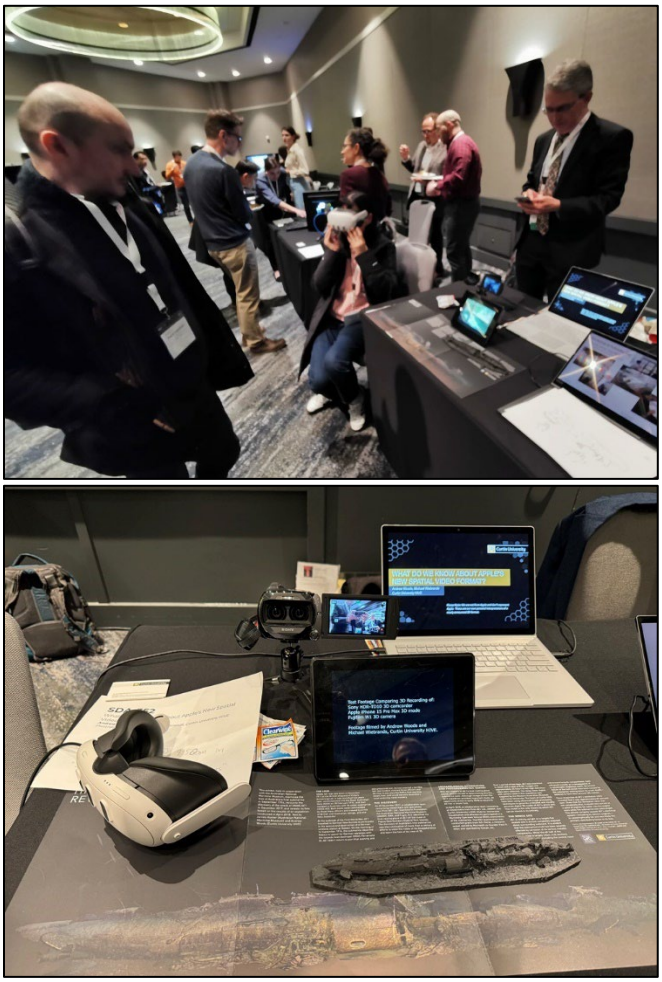

Figure 8 (top and bottom). *Andrew Woods (top-right) from Curtin University provided an illustration of various 3D / spatial video content, plus some of their shipwreck 3D work.*

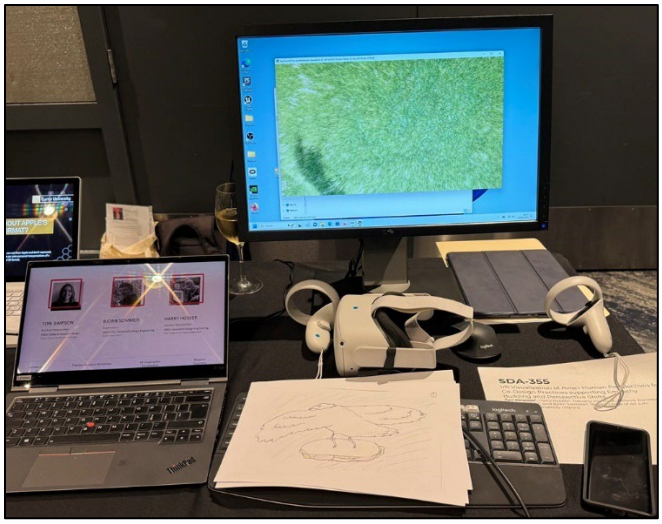

Figure 9. *Bjorn Sommer from Royal College of Art demonstrated VR Visualization of Avian-Human Perspectives for Co-Design Practices supporting Empathy Building and Perspective Shifts using a Meta Quest 2 and UNREAL engine.*

Figure 10. *Nicolas Routhier (right) from CubicSpace (Canada) demonstrated their method of aligning and correcting stereographs.*

Figure 11. *Enrique Criado from 3d Experiences Iberia (Spain) demonstrated a selection of the 3D cinema content on a range of different 3D displays.*

Figure 12. *Leia inc demonstrated an autostereoscopic desktop monitor and laptop.*

Figure 13 (top and bottom). *Eric Kurland from 3D Space Museum demonstrated a selection of vintage stereoscopic viewers.*

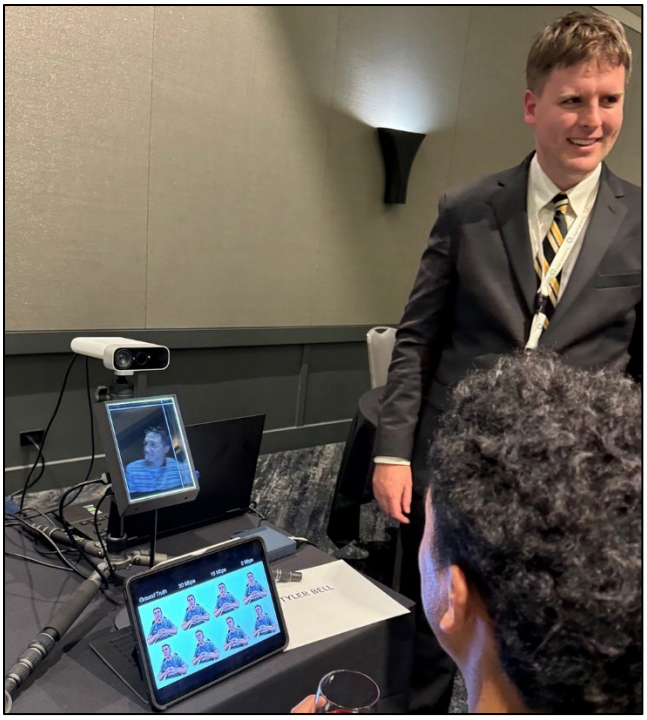

Figure 14. *Stephen Siemonsma (pictured) and Tyler Bell from the University of Iowa showcased HoloKinect, their 3D video conferencing solution.*

Third Day

On the third day there were three SD&A sessions including two joint sessions with the Engineering Reality of Virtual Reality conference.

The first session of the day was “Human Factors and 3D Content Solutions” chaired by Takashi Kawai, and had the following presentations:

- The Effect of Stereoscopic Depth Distortion on the Near Oculomotor Response, Eric Seemiller[1], Eleanor O'Keefe[2], Marc Winterbottom[1], Steven Hadley[1]; [1]Air Force Research Laboratory and [2]KBR (United States) [4]
- Automatic Stereograph Feature Detection, Nicholas Routhier, CubicSpace (Canada)
- Successful One Man, Low Cost, 3D CGI Feature Film Conversion, Enrique Criado, 3d Experiences Iberia (Spain)
- What Do We Know About Apple's New Spatial Video Format?, Andrew Woods and Michael Wiebrands, Curtin University HIVE (Australia)

In the morning we also hosted a discussion forum titled “3D Video Streaming - Solutions and Opportunities” moderated by Bjorn Sommer, with panelists Nicholas Routhier (CubicSpace, Canada), Eric Kurland, and Andrew Woods. The discussion covered the past, present and future of 3D video streaming. The Apple Vision Pro was due to be released just a few days after this forum, so naturally the possibilities of this new platform for 3D streaming were also discussed. (Figure 15)

Figure 15. *SD&A Discussion forum “3D Video Streaming”.*

Immediately after the lunch break, IS&T presented its society awards. Andrew Woods was presented with a Senior Membership Award to his “longstanding track record serving the Electronic Imaging community, including member of the SD&A committee since 1996; a chair of the SD&A conference since 2000, the 3D Theater Session since 2001, and the SD&A demonstration session since 1998; an instructor of the comprehensive short course “Stereoscopic Imaging Fundamentals” for more than 20 years; and EI Symposium Chair in 2005, 2018, and 2019.” (Figure 16)

Figure 16. *Nicolas Bonnier (IS&T President) (left) presents Andrew Woods (centre) with an IS&T Senior Membership award.*

The third EI Plenary presentation was delivered by Joseph M. Howard from NASA on the topic “Imaging the Universe: NASA Space Telescopes from James Webb to Nancy Grace Roman and Beyond”. (Figure 17)

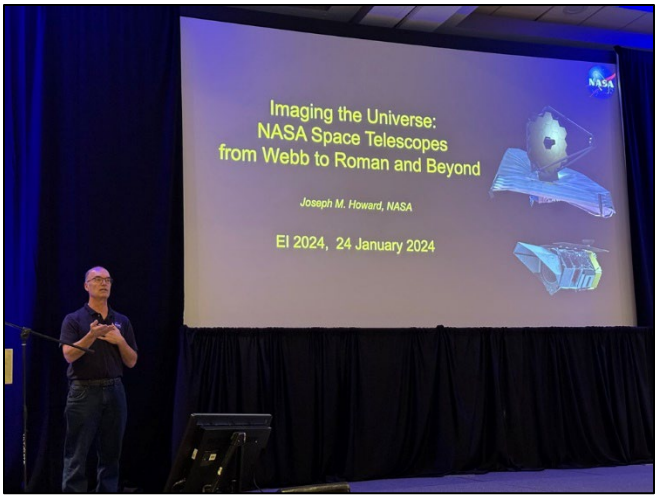

Figure 17. *Joseph M. Howard delivering his EI plenary presentation.*

The last two technical sessions of the day, and this year's SD&A conference were held jointly with the Engineering Reality of Virtual Reality conference. The Stereoscopic Displays and Applications conference and the Engineering Reality of Virtual Reality conference have been 'sister' conferences at the Electronic Imaging Symposium since 1994. There are obvious connections between the topics of stereoscopic imaging and virtual reality, hence the link between SD&A and ERVR are strong.

The "Virtual Reality I" session was chaired by Bjorn Sommer, and had the following presentations:

- Comparative Analysis of User Experience in Virtual Reality (VR) and Mixed Reality (MR) Systems Using Eye-Tracking Measurements, Yoshihiro Banchi, Yusuke Ohira, Mahiro Ito, and Takashi Kawai, Waseda University (Japan) [5]
- Virtual Reality (VR) Space for Radiation Oncology Education and Collaborative Learning, Kulbir Sandhu and Marie Vans, Colorado State University (United States) [6]

The "Virtual Reality II" session was chaired by new ERVR co-chair Sharad Sharma (University of North Texas, USA), and had the following presentations:

- VR Visualization of Avian-Human Perspectives for Co-Design Practices supporting Empathy Building and Perspective Shifts, Tori Simpson[1], Harry Hosker[1], Tokushu Inamura[2], Melanie Sarantou[2], Yasuyuki Hirai[2], and Bjorn Sommer[1]; [1]Royal College of Art (UK) and [2]Kyushu University (Japan) [7]
- JIST-first: Spatial Analysis and Visual Communication of Emergency Information through Augmented Reality, Sharad Sharma and Rishitha Reddy, Pesaladinne University of North Texas (United States) [8]
- Real-time Stereoscopic Image-parallel Path Tracing, Erwan Leria and Markku Mäkitalo, Tampere University (Finland) [9]
- Interactive Aviation Maintenance Classroom, LaTasha Starr, consultant, and Marie Vans, Colorado State University (United States) [10]

It is worth noting that all of the presentations in the two Virtual Reality sessions have a corresponding published manuscript. Please see the citation for each in the References.

Discussion

It takes a huge team effort to organize and run the Stereoscopic Displays and Applications conference and the Electronic Imaging symposium each year. Please join us in thanking all of the individuals and groups that contribute to the success of this meeting:

- conference authors and attendees,
- demonstration session presenters,
- the SD&A conference committee: Neil Dodgson, Gregg Favalora, Justus Ilgner, Eric Kurland, Bjorn Sommer, John Stern, Chris Ward and Laurie Wilcox,
- the staff at the Society for Imaging Science and Technology (IS&T / Imaging.org): Suzanne Grinnan, Marion Zoretich, and Donna Smith; and Palisades Convention Management: Jenny Donelan and Bill Klein. (Figure 18)
- the AV staff at the venue managed by Adrian Romero from Spectrum Audio Visual.
- Eric Kurland from 3-D Space Museum for supporting the presenters' technical requirements at the meeting.

Figure 18. *Jenny Donelan and Bill Klein at the Electronic Imaging 2024 registration desk.*

Two of the SD&A conference committee positions are rotating this year. We'd like to sincerely thank Neil Dodgson and Gregg Favalora for many years of service to the stereoscopic imaging community through the SD&A conference. We are pleased to welcome to the SD&A conference committee two new members: Eleanor O'Keefe and Nicholas Routhier. Both Eleanor and Nicholas have attended the SD&A conference on many occasions and have a deep understanding of the field (pardon the pun).

Eleanor O'Keefe is a vision research scientist with KBR Inc. She received her BS in biopsychology from the University of California, Santa Barbara (2010) and her PhD in experimental psychology from the University of Louisville (2017). Since then she has worked in the Operational Based Vision Assessment Lab at Wright-Patterson Air Force Base. Her work has focused on

remote vision system image space and stereoscopic 3D performance.

Nicholas Routhier is Founder of CubicSpace Technologies and President of Mindtrick Innovations Inc. He is a high-tech executive with more than 15 years experience in the tech start-up environment, and is recognized for his strategic vision, integrity and leadership. He has a deep technological understanding of stereoscopic 3D and immersive technologies (capturing, image processing, distribution). He was co-founder, President and CEO of Sensio Technologies from 2000 to 2016.

The SD&A conference has an online presence via our website, Linkedin group and Twitter feed,

Visitors can refer to the SD&A website to learn about the extensive history of the conference, see a full listing of all conference papers and presentations, and refer to a selection of historical 3D books in PDF format. The SD&A conference website is at:

www.stereoscopic.org

The SD&A LinkedIn group and Twitter feed are available here:

www.linkedin.com/groups?gid=1945944, and
https://twitter.com/SDnAconf

The conference also has an announce-only mailing list which you can sign up for:

https://lists.curtin.edu.au/mailman/listinfo/sdalist

Most presentations at the 2024 SD&A conference, and also the joint sessions with the ERVR conference, were recorded. In time they will be made available on the Electronic Imaging YouTube channel:

https://www.youtube.com/@ElectronicImaging

Manuscripts presented at the conference will be indexed via the SD&A conference website:

http://www.stereoscopic.org/2024

Conclusion

Next year's SD&A conference will be held in February 2025 as part of the 37th annual IS&T Electronic Imaging Symposium at the Hyatt Regency San Francisco Airport Hotel in Burlingame during the period 2-6 February.

Join us in February 2025 for an in-depth in-person 3D immersion experience – to attend, present, or demonstrate at the 2025 SD&A conference. Please visit the Electronic Imaging website www.ElectronicImaging.org or the SD&A conference website www.stereoscopic.org for details and deadlines. We look forward to seeing you there – in 3D! (Figure 19)

Figure 19. *Eric Kurland tests a DLPlink dongle and DLPlink active 3D glasses for use with select Android mobile phones for stereoscopic 3D display purposes.*

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[10] L. T. Starr, K. Shorts and M. Vans, “Interactive Aviation Maintenance Classroom” in Engineering Reality of Virtual Reality 2024, Proceedings of Electronic Imaging, Burlingame, California, 2024. DOI: https://doi.org/10.2352/EI.2024.36.13.ERVR-182

Author Biographies

Andrew Woods is an Associate Professor at Curtin University where he manages the HIVE visualisation facility (Hub for Immersive Visualisation and eResearch) and is a Research Engineer at the Centre for Marine Science & Technology. He specialises in visualisation, stereoscopic 3D imaging, 3D reconstruction, 3D cameras and displays, video electronics, underwater vehicles (ROVs), and engineering software development, with applications in offshore oil and gas, and maritime archaeology. He has BEng and MEng degrees in electronic engineering and his PhD was on the topic of crosstalk in stereoscopic displays. He is a senior member of IS&T. He was the technology lead on the Sydney-Kormoran Project which surveyed the wrecks of HMAS Sydney (II) and HSK Kormoran in 2015, and imaging lead for the survey of the wreck of HMAS AE1 in 2018. In 2017 he was recognised as one of Australia's Most Innovative Engineers by Engineers Australia. He has been co-chair of the Stereoscopic Displays and Applications conference since 2000.

Nick Holliman is Director of CUSP London (Centre for Urban Science and Progress) and Professor of Computer Science at King's College London researching the science and engineering of visualization and visual analytics including the fundamental challenges of visualizing big data. This includes working with psychologists to understand how the human visual system processes information, developing novel computational algorithms for the control of image content and demonstrating how these algorithms work in practice in cloud-based software tools and award winning stereoscopic 3D visualizations. He has worked in both industrial and academic environments and is experienced in delivering commercial impact from research outputs.

Takashi Kawai is a Professor in the Department of Intermedia Art and Science, Faculty of Science and Engineering, Waseda University, Japan. He received his Ph.D., M.A. and B.A. in Human Sciences from Waseda University in 1998, 1995 and 1993, respectively. His research interests include ergonomics and human factors in advanced imaging technologies such as stereoscopic imaging, virtual / augmented / mixed reality and cross-modal systems. He is a Certified Professional Ergonomist (CPE).

Bjorn Sommer is a Research Tutor at the Royal College of Art (London) where he is leading Year One of the Innovation Design Engineering program. He is working on the boundary of Visual/Immersive Analytics and design of ocean-related data, collective behaviour, as well as mesoscopic and molecular data modelling. He has experience since more than a decade in the development of 3D-stereoscopic applications. He holds a B. Sc. in Media Informatics, an M.A. in Interdisciplinary Media Sciences, and a PhD in Bioinformatics from Bielefeld University. He is also part of the UNESCO Ocean Decade-associated NEMO (New Economic Models for the Ocean) team at the RCA and co-led in this context the Grand Challenge 2023/24 involving around 700 students in London-based design challenges.