Display Week 2024

San Jose, CA.

Shammika Wickramasinghe

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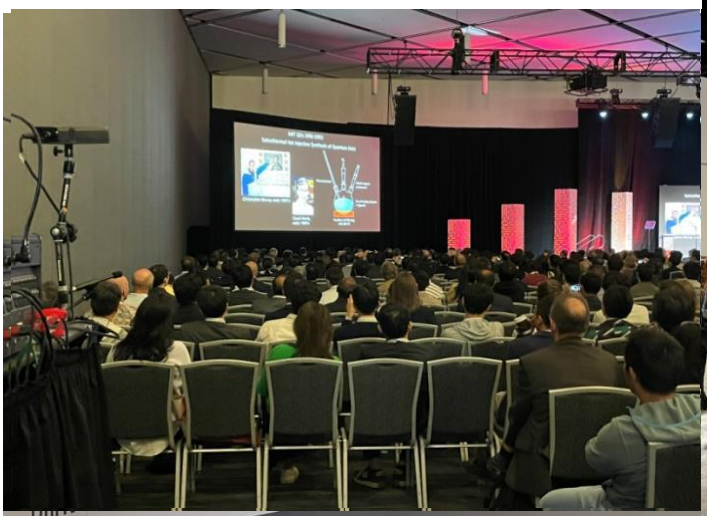
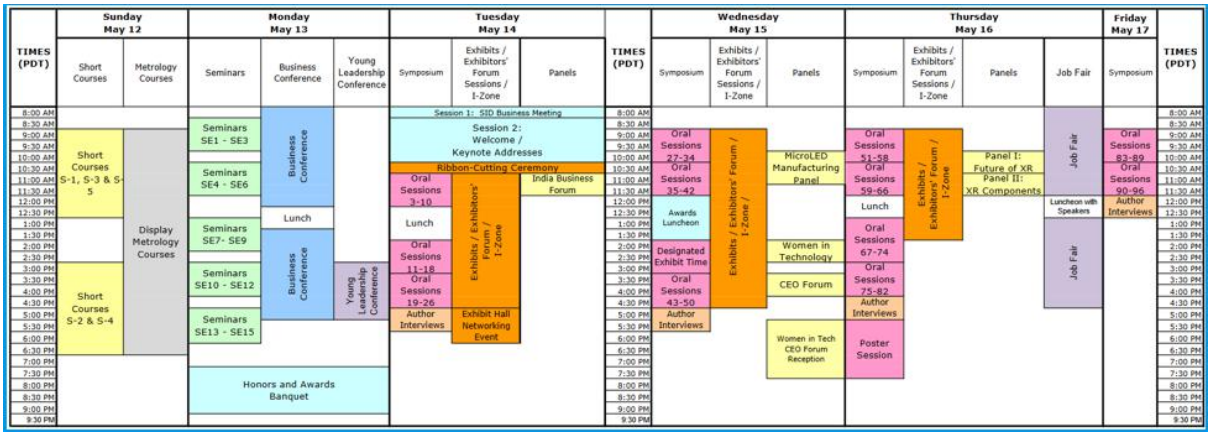


The Event:

The largest Display Conference 2024 took place during May 14th – 16th in San Jose, California and I was amongst the 1000's of industry experts and guests that attended the event. The event spanned across 5 days.



However the main event was spread across 3 days. There were additional days of lectures and workshops planned for Sunday, Monday and Friday where attendees could join short courses and lectures.

The event consisted of 3 key notes speakers from industry experts such as **Lester Wolfe** Professor of Chemistry, MIT Department of Chemistry, **Jason Hartlove,** Vice President of Display and Optics Meta, **Jun Zhao,** Chief Executive Officer TCL CSOT as well as lectures and demonstrations from suppliers. The event featured 95 technical sessions consisting of more than 370 oral presentations and 250 poster presentations. The program presented significant advancements covering imaging related technologies, that will become critical drivers for the future of metaverse, automotive, medical imaging, digital signage, microLEDs, display electronics, oxide TFTs, plus other new active-matrix advancements and novel methods and materials for imaging.

The AR/VR/MR/XR technical discussions / presentations as well as the posters showcased the significant stride in engineering advancements. The fast and vast advancements of the "near-to-eye" imaging products provide insight into technologies determining the future of AR/VR/MR, holographic systems, display and system components, along with manufacturing and critical measurement and control methods. This technology will eventually replace many current-generation smart phones, computers, and other products while enhancing and extending human sensory capabilities, memory and recording, and faster access to information.

The main sponsors for the event were BOE, TCL CSOT, TIANMA, 3M, Meta & RADIANT who showcased some great technical advancements in technology be it screens, integration, films and film based applications.

There were over 130 suppliers present where they displayed their Technology. Amongst the suppliers there were Tier1, suppliers as well as Tier 3 & 4 suppliers and test and development establishments that were promoting and show casing new test protocols, as well as equipment.

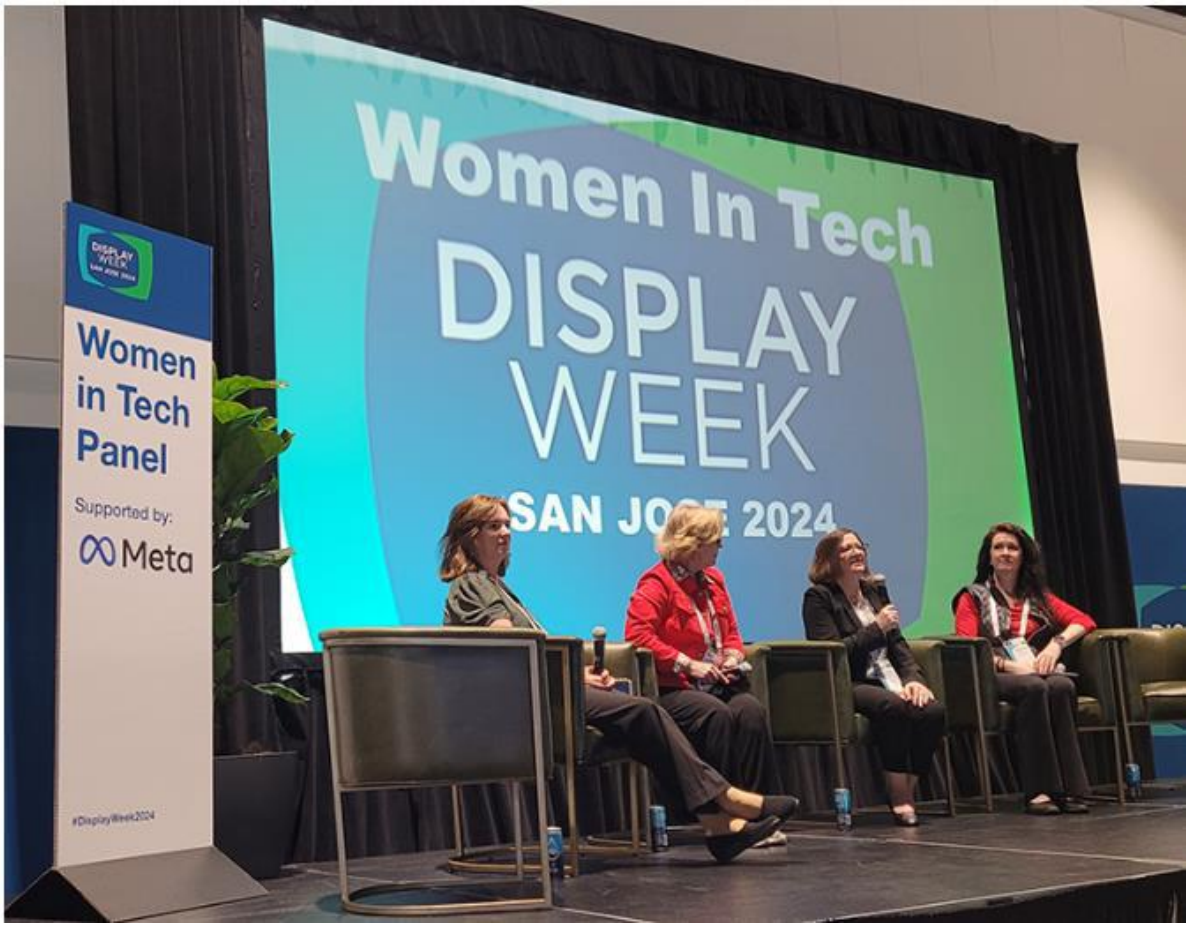
The event was well attended and supported by suppliers from all over the globe. There were a significant number of startup suppliers from the Far East and from the USA.

The key players such as LG, Samsung, TDK, Meta, 3M, TIANMA, BOE, TCL CSOT however took center stage while the “German Pavilion” – suppliers from Germany had some great displays on the stands. The “India Business Forum” was another great display of talent and capabilities from emerging markets.

Some of the suppliers had special booths and there were a significant number of new inventions displayed behind closed doors away from the prying eye.

This year’s focus and the special topics and tracks provided technical and professional insights into the future of imaging technologies for enhanced near-term and future capabilities.

One of the other key highlights of the event was the recognition for “Women in Tech” and the recognition of women in the male dominated Engineering and Manufacturing space.



The 2024 Women in Tech Panel features a panel of accomplished technical and business professionals with decades of experience in consumer electronics, and just as many years spent trying to strike the right “work/life balance” along the way. The discussion panel was quite insightful and was a great example of people following their dream. The speakers who took center stage here were, from left to right, **Susan Kent** who is the global laboratory director within 3M’s Display Materials & System Division, responsible for augmented and virtual reality technology development and product commercialization, **Lori Hamilton** divisional vice president and director, Technology, Corning Gorilla Glass, **Erin McDowell,** the chief revenue officer at FlexEnable, where she is responsible for growing business in FlexEnable’s core markets, including augmented and virtual reality optics, and **Michelle Gebbie** who is a senior marketing operations leader with over 25 years’ experience in developing and optimizing integrated marketing programs, who was also the moderator for the session.

This year's event focused on the key topics below.

- Ultra-high bandwidth transmission and processing (new for 2024)
- Sensors integration and functional displays
- Artificial intelligence (AI) including machine learning (ML) for imaging
- Digital signage (indoor and outdoor information displays)
- Sessions in imaging technology for Automotive applications
- Tracks and sessions advancing XR Technology, Optics, OLEDs, Quantum Dots, MicroLEDs, Healthcare and Biotech Imaging, and more.

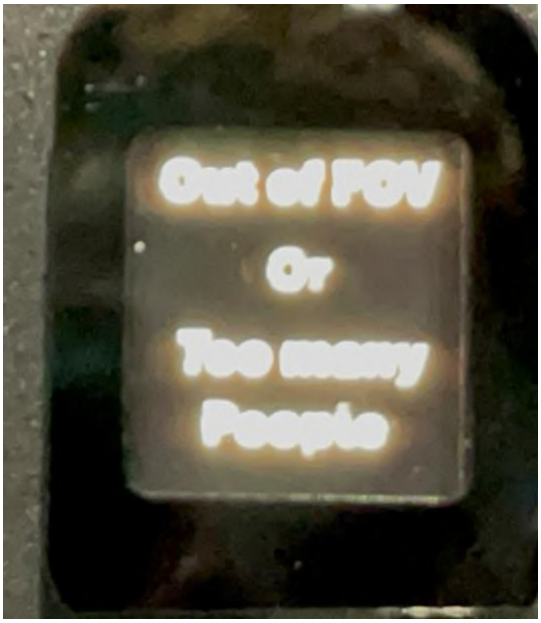
Ultra-high bandwidth transmission and processing (UHBTP) (new for 2024) was a key topic and discussion for 2024. Novel ultra-high bandwidth solutions are needed to enable the next generation of beyond-8K resolution and data-intensive applications such as holography, stereovision, light-field displays, and next-generation AR/VR/MR. Achieving retina resolution at large field of view and high frame rate necessitates a significant increase in data generation, processing, and transmission bandwidth. Foveal tracking and other functions can require intensive high-speed processing in small form factors. Additionally, the inclusion of numerous sensors and cameras compounds the need for ultrahigh- bandwidth data requirements and intuitive user controls.

This is a key area of focus for eye tracking as well as real time AR/VR applications and a key enabler for level 5 automation in the motor industry and beyond. The sensor suite as well as the cameras will require ultra high bandwidth processing to

achieve retinal resolution at a large field of view and high frame rate of processing data. UHBTP is one of the key enablers for this and these challenges pose a significant hurdle for existing hardware architectures to meet the demands of low power consumption, low thermal budget, low latency, ease of use, and long battery life products.

Sensor integration and functional displays.

Another key focus area was Sensor integration and functional displays.

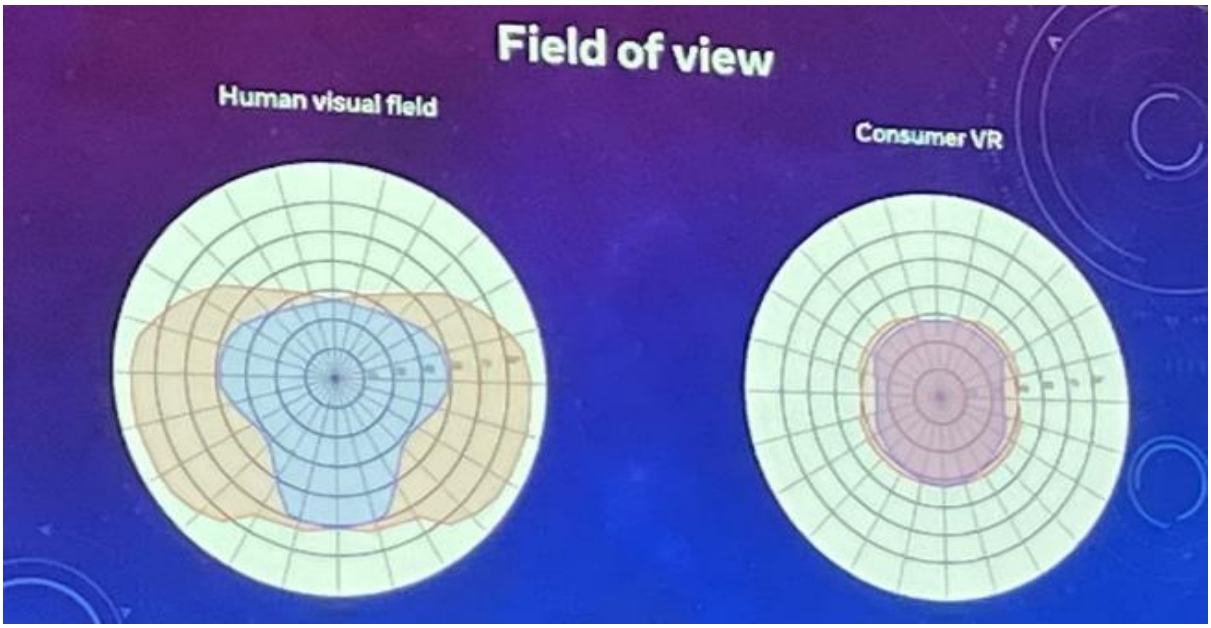


The focus for sensor integration and functional display opens up new avenues with OLED technology, not only in the automotive environment, but also in the commercial environment, for Bio Metric recognition, Retinal scan, Eye tracking and drive monitoring areas. Embedded sensors in screens as well as in displays makes packaging of sensors better from an aesthetic point of view while still maintaining full functionality.

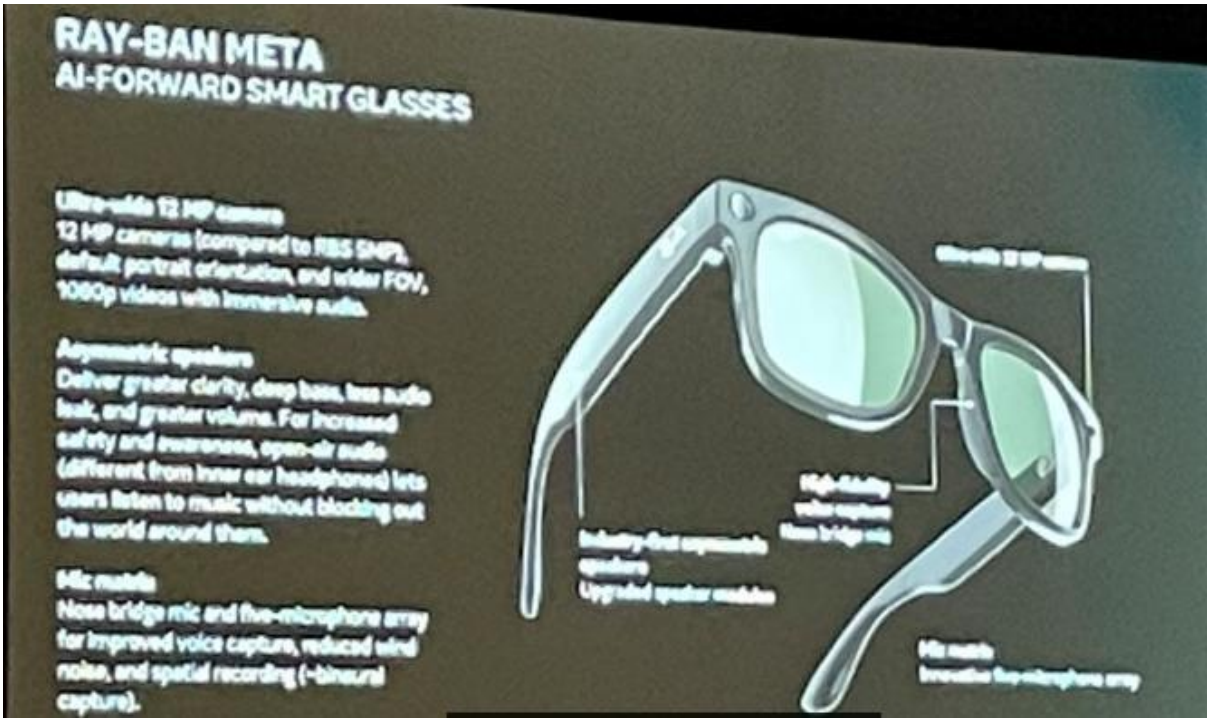
Driver / occupant in terms of vehicles as well as Personal presence detection from a wide tunable field of view integrated into OLED's make the product less conspicuous as well as less power hungry. This not only creates a new dimension for security devices but can be used in conjunction with paired devices for monitoring movement of presence of a person or a child in a vehicle addressed sensing and interactivity that fundamentally are integrated into a display. Some examples include displays with directly integrated output capabilities; touch controllers, sensors, materials, and processes; novel sensors; and novel interaction systems and techniques.

Artificial intelligence (AI) including machine learning (ML) for imaging

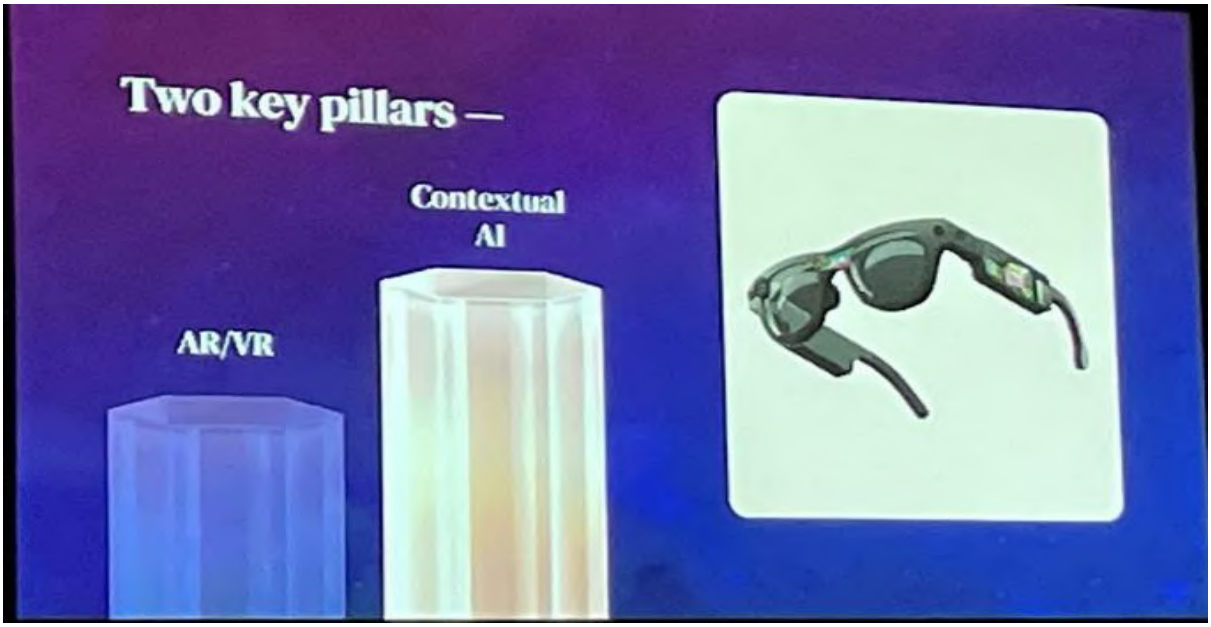
Artificial intelligence (AI) recently became a very popular buzzword, as a consequence of disruptive technical advances and impressive experimental results, notably in the field of image analysis and processing. In medicine specialties where images are key, like radiology, pathology or oncology, have seized the opportunity and considerable efforts in research & development have been deployed to transfer the potential of AI to other applications. While the development initially focused on medical imaging the technology has now evolved to be used in automotive and commercial applications but there is further work needed to match the human FOV.



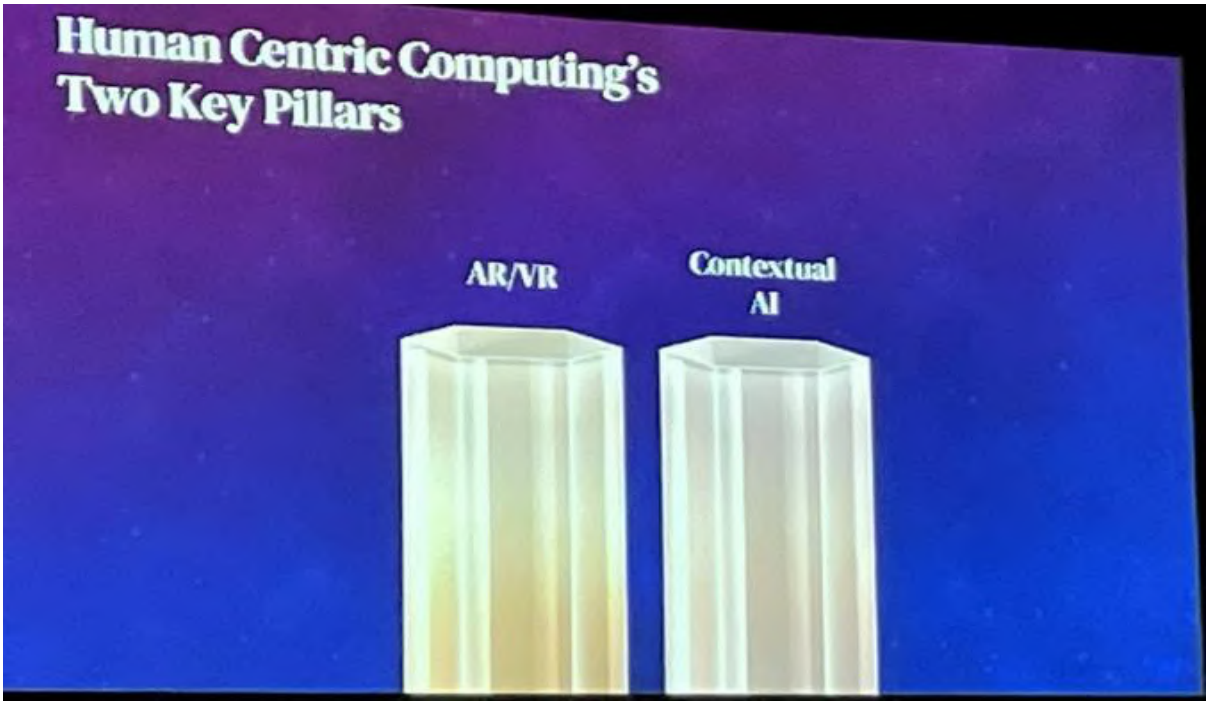
AI is becoming more mainstream tool for typical imaging tasks, such as diagnosis, segmentation, or classification. The basic technological pillars of AI, together with the state-of-the-art machine learning methods (ML) application of imaging and displays has grown significantly in the last decade.



The locution Artificial Intelligence (AI) has progressively flooded many scientific journals, including those of image processing, medical and physics. Paradoxically, though, AI is an old concept, while the term of artificial intelligence itself, was coined in 1956 by John McCarthy. AI refers to computer algorithms that can mimic features that are characteristic of human intelligence, such as problem solving or learning. The latest success of AI has been made possible due to the computational power as well as the availability of large data models. In particular, AI applications based on machine learning (ML) algorithms experienced unprecedented break through during the last decade in the field of vision.



More recently, ML tools have become mature enough to fulfill clinical requirements and, thus, research and clinical teams, as well as companies are working together to develop clinical AI solutions. Today, we are closer than ever to the clinical implementation of AI and, therefore, getting to know the basics of this technology becomes a “must” for every professional in the medical field. Helping the medical physics community to acquire such a solid background knowledge about AI and learning methods, including their evolution and current state of the art, will certainly result in higher quality research, facilitate the first steps of new researchers in this field, and inspire novel research directions.



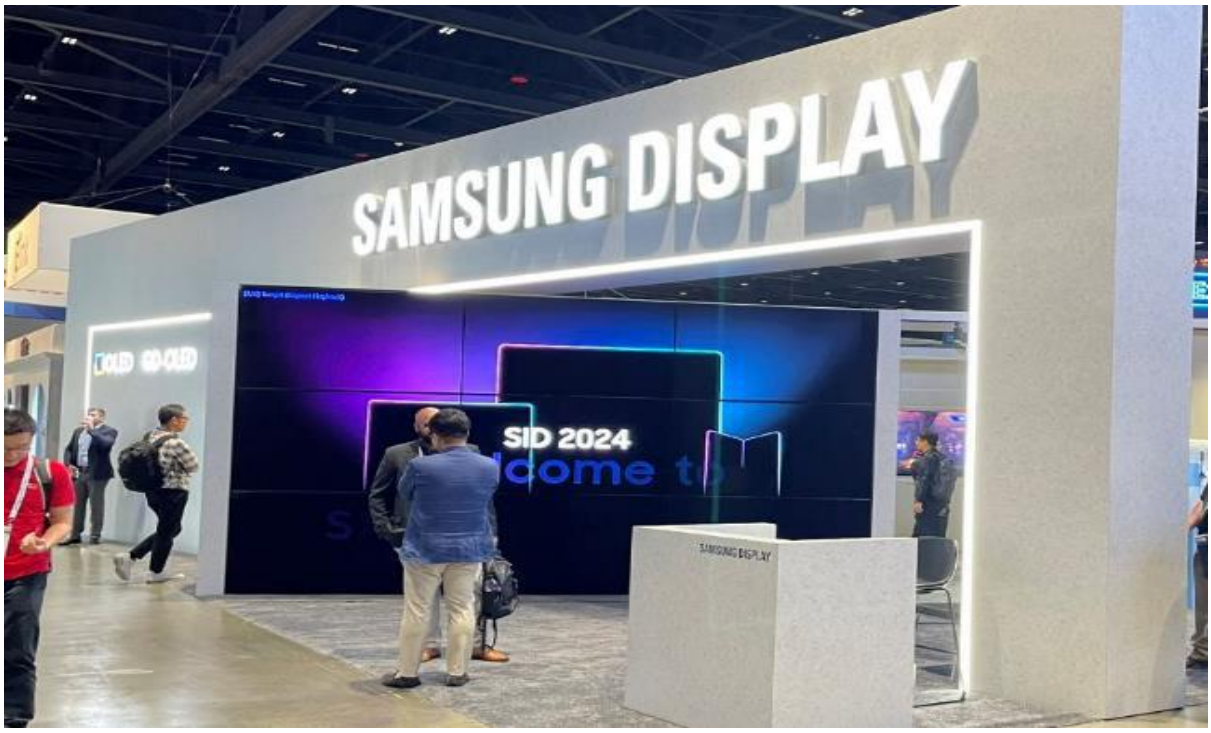
These key pillars today are set to tip the balance in the future with the commercial applications of AI and ML in non medical segments, namely for autonomous driving as well as security applications. AR/VR and Contextual AI together with ML are expected to grow in parallel while AR/VR will start to become more main stream in the commercial arena and its applications while VR is opening up endless possibilities.

Digital signage (indoor and outdoor information displays)

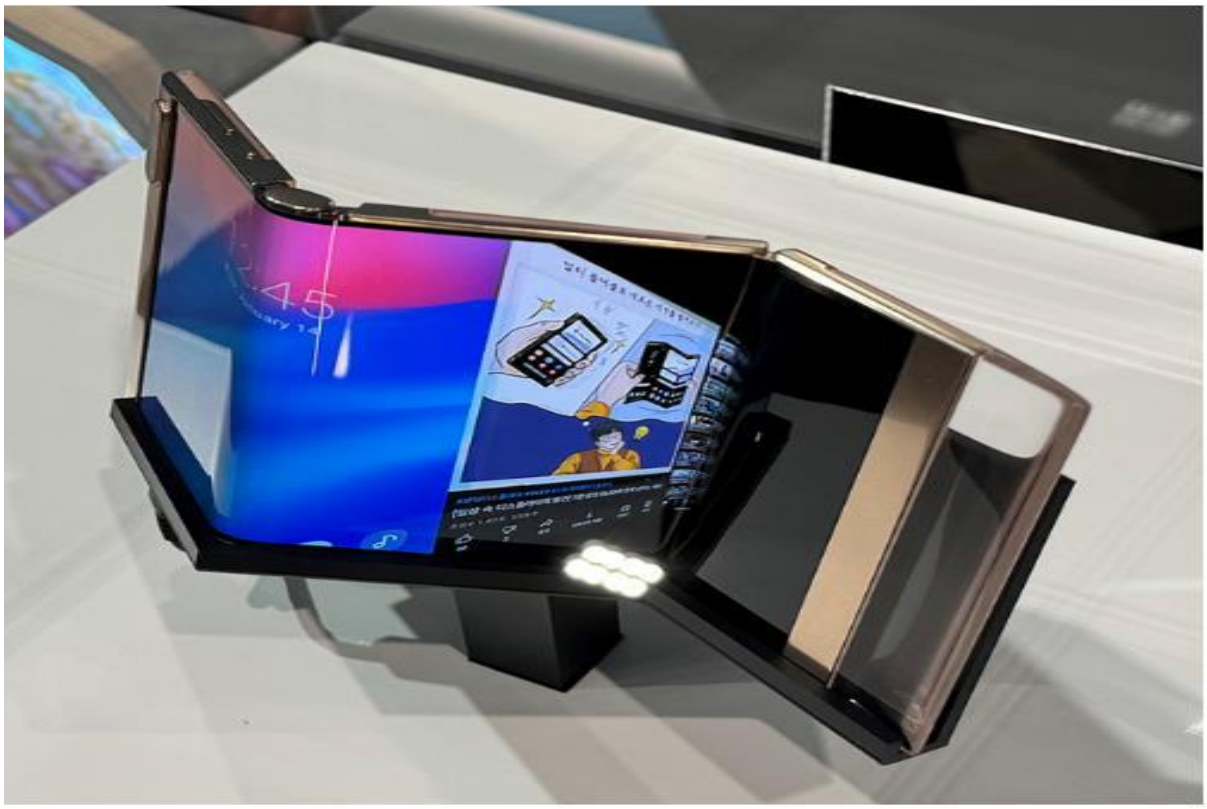
There were a number of clear trends in this area focusing of OLED, Transparent OLED, Bendable and flexible OLED as well as large scale uLED displays

LG Display for its 77-in. 8K Meta OLED display was one of the key highlights of the event, however this was closely followed by

Samsungs Display for its 77-in. QD-OLED TV.



Bendable and flexible OLED displays.



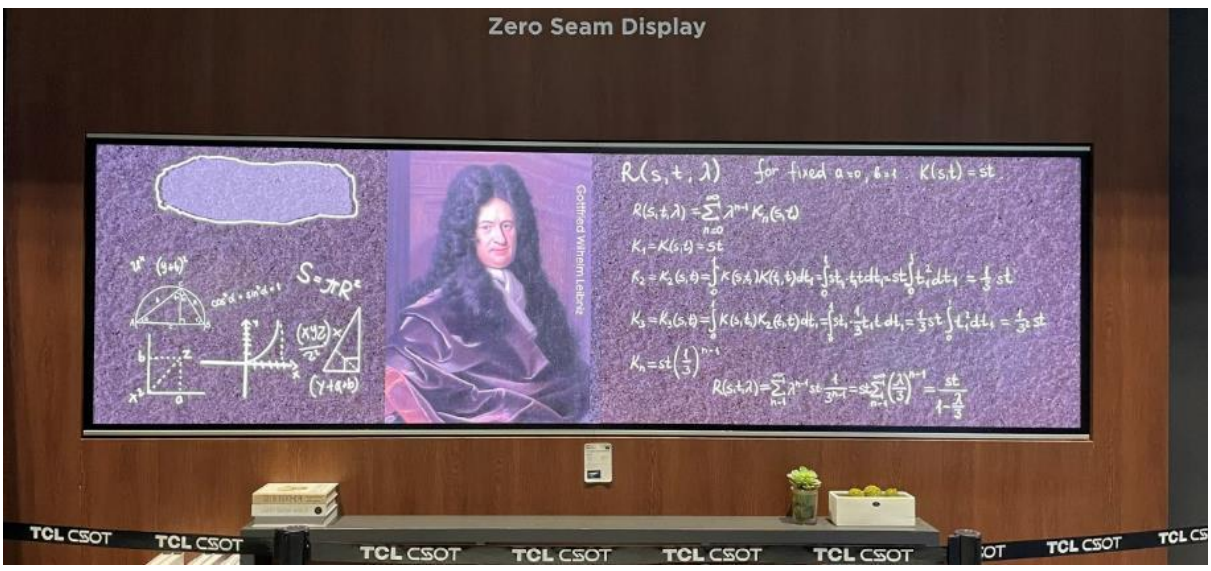
Flexible automotive applications and displays presented by BOE

Smart cockpit Display by BOE were amongst the top contenders.

The automotive industry is undergoing a significant transformation as technology advances and the demand for intelligent driving features increases. This has led to a rise in the need for new types of vehicle displays, which are experiencing rapid changes in design, technology, supply chain, and business models. Vehicles have evolved from simple means of transportation to highly sophisticated products that can be described as “computers on wheels.” This transition has given rise to a new industry that focuses on smart mobility. Consequently, automotive displays are undergoing a revolution in terms of design and technology, and the supply chain ecosystem is fluctuating accordingly.The automotive interior displays focused on a number of areas. The predominant focus was full width pillar to pillar display that were smart and customisable by the driver as well as the occupants. The trend was to integrate smart sensors into these displays for driver condition monitoring as well as occupant detection for smart displays and eye tracking with sharp cutoff.

Direct backlight LCD is expected to be the major display technology, although OLED also is gaining popularity. LG Display’s 27.2-inch flexible OLED with a resolution of 6K1K was reportedly used in the Genesis GV80 facelift from 3Q23, while Lucid is expected to use a 33.9-inch 6K1K flexible OLED by LG Display in 2024. Audi and Mercedes-Benz also is expected to incorporate large-sized OLEDs in their future models.

Curved cockpit design solutions with customizations and smart display and integrated sensing capabilities and seamless bonding are some of the other developments in pillar to pillar displays. The separation between screens seen here can be customized in such a way that when you are in the driver or passenger seat these boarders are not visible.



Some of the key highlights for the automotive industry were the full pillar to pillar displays, filters and sharp cut off for the display that had seamless transition between sections and screens, as well as a unique collapsible screen that would extend to a passenger display when an occupant was present and just a Driver Display (DD), Center Information Display (CID), when the occupant was not present in the vehicle. Projections on to the windscreens, 3D displays as well as the evolution of film based technology are being used in conjunction with Micro LED's to open up new possibilities not only in the display space but also in the exterior and interior lighting applications.

Mobile devices have influenced the demands on displays in all areas of life and significantly increased consumer expectations, also in vehicles. Technological innovations from the consumer market are being adopted in vehicles more and more. Especially in medium and high price segments, significantly more displays are used in today´s vehicle models. The trend is moving towards larger displays with higher resolution. In addition, we see the trends towards merging several displays into one for a uniform and elegant overall impression.

Emerging Technologies

Some of the key Emerging Technologies and Applications covered the breakthroughs for emerging technologies that have utility in the display industry that are progressing but not yet mainstream, novel applications of displays and related technologies, and unique uses of technologies in non-display applications.

The poster displays and lectures covered some of the following topics.

Optical Simulation and Improvement of the Reflection Pattern of Polarizer-Free OLED Panel, the improvement of power efficiency, reduced thickness, and lower cost was another key emerging technology topic that was up for discussion.

Temperature-Dependent Electrical and Emissive Behavior of UV-Excited Cd-Free QD MicroLED Display, and applied materials with a nontoxic alternative to conventional quantum-dot (QD)-enhanced displays.

Reducing Resolution Loss in Naked Eye 3D Display Using Dual Ferroelectric Liquid Crystal Shutters for Time-Multiplexed Light Field Display

Quantum dots (QDs) or semiconductor nanocrystals are semiconductor particles a few nanometres in size with optical and electronic properties that differ from those of larger particles via quantum mechanical effects. They are a central topic in nanotechnology and materials science.

Emissive, MicroLED, and Quantum-Dot Displays with advances in materials, processes, designs, and functions of emissive displays, including electroluminescent (EL) and photoluminescent QD displays, microLED displays and processing, LED displays and video walls, inorganic EL displays, and perovskite materials.

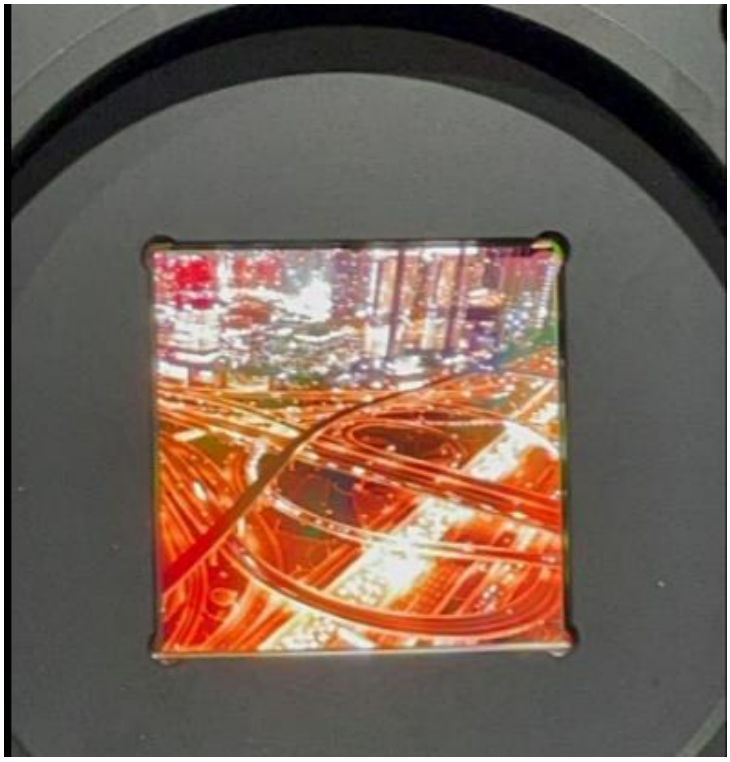
The development and innovations as well as the advancements in MicroLED's played a significant part of the event. Exploring the possibilities of the future market and innovations linked to Micro LED's in the industry for consumer, medical as well as automobile showed a significant growth in the area of the advancements in Micro LED application, not only for displays but other areas of OEM's. One supplier (name cannot be mentioned due to NDA with an OEM) had taken this to the next level, showcasing the significant advancement of application of Micro LED in automobile lighting applications not only for displays but other areas.

MicroLEDs have innate potential performance advantages over LCD displays, including higher brightness, lower latency, higher contrast ratio, greater color saturation, intrinsic self-illumination, and better efficiency.

Current microLED display offerings by Samsung and Sony consist of "cabinets" that can be tiled to create a large display of any size, with the display's resolution

increasing with size. They also contain mechanisms to protect the display against water and dust.

MicroLEDs have garnered a lot of interest because of the potential advantages over other flat-panel display technologies, most notably in high efficiency, high brightness, high color saturation, faster response rate, and longer lifetime. This unique combination of features would make MicroLED the superior display for many applications, ranging from super large TVs to micro displays for use in AR/VR headsets. The ability to withstand harsh environmental conditions is also particularly attractive for the automotive industry.



Showcasing the significant advancement of application of Micro LED in automobile lighting applications not only for displays but other areas. One supplier (name cannot be mentioned due to NDA with an OEM) had taken this to the next level, showcasing the significant advancement of application of Micro LED in automobile lighting applications.

MicroLEDs have generated a lot of hype, but also a lot of confusion amongst the mainstream media. This is because MicroLED displays can be manufactured in different ways, and each one will bring its own set of challenges and possible applications.

The two general manufacturing methods: monolithic or mass transfer. The monolithic approach is the preferred route to make microdisplays that are below 1-inch in diagonal and with a very high pixel density above 2,000 PPI. These miniature displays are very promising for AR/VR since they can achieve millions of nits in brightness without sacrificing contrast or compactness. However, obtaining a full color display has proven to be a challenge.

The mass transfer approach consists in moving a large number of individual MicroLEDs on the display substrate. This method can, in theory, produce displays of any size, including large TVs above 100-inch in diagonal allowing large scale applications. There are currently several mass transfer technologies under development which I foresee will be the enabler for the lowering of the costs and gaining momentum in a wider field of applications.

Micro-LED are also known as mLED or µLED is a display technology that is based on tiny (hence, micro) LED devices that are used to directly create color pixels. Micro-LED displays have the potential to create highly efficient and great looking flexible displays, to challenge the current high-end OLED displays in my view enabling design flexibility, lower cost, and lower power consumption.

OLED is the current premium emissive display technology, already adopted in many mobile devices, wearable’s and even TVs. In 2023 around 800 million OLED displays shipped to companies such as Samsung, Apple, LG, Sony and others. OLEDs can be made flexible, foldable and even rollable and the displays offer the best image quality currently in production.

OLEDs use tiny sub-pixels made from organic emissive materials. Micro-LEDs are somewhat similar - but with an inorganic LED structure. Compared to OLEDs, Micro-LEDs promise to be much more efficient and bright, more durable (higher lifetime) and with a higher color gamut. Micro-LEDs are based on well established LED devices, which means that it could potentially be a technology that is relatively easy to scale up making this technology highly scalable and adaptable.

Flexible Displays and E-Paper and wearable display technologies, including stretchable, bendable, foldable, or roll-able display devices and system-level integration of such devices and printed electronics based on organic and inorganic materials. Advances in flexible-display materials, electro-optical effects, sensor technologies and interfaces, driving techniques, and device performance with reliability, ergonomics, and applications.

Light control through film was another topic that was covered mainly by 3M, opening up the avenue to reduce weight and cost while maintaining the homogeneity and lighting functions as one would with PC material based solutions in Interior and exterior lighting as well as display applications.

Transparent displays was another area where this is made possible due to the availability of uLED,

Finally while I can go on writing for many more pages what I would like to wrap up is with how the display industry and exterior and interior lighting is fast converging due to uLED and OLED based solutions with active matrix displays opening up many avenues in automotive applications both in smart applications as well as the integration of VR with ML.

List of main DVN monthly reports

Main reports launched in 2008-2020

Koito company profile
China lighting market
The Wonderful World of Passenger Car lighting
Tier 2 and 3 contribution on automotive lighting
ZKW company profile
Simulations in automotive lighting
Mercedes-Benz profile
LED technologies in automotive lighting
LEDs Thermo-Electrics
Interior Lighting
BMW and lighting
Lighting and ADAS
Materials in lighting
Laser Head lighting
Automotive lighting Regulations worldwide
Israeli Startups
Jaguar Land Rover and lighting
Engineering companies involved in lighting
Japanese lighting market
Status of w/w Regulations
Korea Lighting Market
SL Corp profile
ADB/Matrix Beam
India Car Industry and Lighting Market
Vision of lighting 2025-2030
Automotive lighting Regulations worldwide
Vehicle Lighting in USA
New ADB technologies
Interior Lighting
Camera technologies
Varroc profile
Volkswagen profile
US automotive lighting industry
Materials in Vehicle Lighting
The Future of Exterior Lighting
IAA Frankfort Autoshow
DVN Munich WS
GENEVA Autoshow
US Lighting
Marelli AL Profile
50 years Light Styling
ADAS and Lighting

Main reports launched in 2021

Evolution of LEDs
New Models July-October 2020
Audi Lighting & ADAS
Lighting in development countries
ADB Update
DVN Shanghai WS
Innovations in Rear Lighting
Global Landscape of Automotive LED Suppliers

Reports launched in 2022

Technologies presented in CES 2022
Laser light automotive lighting
ISAL report
DVN US workshop
Worldwide Demographic Development
Models launched May to August
DVN Shanghai report
VISION congress
Paris Autoshow + last Vehicle models
L.A. Autoshow

Reports launched in 2023

CES Report
TU Darmstadt Lighting Institute
DVN Paris Workshop
Universities and Lighting
MLA Technology
Models launched in H1-2023
DVN Tokyo Workshop
ISAL Report
DVN US Workshop
Osram Company Profile
DVN Shanghai Workshop

Reports to be launched in 2024

CES
New cars of the semester
DVN Munich Workshop
OLED Technology
Test houses Profile
DVN Detroit Workshop
Indian automotive ecosystem
Lumileds company profile
Nichia
Interior Lighting Market
DVN India Workshop
DVN Shanghai Workshop
Brasilian automotive ecosystem

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