Ultra-compact displays to enable the AR glasses mass market

Presented by Dr. Peter Weigand, CEO TriLite

28 March 2021
Content

- Introduction
- From earwear to eyewear
- Our vision for the eyewear of the future
- Key requirements for always-on eyewear – and how to address them
- Outlook
Speakers have gone personal. Displays are next!

Hearables
[electronic in-ear-devices / smart headphones, enabled by True Wireless Stereo technology]

Worldwide Hearables annual shipments estimates and forecasts (m units) 1

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<td>277.6</td>
<td>316.7</td>
<td>361.4</td>
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CAGR 2017-2024 53%

Head-Mounted Display (HMD)
[electronic display worn on the head, enabled by disruptive display technology]

Worldwide HMD annual shipments estimates and forecasts (m units) 2

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<th>Year</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
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CAGR 2020-2027 60%

1) Data generated by TriLite based on main sources from (1) IDC, Worldwide Wearables Market Forecast Sep ‘20 & (b) IDC, Shipments of Wearable Devices Mar ‘20

2) Data generated by TriLite based on main sources from (a) IDC Worldwide Quarterly AR and VR Headset Tracker, Mar ‘20, (b) DigiCap Report 2019 & (c) Grand View Research Jun 2020
Our Vision!

Everyone enjoys augmented vision as lightweight as the eyewear of today.

We design and build the world’s smallest projection displays based on our proprietary hardware and software laser beam scanning (LBS) technology.
Key requirements for always-on eyewear!

**End User**

- **PERFECT FIT**: small & lightweight
- **STYLISH & FASHIONABLE**: flexible integration
- **ALWAYS ON**: brightness & contrast

**End User**

- **GREAT IMAGE QUALITY**: color gamut & distortion-free
- **IMMERSIVE EXPERIENCE**: low latency & high FOV
- **LONG CHARGING INTERVALS**: low power consumption

**OEM**
End User: Need AR glasses that are lightweight and fit perfectly

OEM: Need a display with small size & low weight

Scanning-based Display

Laser Beam Scanner (LBS)

mLED & OLED

Panel-based Display

LCoS & DLP

SPIE 2021 Industry Talk: Ultra-compact Displays to Enable the AR Glasses Mass Market
Author: P. Weigand, CEO TriLite © TriLite, 2021
End User: Need AR glasses which are stylish and cool to wear

OEM: Need a display that is easy to integrate into different glass types

- Fitting adaptability to different combiners and position
- Fitting to meet face wrap and pantoscopic tilt requirements for different combiners
- Adaptable to monocular and binocular displays.

Various integration geometries for LBS displays
End User: Need AR glasses which work also on really sunny days

OEM: Need a display with outstanding brightness & high contrast

LBS Brightness / Luminance at LBS Out

- LCoS: 50k cd/m² (nits)
- mLED: 350k cd/m² (nits)
- LBS: 6m cd/m² (nits)

LBS Contrast Ratio

- LCoS: 10.000:1
- mLED: 1.000:1
- LBS: 50.000:1

For details, see SPIE 2021, Paper 11765-1, Fidler et al.,
Laser beam scanning in XR: benefits and challenges

SPIE 2021 Industry Talk: Ultra-compact Displays to Enable the AR Glasses Mass Market
Author: P. Weigand, CEO TriLite | © TriLite, 2021
End User: Need AR glasses with full range of colors and real life geometries

OEM: Need a display with high color gamut & without distortion

LBS color gamut

LBS distortion correction

For details: see SPIE 2021, Paper 11765-1, Fidler et al., Laser beam scanning in XR: benefits and challenges
End User: Need AR glasses that provide an outstanding user experience

OEM: Need a display with high FOV, high refresh rate & low latency

LBS allows ultra high FOV since projection optics can be eliminated and since the resulting FOV is limited only by the combiner optics.

LBS allows high refresh rates through advanced pixel painting algorithms and high speed MEMS mirror design and its optimum integration.

The perceived latency of LBS is significantly lower than panel based displays due to high speed scanning.
**End User:** Need AR glasses with a long runtime

**OEM:** Need a display with low power consumption

- Laser diodes convert electrical current into photons with very high efficiency, further optimization can be achieved by driving the laser diodes in a smart way taking the low-power MEMS mirror characteristics into account (e.g. pulse shapes)
- Minimization of optical elements in the beam path (e.g. no projection optics) optimizes the efficiency
- Laser light is highly polarized (for combiners where it matters)

**LBS allows ultra-low power consumption**
Our outlook for upcoming LBS devices optimized for AR user experience

- **Weight:** < 1.5 g
- **Volume:** < 1 cm³
- **Power Consumption:** < 500 mW
- **Brightness (at Laser Beam Scanner out):** > 15 lm
- **Brightness (at waveguide out):** > 3000 nits
- **Field of View (at > 90 Hz Refresh rate):** > 50°
Thank you for joining this session - we are looking forward to talking to you!
For additional information, refer to our other SPIE AR, VR, MR 2021 technical talks:

- **SPIE 2021, Paper 11765-1, Fidler et al.**, Laser beam scanning in XR: benefits and challenges

- **SPIE 2021, Paper 11765-3, Reitterer et al.**, Ultra-compact micro-electro-mechanical LBS for AR applications

- **SPIE 2021, Paper 11765-7, Noui et al.**, Laser beam scanner and combiner architectures
TRILITE

World’s Smallest Projection Display