DISPLAYS & OPTICAL VISION SYSTEMS FOR VR, AR & MR

Market & Technology report - June 2018

Technological reality is piercing the hype for virtual and augmented realities, reminding everyone about all the challenges that are yet to be overcome.

KEY FEATURES OF THE REPORT

- Analysis of key challenges related to VR/AR/MR systems
- Technical analysis of Displays and Optical Vision Systems for VR/AR/MR, and associated roadmap
- Analysis of related industrial and technological ecosystems
- Market analysis/forecast for Displays and Optical Vision Systems
- Analysis of future trends and evolution of VR/AR/MR landscape

OBJECTIVES OF THE REPORT

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- Understand the current status of VR/AR/MR systems including performance and technical choices
- Review main challenges related to VR/AR/MR systems including field of view (FOV), pixel density and foveated rendering
- Analyze display and optical vision system technologies, and relation with other sub-systems and functions within the VR/AR/MR system, alongside some associated manufacturing challenges
- Analyze display and optical vision system markets
- Analyze future trends and evolution and their impact on the VR/AR/MR ecosystemsegment
- Major global actors
- Technology trends
- Main technical challenges

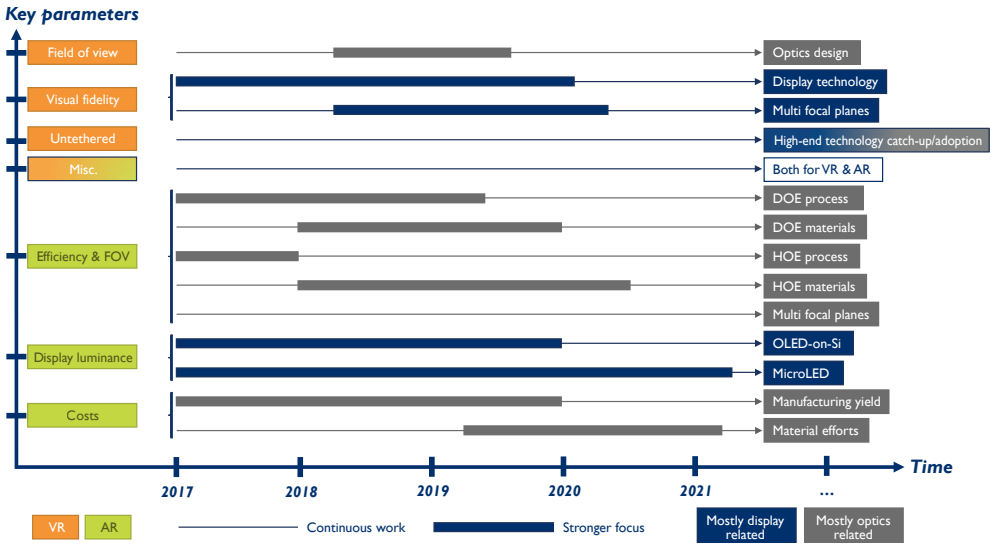
TODAY'S TECHNOLOGY IS VERY COMPLEX AND BARELY ENOUGH FOR IMMERSIVE REALITIES

Virtual Reality (VR) and Augmented Reality (AR) have been hot topics for decades. As these concepts aim at changing our reality, it is extremely important to have systems that are properly designed to trick our brain and produce a feeling of immersion. But as the brain is a complex piece of machinery, VR and AR systems require advanced technologies that are not quite ready yet. The key is to understand what must be developed in terms of displays and optics for these headset markets to thrive.

VR has been developed with off-the-shelf components, mainly smartphone-sized displays and magnifying lenses. However, the field of view in today's headsets is small and restricts the user's immersion in the image. Improving it by working on the optics may seem trivial but it implies headset ergonomics and manufacturing challenges regarding size, weight, scalability. And then comes visual fidelity, as improving the field of view without improving the pixel density reduces the number of pixels over each degree of visual acuity, which restricts immersion again. So displays need to improve pixel density, amongst other parameters, in parallel to optics improvement. But associated technical and manufacturing challenges are difficult to attain. Alternative developments are ongoing and should pave the way towards an ideal VR headset: the proper number of pixels per degree on a wide field of view at a very fast framerate, with perfect color reproduction and in a compact form factor.

AR presents a very different visual paradigm compared to VR, as the user needs to clearly see the world through superimposed virtual images. Having a screen in front of the eye is impossible, so the image must be brought to the eye in an efficient and undistorted manner. AR is already big in the military, a field in which there are few restrictions in terms of size, volume and design. But the consumer wants nothing but a sleek headset that must not be cumbersome, and be perfectly see-through. The road to miniaturization and cost reduction from existing technology is extremely complex. Physics cannot be violated, and étendue management, efficient

Roadmap* for VR & AR headsets improvements, with technological choices



(Yole Développement, June 2018)

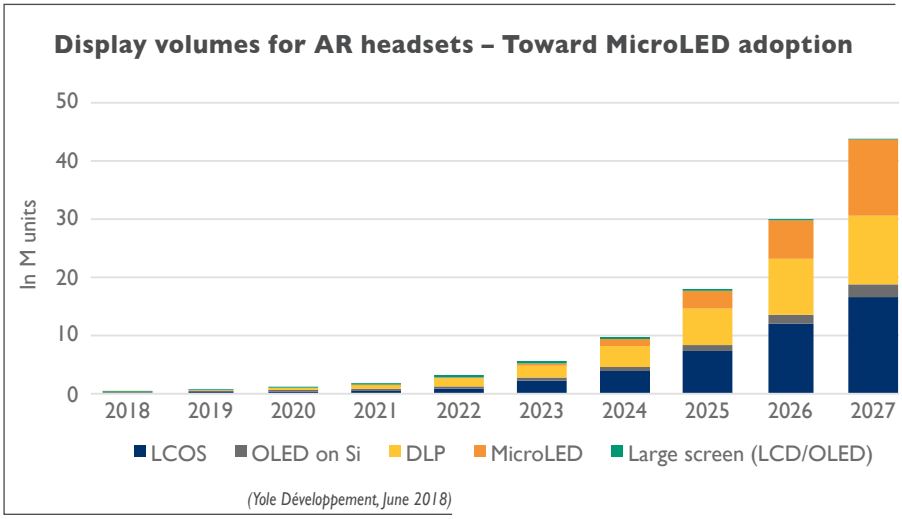
*A complete roadmap is available in the report

diffraction, transparency, field of view, and many other parameters have to be handled. Similarly to VR, developments are ongoing and will define the roadmap for upcoming AR headsets. However due to manufacturing challenges, adoption will start slowly before markets soar.

The report presents a comprehensive technological review of the working principles of VR headsets and AR headsets, with a deep dive into the key elements of displays and associated optics, the main players involved, the potential impacts on manufacturing challenges, and more.

MICROLEDS COULD DISRUPT THESE REALITIES AND BE AN ENABLER

VR uses smartphone-like displays and the technology that initially dominated was organic light emitting diodes (OLEDs), despite their price premium, because of their superiority in terms of VR-related specifications such as pixel refresh rate, true black, and form factor. There is however a push for liquid crystal displays (LCDs) that are found in today's lower-end headsets, pending progress on their bottlenecks in achieving required refresh rates, and perfect dimming. There is potential for OLED-on-silicon microdisplays but optics and price challenges are slowing the technology. The time it takes to mature could be the time required for MicroLEDs to become predominant.

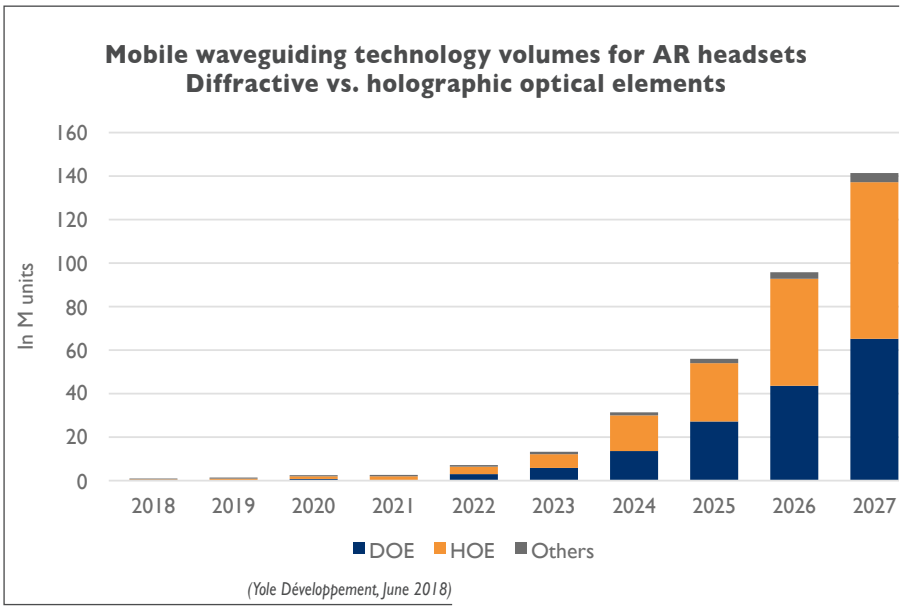


MicroLED technology is far from being mature, but has made advancements in monolithically-assembled microdisplays. If the technological roadblocks associated with MicroLEDs are overcome, this display technology would be an enabler for AR headsets. Today, AR headsets run with either OLED-on-silicon microdisplays or projection display technologies, which are not compact enough, or do not provide enough luminance to the eye. MicroLEDs can link the best of both worlds and provide enough luminance to overcome the poor efficiency of optical waveguiding combiners in a small form factor.

The report presents a detailed analysis of display requirements for VR and AR, the trends and roadmap for the future. This report is also a comprehensive overview of display structures, current challenges and key research directions.

REAL AR HEADSETS WITH SLEEK DESIGN MAY BE WITHIN OUR GRASP

Current optical waveguiding combiners may be poorly efficient, but they are the only technological approach able to couple an image in and out and transmit it close to the eye without having to put bulky optical parts in the headsets. Initiated by Nokia, Microsoft and Vuzix have all followed this path. Diffractive optical elements exhibit performance limitations linked to the underlying physics that also imply complex manufacturing challenges. Some players with holographic optical elements are trying to circumvent these performance and manufacturing issues by going on a different route, such as Digilens.



This directly impacts the cost and explains why AR headsets are not the "smartphone killer" that had been advertised yet. The first real sleek products with more acceptable prices are being released in a few months and should spur AR adoption. By working on improving the technology and the manufacturing of those combiners, and taking into account the ramp up time, the AR market will eventually take off, first in business, followed by consumer adoption.

The report presents a detailed analysis of optical vision systems for VR and AR, the trends and roadmap for the future. This report is also a comprehensive overview of optical structures, current challenges and key research directions.

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