A microLed imager for AR headset for use in high luminance environment

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1. Introduction

Today, popular Augmented Reality headsets suffer from a lack of brightness to allow the diffusion of readable information against a very bright landscape, in particular for avionics use, and more generally, outdoor applications.

We present in this paper, the project "HiLICo", aiming to develop an emissive GaN micro-displays with 1640 x 1032 pixel resolution (WUXGA), 9.5-µm pixel pitch, very high brightness (over 1Mcd/ cm²) and good form factor capabilities that will enable the design of ground breaking compact see-through system for next generation Avionics applications.

2. Objective

To achieve an acceptable user experience and help the pilot with an improved situational awareness, the display shall be readable under the most severe daylight environment. SAE ARP 4102 [1] requires a contrast greater than 1.2 under 34,000 cd/m² of background luminance, corresponding to 100,000 Lux of illuminance on white clouds. According to regulation rules [1], 6800 cd/m² are needed, but for a better user experience, a contrast of 1.5 corresponding to 17,000 cd/m² is targeted.

3. Background

Several display technologies are available today for AR headset such as LCOS, DMD, LCD and OLEDs.

The three first technologies are non-emissive, and require a powerful and bulky backlight system. They suffer from a low efficiency, and product like Hololens or Magic Leap deliver only 320 cd/m² [2]. Oled microdisplays are emissive and so, don't need backlight. But the organic electroluminescent material suffers from ageing issues when delivering fixed images at maximum brightness. MicroLed displays made from Gallium Nitride (GaN) are able to deliver 100 times more luminance than other existing technologies, so, they represent the best choice for outdoor AR device.

4 Microdisplay Requirements

Luminance on the display combiner depends on optical components transmission and combiner reflectance. In the best case the optical system efficiency is around 30%, so, the minimum luminance for the microdisplay shall be 56,000 cd/m². But if we want to keep this contrast for at least 16 levels of grey, we need a minimum of 1 Mcd/m²

5 Advanced Technologies and Challenges

To achieve this goal, the HiLICo project addresses several challenges. Among them (i) the synthesis of high-quality GaN based LED epilayers designed for blue or green native emission, (ii) the design and fabrication of an active matrix in advanced Complementary Metal Oxide Semi-conductor (CMOS) technology to drive each individual pixel and (iii) the coupling of both LED and CMOS structure to eventually come up with a monolithic structure ready for LED array micro-engineering, paving the way to high resolution and very small pixel pitch GaN micro-displays. On this basis monochrome and full-colour emissive micro-displays will be manufactured. For this last display, blue-to-green or blue-to-red colour conversion will be necessary using either quantum dots or 2D multi-quantum wells layers. This task is on itself very challenging considering the expected light conversion efficiency (over 50%) and lifetime (over 10,000H) necessary for the application. A dedicated electronics will be designed and manufactured for a full evaluation of the various micro-display devices. As an ultimate goal, the integration by the end-user (THALES Avionics) of a micro-display in an avionic system should help validating the HILICO technology and concept.

6 Discussion

After a general introduction on the project, the purpose of this talk is to review the various technological routes selected by the HILICO consortium and some of the technological challenges to overcome.

8. Acknowledgements

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9. References

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[2] https://www.kguttag.com/