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Photonics create virtual worlds

Whether head-up displays or virtual reality headsets: Photonics paves the way in virtual worlds and enriches reality with useful information.

Head-up displays (HUD) project information and warnings directly into a driver's field of vision. Until now, complicated optics have controlled and enlarged the augmented reality (AR) projections on the windshield. Disadvantage: The systems allow only a very small amount of glare and take up too much space in the already crowded dashboard. Automotive components supplier Continental, with its associated company, the US startup DigiLens Inc, is taking a new path, also based on photonics. Instead of controlling the light with optics, it's modulated with specially structured optical waveguides. The innovative system reduces the installation space to a sixth of the present size and also doubles the field of vision. The miniaturized HUDs can even be integrated into motorbike and pilot helmets to make AR information visible directly in the field of vision.

DigiLens replaces lenses and mirrors with fine diffractive structures made from a holographic photopolymer, which was developed by the company. These Bragg gratings are applied with an inexpensive ink jet printing process to waveguides that are optimized for red, green, and blue light. The trick: The polymer, or rather the size of its diffraction, is electrically switchable. Consequently the switchable Bragg gratings (SBGs) work like an optical "system on a chip," which diffracts, shapes, enlarges, and ultimately projects the light stored in the optical wave-guides on to the target surface. It's fed in by an input module consisting of a pico projector and an RGB LED module.

Competition in optical processes

According to Continental, the compact HUDs have "the potential to revolutionize the market." This is quite a realistic claim, when we consider that other research groups and manufacturers are also working on this technology. For example, a research team from the College of Optical Sciences of the University of Arizona is developing holography-based HUDs. Together with US-based Honeywell, they plan to make systems for aviation ready for series production. An-other prominent example is Microsoft with its mixed reality glasses HoloLens. This

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technology also implements augmented reality on the basis of Bragg gratings, which are etched into sili-con. As opposed to the DigiLens technology, these surface-relief gratings (SRGs) are not switchable and their field of vision corresponds to the normal useful field of vision of about 20 degrees. On the other hand, with the help of the switchable Bragg gratings, DigiLens claims that it can provide 40 to 70 degrees together with superior optical properties. The less expensive printed HUD system is also more energy efficient, which predestines it for motorbike helmets and smart glasses.

The virtual reality headset VR One takes a completely different path. Its core element is two large precision lenses that create the desired stereoscopic effect when users slide an iPhone or Android smartphone (4.7”-5.5”) into the headset and start the corresponding VR apps. The app stores from Apple and Google contain hundreds of these apps. Apart from Zeiss, various other manufacturers also offer VR headsets that work only in combination with a smartphone.

Liquid crystals depict virtual worlds

There are also a growing number of VR headsets with integrated displays. A display technology based on ferroelectric liquid crystals developed and produced by Forth Dimension Displays based in Scotland, is already well advanced. Customers from various industries use VR head-sets with these FLCoS displays for training purposes.

FLCoS stands for Ferroelectric Liquid Crystal on Silicon. The liquid crystals to modulate the light in the electric field are located between an active CMOS (complementary metal oxide semiconductor) backplane with individually controllable pixels and a glass front that is coated with a transparent electrode. In the electric field, the liquid crystals can be switched with response times of just 40 microseconds (µs). According to the manufacturer, this rapid response time and resolutions of 2048 x 1536 pixels per eye allow realistic presentations of digital worlds that no other technology on the market is currently able to emulate. Users have a choice between true color images with 24-bit color depth or monochrome presentations. LEDs or lasers can be used as a light source, although in combination with lasers the FLCoS micro displays can also be used for binary phase modulation of computer generated holograms.