## Publication abstract:

It has always been a hot topic to break the resolution/field-of-view (FOV) invariant and achieve a near-eye display with a large FOV and high-resolution. We present a super-resolution method for near-eye displays by overlapping images from two display panels using a half mirror. Key aspects including theoretical analysis, optimized method, system set-up, and calibration process are discussed detailly. A proof-of-concept prototype was developed to provide a super-resolution image capable of providing significantly higher sampling rate.

Light field near-eye display has received a lot of attention, because it can solve convergence and accommodation conflict during the usage of near-eye displays. However, in actual systems, convergence depth and accommodation depth may not match with each other, due to the repeating zones produced by traditional light-field methods. We have proposed a novel method to construct a light-field near-eye display based on random pinholes. Random pinholes have been employed as a spatial light modulator to break the periodicity of elemental images, and the light field images for a unique view zone in space can be provided. A proof-of-concept prototype has also been developed to verify the proposed method.

We have presented a panoramic imaging system based on two afocal lens and a smart phone that consists of cameras on both sides is presented. One Individual afocal lens has been developed with a large field of view (FOV) and a large exit pupil, and it which can enlarge the FOV of a smart phone camera to above 190°. A 360° panoramic imaging system can be obtained based on two tiled imaging channels on the both sides of the smart phone. In this study, some typical issues on smart phone based 360° panoramic system methods based on a smart phone, such as relative illuminance, and assembly tolerance, were analyzed in detail and taken into consideration during the design procedure. A proof-of-concept prototype has been developed with a cheap price low fabrication cost yet producing

impressive a panoramic image quality with an acceptable image quality has been developed based on a commonly used smart phone.

A subpixel area-based evaluation method for an improved slanted lenticular film that minimizes the crosstalk in a quasi-three-dimensional (Q3D) display is proposed. To identify an optimal slant angle of the film, a subpixel area-based measurement is derived to evaluate the crosstalk among viewing regions of the intended subpixel and adjacent unintended subpixel by taking the real subpixel shape and black matrix into consideration. The subpixel mapping, which corresponds to the optimal slant angle of the film, can then be determined. Meanwhile, the viewing zone characteristics are analyzed to balance the light intensity in both right and left eye channels. A compact and portable Q3D system has been built and appropriate experiments have been applied. The results indicate that significant improvements in both crosstalk and resolution can be obtained with the proposed technique.

A method to improve the design of an off-axis lightguide configuration for near to eye displays (NED) is proposed using freeform optics technology. The advantage of this modified optical system, which includes an organic light-emitting diode (OLED), a doublet lens, an imaging lightguide prism and a compensation prism, is that it increases optical length path, offers a smaller size, as well as avoids the obstructed views, and matches the user's head shape. In this system, the light emitted from the OLED passes through the doublet lens and is refracted/reflected by the imaging lightguide prism, which is used to magnify the image from the microdisplay, while the compensation prism is utilized to correct the light ray shift so that a low-distortion image can be observed in a real-world setting. A NED with a 4 mm diameter exit pupil, 21.5° diagonal full field of view (FoV), 23 mm eye relief, and a size of 33 mm by 9.3 mm by 16 mm is designed. The developed system is compact, lightweight and suitable for entertainment and education application.

A demo system that realistically displays the glasses-free light field 3D effect with a triple-layer structure is presented. By combining multi-layer panels, high refresh rates, and directional backlighting together, we achieve a wide field of view and large depth of field with a thin form factor. Additionally, using some off-the-shelf hardware, this system demonstrates an interesting light field display.

## Publication list:

**Qijia Cheng**, Weitao Song, Feng Lin, Yue Liu, Yongtian Wang and Yuanjin Zheng. “Resolution enhancement of near-eye displays by overlapping.” Submitted to Optical Communications. Manuscript ID: MB-3562.

Weitao Song, **Qijia Cheng**, Yue Liu, Yuanjin Zheng and Yongtian Wang. “Design of a light field near-eye display using random pinholes.” Optics Express 27, no. 17 (2019): 23763-23774.

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Zhenfeng Zhuang, Phil Surman, **Qijia Cheng**, Simon Thibault, Yuanjin Zheng, and Xiao Wei Sun. "Subpixel area-based evaluation for crosstalk suppression in quasi-three-dimensional displays." Applied Optics 56, no. 19 (2017): 5450-5457.

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