Tunable focusing liquid crystal lenses for Augmented Reality

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Augmented reality (AR) refers to a technology by which users can see the real-world environment augmented by computer-generated information. Such computer-generated information is usually projected to human eyes in a form of a virtual image by AR wearable devices mainly consisting of a liquid crystal display (LCD) panel, projection lens modules and light guides. However, the position of such a projected virtual image is focused in certain plane which may not coincide with the physical object. As a result, people suffer from the visual fatigue. Thus, it is required to develop electrically adaptive optical elements to register the projected virtual images to the objects in the real world. In this paper, an AR system with an electrically tunable location of a projected image is demonstrated by adopting a reflective LC lens is demonstrated. The projected image could be a virtual image or a real image. By means of doubling the lens power of the LC lens in reflective operation, the position of the projected virtual image can be tuned from 42 cm to 360 cm, while the tunable range for position of the projected real image is from 27 to 52 cm in the opposite side. The optical principle of the AR system is introduced. The concept in this paper could be further applied to other tunable focusing lenses even though the lens power is small. The impact of this study could be extended to head-mounted display system for vision correction or vision compensation. We believe the tunable focusing LC optical elements could be beneficial for blooming AR applications.

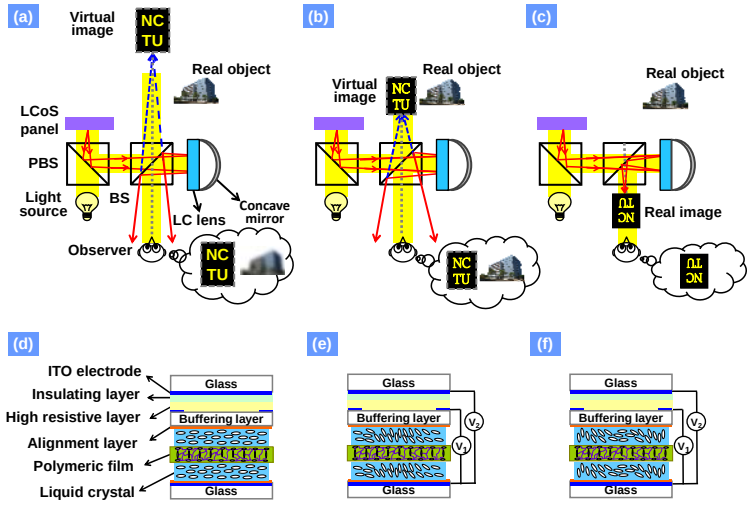

Fig. 1 The optical system of proposed augmented reality. PBS: polarizing beam splitter. BS: beam splitter. (a) The virtual image written in LCoS panel is projected far away as the lens power of the LC lens is zero. (b) The virtual image written in LCoS panel is projected beside the real object as the LC lens is a negative lens. (c) The projected image is a real image near the observer as the LC lens is a positive lens. (d) The illustration of the structure of the LC lens in (a) without applied voltage. The LC lens is (e) a negative lens as $V_1<V_2$ and (f) a positive lens as $V_1>V_2$.

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References

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