contrast ratio of 1.17 causes a signal transmission delay of about 9 microseconds [30]. Diamond indicated that human visual system would generate the illusory depth perception when both eyes receive a binocular contrast ratio larger than 0.63 [18]. Nevertheless, the viewing zone of 3D effect is limited about 10 degree except for attaching irregular micro-prism structure. Moreover, this study also precedes classic Pulfrich effect [6] from the autostereoscopic display with micro-prism array. The viewer would generate illusory depth perception when left and right eye receive video from the bright and dark zone individually.

The design of Q1 and Q4 tends to confirm the stereo perception when the participants viewing with the micro-prism film. Group A receives lower scores than Group B for Q1, but higher scores for Q4, and both Q1 and Q4 appear statistically meaningful differences (Table 2). Such results show that the stereo perception actually appears when the participants viewing the display with the micro-prism film (Table 2). The participants perceive the image emerging or embedding in the display in Q2 and Q3 with remarkably statistical differences. When the participants receive the dark region with the right eye and the bright region (0° ~-25°) with the left eye, the perception of emergence would appear; i.e. negative parallactic image. When the right eye receives the bright region and the left eye receives the dark region (25° ~0°), the perception of embedding appears; i.e. positive parallactic image. Such results are consistent with Pulfrich effect. However, when the micro-prism film is attached on the display panel, the stereo perception would appear on both embedding and emergence.

Research on stereoscopic human factors contains visual fatigue test, questionnaire assessment, blood pressure measurement, and other physiological signal measurement [31]. Frank L. Kooi *et al.* found out binocular parallax as the major factor in discomfort when viewing 3D images [32]. Besides, Marc Lambooij *et al.* also pointed out the factors of the depth caused by speed change of an object, insufficient depth information in the incoming data signal yielding spatial and temporal inconsistencies, and asymmetry and unnatural blur of stereoscopic images in discomfort when viewing 3D images [2]. The participants do not reveal any discomfort after viewing the display attached with a micro-prism film, and no significantly statistical difference appears in the questionnaire (Q6). The major reason might be the participants view the bright/dark image from the same picture, which presents the stereoscopic perception simply by the distinct speed of human eyes responding to brightness/darkness. It is different from the images in an autostereoscopic display requiring image processing and algorithm for two stereoscopic images with distinct angles of view.

5. Conclusion

By attaching a micro-prism film on a display panel to generate bright and shade regions on a display, the characteristic of human visual system presenting faster responses to brightness than shade is utilized for interocular delay to generate illusory depth. Moreover, the image contents do not require complex image processing, but simply apply a general 2D image with a micro-prism film to perceive the stereo image. It omits the production of 3D contents and is suitable for current displays.

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