Abstract

Three-dimensional (3D) display technology is a fascinating research topic with wide applications such as 3D entertainment, medical imaging, interactive displays and virtual reality, etc. However the prevailing solutions has various defects such as great loss of resolution, low brightness, fixed view location and the constraint of wearing special glasses. Glasses-free 3D displays which can provide vivid 3D scene without any constraints are particularly attractive and will greatly change the way human beings perceive the world. In this thesis, two high resolution Autostereoscopic 3D displays have been proposed and experimentally demonstrated.

For the first prototype, an eye-tracked 3D display using modulated laser-based backlight has been proposed, which is composed of a scanning laser module, a ferroelectric liquid crystal (FLC) spatial light modulator (SLM) array module, an assembled liquid crystal display (LCD) module. In our proposed system, the scanning laser backlight is modulated by the aperture pairs generated on FLC SLM array. Each aperture pair projects two exist pupils on single viewer's left and right eyes in time sequence. By means of eye tracking technology, the dynamic aperture pairs are mapped with the location of viewers' eye pupils simultaneously, which enables free movements of multi-viewers. A prototype system has been set up to verify this method. The experimental result shows that the 3D image resolution is lossless. High brightness, low crosstalk 3D contents are achieved due to collimated laser backlight. Viewers are enabled to move freely to observe 3D contents without wearing any glasses.

For the second prototype, an autostereoscopic 3D display using a set of cylindrical optical elements as the backlight steering is proposed. The high density LED-based lens array controls the direction of the backlight for the user's right and left views. A prototype system using a set of LED-based cylindrical lens, LED array modules and a high resolution LCD module is constructed. The directional backlight beams are synchronized with the right and left images alternately on the LCD screen, and two convergent viewing zones are formed alternately for one viewer. The experimental result shows a stereo video image with a natural 3D effect. A good colour 3D perception with full resolution is achieved without wearing glasses.