設計與製作具方向性背光系統以應用於攜帶型立體影像顯示器

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摘要

現今的平面影像顯示技術雖然能夠顯示豐富多彩的影像，卻無法提供類似自然視覺的立體效果。所以，在人們追求接近自然視覺，更好的視覺享受的原始動力下，立體影像顯示技術被視為下一波顯示技術的改革主流。在所有的立體影像顯示技術當中，時間多工的立體影像對式(stereo pair type)係依序將成對的視差影像分別投射到觀察者的左右眼，以形成立體視覺，因此除了高度相容於現今流行的平面顯示器，具有體積小、成本低的優點之外，還具有媲美平面顯示技術的影像品質。然而目前的相關設計大多結構複雜，且控光結構之間可能存在對位問題。因此，為了解決以上所提的問題，我們針對時間多工方的立體影像對式，提出一個具方向性背光系統以應用於攜帶型立體影像顯示器，其包含兩片相同的導光板、兩組光源和一片吸收板。此背光系統的特色係只利用一種簡單的微溝槽結構來控制光的方向，架構簡單，因此沒有對位問題。

根據上述的原理，我們利用軟體建立一個模型來描繪此具方向性背光系統的特性。在本論文中，我們針對 1.8 吋的立體影像顯示器，設計此具方向性背光系統。藉由改變導光板上微溝槽結構的斜面角度、大小與分佈，我們可以得到一組最佳化的導光板規格：微溝槽斜面角度固定為 38 度，微溝槽寬度固定為 25μm，微溝槽間距範圍由 25μm 到 368μm。此外，我們也設計另一組免除雲彩花紋的具方向

性背光系統，其最佳化結果為：微溝槽斜面角度固定為 38 度，微溝槽寬度落在 18 μm 到 27 μm 之間，微溝槽間距則落在 4 μm 到 160 μm 和 270 μm 到 290 μm 之內.

根據上述最佳結果，我們利用鑽石加工技術製作出兩組導光板。然後，使用光學儀器量測此具方向性背光系統的角度分佈。量測結果顯示，所設計的具方向性背光系統具有良好方向性，很少有光漏到相反方向。經過分析，就第一組設計的導光板而言，適合觀賞立體影像的距離約距離背光系統 7 到 23 公分之間；就第二組設計的導光板而言，適合觀賞立體影像的距離約距離背光系統 4 到 23 公分之間。除此之外，彩色濾光片與微溝槽結構產生的雲彩花紋亦被明顯改善。另一方面，兩個設計的最佳出光均勻度分別高於 70%和 75%，可進一步經由減小製程誤差而獲得改善。

將此具方向性背光系統搭配應答速度小於 8ms 的液晶面板，可組成一個完整的立體影像顯示系統。目前利用液晶層間距 2 μm 的 90°扭轉向列型液晶（90° TN liquid crystal），液晶反應速度已經可以達到 7.1 ms。一些影像驅動方式也正在研究當中，並可在不久的將來被實現。

Design and Fabrication of Dual Directional Backlight System for 3D Mobile Display

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Abstract

2D displays nowadays can display rich and colorful images but can not provide 3D perceptions similar to the natural vision. Under the desires for more natural and better viewing experiences, therefore, 3D display technology is expected to be the next key display technology. Among various 3D display technologies, the time-multiplexed stereo pair type, forming 3D vision by projecting pairs of parallax images to the viewer`s respective eyes sequentially, has high compatibility with the current popular flat panel displays and advantages of compact size, low cost and comparable image qualities with 2D display. However, they suffer from complex structures and alignment issue between each light-controlled structure. In order to resolve the concerns mentioned above, a dual directional backlight system for 3D mobile display, based on the time-multiplexed stereo pair type, was proposed in this thesis. The dual directional backlight system composed of two identical light-guides, two light sources and an absorber features only one simple micro-groove structure to control the light direction and, thus, no alignment issue.

According to the principle mentioned above, we established a simulation model to

characterize the features of the dual directional backlight. In the thesis, the dual directional backlight was designed for a 1.8” 3D mobile display. By varying the micro-groove structures, including groove angle, groove size and groove distribution, one of the optimized dual directional backlight with the specifications of groove angle of 38°, groove width of 25μm and groove gap varying from 25 and 368μm was obtained. Furthermore, another dual directional backlight for free of moiré` pattern was also designed and optimized, whose optimized specifications are groove angle of 38°, groove width varying from 18 to 27μm and groove gap varying from 4 to 160μm and varying from 270 to 290μm in different part.

According to the optimized results, two sets of the light-guides were fabricated by diamond tool machining. The angular distribution of the dual directional backlight measured by an optical instrument, Conoscope^{TM}, shows that the directionality of the dual directional backlight meets the angular requirements for the time-multiplexed 3D display, i.e. less light leaked to the opposite direction. After some analyses, the viewing distances, suitable for 3D vision, of the first design and the second design for free of moiré` pattern were located within 7 and 23 cm and 4 and 23 cm, respectively. Besides, the moiré` pattern was suppressed markedly by the design for free of moiré` pattern. On the other hand, the best light uniformities of the first and the second designs were higher than 70% and 75%, respectively, and can be further improved by the fabrication process.

Using the proposed dual directional backlight and a fast switching liquid crystal display with response time of less than 8ms, a complete 3D mobile display can be realized. Now a LC panel with response time of 7.1 ms has been achieved by over driving the 90° TN liquid crystal panel with cell gap of 2μm. In addition, a few solutions to the image driving are being investigated and will be developed in the near future.

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