RGB LED 배열을 사용하는 역광선 단위의 광학 분석

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Optical Analysis of Backlight Units Using RGB LED Array

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Abstract : In this work, we have simulated a 42-inch LED BLU which was based on 300 RGB LEDs. We have done an adjustment of LEDs' strip distance and a height of the top of the LED to the back of the LCD to get white color uniformity. So, we have changed simultaneously the distance between the top of the LEDs and the back of the LCD. Moreover, we set a fixed position for the horizontal of LED's pitch. And then, we have experimented and compared to our simulation data.

Key Words : LED arrays, backlight unit, luminance uniformity, LED's strip distance

1. Introduction

Recently, LED-based backlight unit (BLU) provides general advantages, in terms of good brightness uniformity, high dimming ratio, reliability, low temperature operation and Hg-free light source, over conventional light sources such as Cold Cathode Fluorescent Lamp (CCFL). BLU can be classified into two categories in terms of the location of the light sources inside the module, i.e. side lighting and direct lighting [1,2].

A side lighting BLU has the light source located on one edge side of the module and a light guide plate is installed for light to travel from the source to the viewer [3]. The light guide is unnecessary in a direct lighting BLU in which the light source are distributed behind the display screen for the direct view. The advantage of the light guide in side lighting BLU is the relatively uniform luminance for the entire module. However, the existence of the light guide would be effective to increase the module's weight. Therefore, the side lighting BLU is more suitable in small-size LCD (liquid crystal display) applications such as mobiles. One the other hand, without the light guide, the direct lighting BLU is more used in large-size LCD. How to achieve high brightness and homogeneous luminance has always been an important issue in the optical designs of both types of BLU.

2. Design

A direct LED backlight has been developed for a 42-inch LCD, with an aspect ratio of 15:9, and its design is shown in figure 1. The backlight size is 930.25 × 523.01 mm with a thickness of 30 mm. It consists of a metal (aluminum) housing containing 10 linear arrays of 30 LEDs on a Metal Core Printed Circuit Board (MCPCB). The LEDs for each array were connected in series and the maximum current for each color was limited by appropriate series resistors. The strips were connected in parallel, that is, this has the advantage that in spite of the high LED count, the required supply voltage can be kept low. The LEDs were positioned with a spacing of 31.01 mm. The strips were equal arranged with a spacing of 51.41 mm within 930.25 × 523.01 mm. The required optical films, diffuser and prism sheet, are also added to the BLU, followed by the LCD itself. In case of this, we were used Z-power LED with 1W.

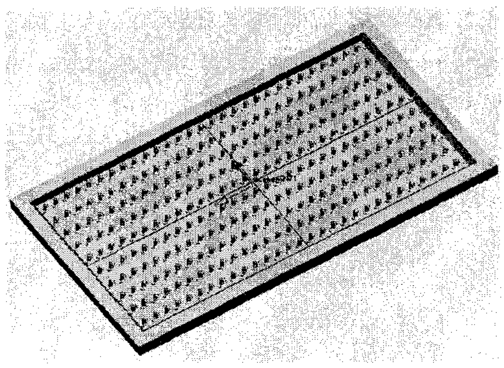


Figure 1.RGB LED arrays within reflective cavity

3. Results

3.1 Simulation

The design in figure 1 was modeled in a LightTools program developed from Optical Research Associates. The most important design parameters of our work are the module thickness, the spacing between LED's strip and arrangement of light sources.

The diffuser, prism sheets and protector sheet were geometrically set up on program. The design was optimized for brightness and luminance uniformity by an adjustment of LEDs' strip distance and a height of the top LED to the back of the LCD. Figure 2 shows the simulation results of brightness uniformity for a height ranging from 0 mm to 19.2 mm. For a height of 12.8 mm, the brightness uniformity is high and the more decreased uniformity the far height ranging. So, we issued that it is suitable to get high brightness uniformity for our work.

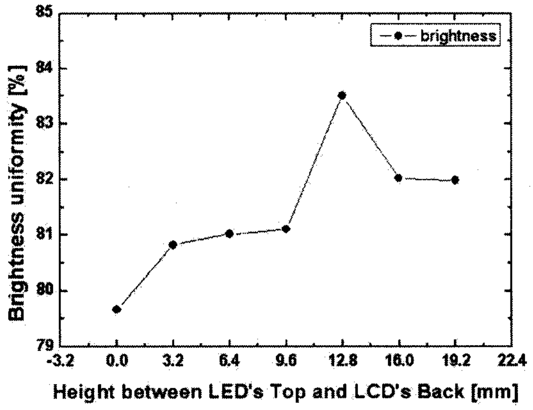
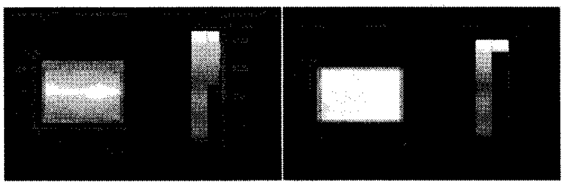


Figure 2.Brightness uniformity by changing height between LED's top and LCD's back

For second parameter in our work, we have made design with unequal spacing between LEDs' strips (see figure 3.a). And then, we have changed the distance of LEDs' strip in equal spacing (see figure 3.b). According to simulation, we confirmed that the equal spacing of LEDs' strip gave the brightness uniformity back.



(a) (b)

Figure 3.Brightness uniformity by arranging the distance of LEDs' strips

Moreover, we were made light sources' array in the form of anti-parallel configuration. After setting the resulted data, we were simulated this module in LightTools program. From this simulation, the luminance uniformity, 83.5% has been achieved.

3.2 Experiment

After making as much as possible in program, several LED direct backlights were built to get optimal brightness and luminance uniformity. In this experiment, we used MINOLTA CS-1000 portable spectral radiometer for measuring brightness. An array was made up of 300 LEDs consisting of 10 strips of 30 LEDs with a color sequence optimized to manage brightness uniformity on the screen. The average luminance was measured at 80% uniformity based on 9-point test. It was little different compared to simulation results.

4.Conclusion

This work efforts are confirmed thinner module design and higher brightness efficiency. We were made this design which 930.25 × 523.01 mm active area with 30 mm thickness to get good color mixing. For higher brightness efficiency. We set up a height of 12.8 mm between the top of the LED and the back of the LCD. Moreover, we were made design with equal spacing of LEDs' strip and arranged LEDs with anti-parallel configuration. This design in simulation, using RGB LEDs as a light source, provided a good color mixing and an optical efficiency of 83.5%. The design in experiment gave good color mixing back ,but provided a decreased optical efficiency of 80%. So, we would considered that the other optical properties of LED BLU such as diffuser sheet, prism sheet,etc., to get higher brightness efficiency.

Acknowledgements

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