Development of High Brightness Picture Generator Unit for Head-Up Display

Po-Jui Chen[1], Wei-Jei Peng[1], Kun-Huan Wu[2], Ming-Fu Chen[3]*

[1] *associate researcher*

[2] *assistant researcher*

[3] *researcher*

The high-brightness picture generator unit (PGU) works like a home TV screen. Its main function is to display the input digital image signal on its LCD. However, unlike common commercial screens, PGU is usually used for various head-up displays or projection equipment as the source of dynamic or static image. Since some projection devices are used for outdoor activities, PGU needs to provide high brightness and uniform light image against strong ambient light. In this paper, the PGU embeds a Kyocera 4.1 inch full-color car-gauge LCD panel with a resolution of 1280 x 640 and a transmittance rate of up to 7.2%. In order to ensure image quality, the device is optimized the illumination performance in the central 3.26 inches area of the LCD panel. After the processing of lens group optimization, optical specifications evaluation, lens manufacturability evaluation and tolerance analysis, the central edge light is limited within 24 degrees and the central light deviation is less than 5 degrees at 1 field far away from the LCD. The illumination area is designed to be 100mm so that the space of 8mm on the margin can be reserved for system assembly. LCD screen may flicker and drift due to high temperature that is mainly caused by the high-brightness backlight source. Avoiding the working temperature of the device is too high, 6 pieces of Cree XLamp MHD-E LED are used as the backlight source of PGU. A single LED can provide 143 lumens per watt, up to 13 watts. These 6 LEDs are arranged in the matrix array in order to make the brightness of the light-emitting surface more uniform. With three self-developed lenses and high-gain diffusers, the total power of 6 LEDs only needs 30 watts to make the maximum display brightness of the LCD screen up to 49,000 nits, meeting the demands of various high-brightness display applications.

There are three lens in the PGU condensing and homogenizing the backlight. The OTL (Optical Track Length) is 90mm, and the total focal length of the optical system is 47.66mm. Len L1 is used to converge the light emitted by the LED as much as possible. The closer L1 is placed next to the LED, the better illumination efficiency can be obtained. Although the best optical path design is let all the LEDs adhere to L1, it is impossible to achieve in real products. Since the gap between L1 and LED is taken into account, light rays at large angles emitted by the LEDs will be discarded. Considering to match external light path angle, L3 is designed to regulate the output light angle of PGU to form the required angle distribution on the panel. Len L2 serves as a transition link between L1 and L3. The sensitivity of system assembly tolerance may increase because the light angle is enlarged after passing through L1. The L2 can converge the light angle and flattens the ray trace. L2 can greatly reduce the assembly tolerance sensitivity of the optical system.

Keywords: PGU, High Brightness, HUD