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Relationship between Background Luminance and Subjective Readability in Curved Organic Light-Emitting Diode Displays

Takushi Kawamorita [1)] Tatsuya Iizuka [1)] Makiko Miyasaka [1)]

Yoshiyuki Matsubara [2)] Norio Samma [3)]

[1)] Department of Orthoptics and Visual Science, Kitasato University School of Allied Health Sciences
1-15-1 Kitasato, Sagamihara, Kanagawa, 252-0373, Japan (E-mail: kawa2008@kitasato-u.ac.jp)
[2)] DENSO CORPORATION
1-1 Showa-cho, Kariya, Aichi, 448-8661, Japan
[3)] SOKEN, INC.
500-20, Minamiyama, Komenoki-cho, Nisshin, Aichi 470-0111, Japan

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The recent improvement in the degree of freedom of display shape using curved organic light emitting diode (OLED) display has made it possible to set large curved displays inside vehicles. However, the resulting increase in power consumption has raised concerns. Moreover, the establishment of a method to achieve low-power consumption is also an issue. Based on the above, to realize a large-screen in-vehicle information display that is both easy to read and has low-power consumption, we investigated the relationship between background luminance and easy-to-read character luminance in OLEDs by changing the background luminance in a laboratory setting; additionally, we further evaluated the lower limit of the black tone of the display background luminance and ease of viewing.

A 13.96 inch curved OLED in-vehicle display was used in the experiment. The surface was film-treated and had a resolution of 1920 × 1080 pixels (158 dots per inch). The curved surface had a radius of curvature of 200 mm in the vertical direction. The OLED display was placed at a viewing distance of 740 mm. The threshold of character luminance was measured to find the lower limit of legibility by changing the gradation of the OLED display. This changed the background luminance to black and the character luminance in steps to evaluate the luminance at which the OLED display was perceived to be easy or difficult to read. We investigated the relationship between background luminance and the lower limit of luminance for legibility when the in-vehicle display was at 0°, -50°, and in nighttime and daytime conditions.

The experimental results revealed that the lower luminance limit for legibility increased significantly at increasing background luminance and with off-axis light ($p < 0.01$, Figure 1). In the general linear model, the results of subjective evaluation of these lower limits of legibility yielded significant differences in background luminance ($p < 0.001$), age group ($p = 0.036$), gender ($p < 0.001$), off-axis light ($p = 0.006$), and visual target position ($p = 0.007$).

Although it is necessary to acquire more data while changing the display conditions in future and to compare the results of accuracy studies using a driving simulator and an actual vehicle, the results suggest that it is possible to conduct verifications in a laboratory environment, similar to an outdoor environment. The results are also expected to help in realizing a large-screen in-vehicle information display that is easy to read and demonstrates low-power consumption.

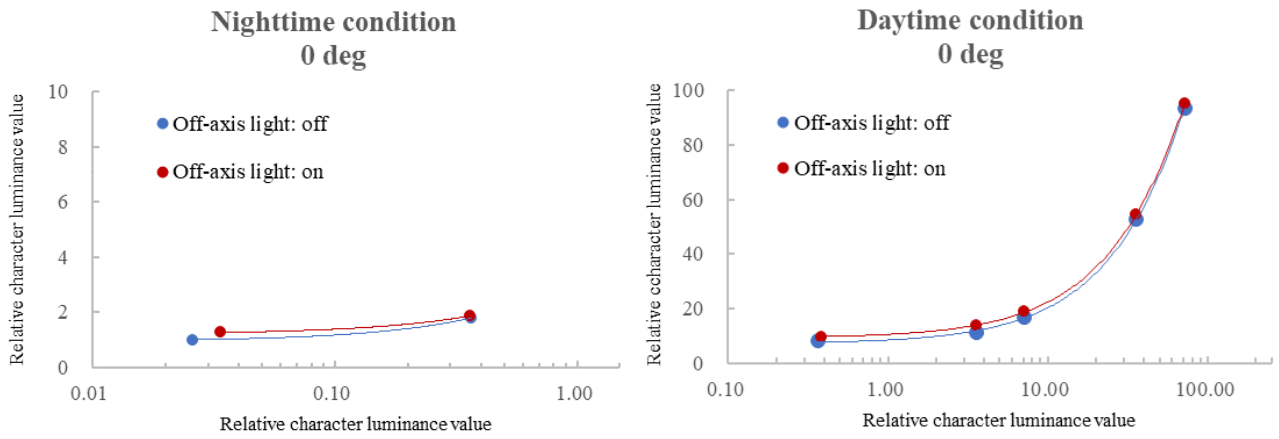

Fig. 1 Relationship between background and character luminance at 0° (left: nighttime condition, right: daytime condition).