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PROPOSAL AND BASIC TEST ON NEXT GENERATION VARIABLE TRAFFIC INFORMATION SIGN

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ABSTRACT

Regarding the signs currently installed along the road, several signs exist to deliver various information, which causes great confusion to drivers. Also, new technology on road signs today has applied lighting and LED to improve nighttime visibility, but they are still giving great confusion to drivers.
To solve these problems, LED or prism method of variable message signs are being currently applied, but due to limitations in the display itself, only a limited amount of information is being displayed.
In this study, to identify the current level of technology, the current technological trend of variable message signs were verified, and the next generation display was proposed in order to increase the amount of information provided through variable message signs.. Also, through literature review, a technical comparison was performed on current variable message LTD signs along with the next generation display of OLED. Moreover, the next generation display of OLED and the message sign were performed with a luminance contrast test to verify the replace ability of the message sign.

Keywords: *Variable Message Sign, Transparent Display, Flexible Display, Luminance*

I. INTRODUCTION

Regarding current road signs, several signs exist to deliver various information, which causes great confusion to drivers. The National Police Agency states that caution signs, restriction signs and instruction signs should not be collocated unless the information is related, and even in this case, they should not be attached more than necessary [1]. Also, new technology on road signs has applied lighting and LED to improve nighttime visibility, but the signs are still confusing for drivers. To overcome these problems, variable message signs are applied. Regarding these, LED (Light emitting diode) is mainly used in Korea, and prism-types are mostly used in Europe. LED provides basic words and shapes through light-emitting diode displays, and the prism-type involves inserting different information in a triangle in order to provide 3 types of information. However, these methods are limited by the display itself, and only a limited amount of information is delivered.
In this study, the technological trend of current variable message signs will be identified, and a new next generation display will be proposed to compare them from a technological perspective. Also, the luminance contrast test will be performed on the proposed next generation display and general road signs in order to consider the possibility of replacement.

II. MAIN BODY

1.1 Technological Trend of Current Variable Message Signs

1.1.1 Technological Trend of Korean Variable Message Signs

The trend on current variable message signs was reviewed by dividing these signs into domestic and foreign cases. Domestically, LED is applied to the variable message sign, and mainly used in Children Protection Zones. Figure 1 shows the variable message sign applied to Children Protection Zones in Nowon-gu and Yangcheon-gu in Seoul. It delivers a warning according to the neighborhood's driving speed.

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Figure 1. Variable Message Signs Installed in Children Protection Zones in Nowon-gu and Yangcheon-gu in Seoul [2]

In Gimhae-si, a variable message sign was installed as part of a project for improving the Children Protection Zone. This system detects the speed of all vehicles passing the installed point in advance to display the speed electronically, in order to induce safe driving.

Figure 2. Variable Message Sign in Children Protection Zone in Gimhae-Si [3]

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1.1.2 Technological Trend of Foreign Variable Message Signs

The variable message sign designed by Dambach in UK is applied to Expressway VMS, safety warning signs, and to the parking guide . This system applies an LED display on the message sign in order to show the remaining number of parking spaces in the parking lot.

Figure 3. Variable Message Sign in Parking Guide by Dambach UK [4]

Safe Road Company in Finland provides variable information through prism-type variable message signs. Prism-type signs are made of aluminum and stainless materials and composed of 3 panels. The triangular panel rotates to provide three different types of traffic information. Prism-type signs are limited in the number of images compared to the LED display, but they have the advantage of low installation costs. Also, the energy required for operation and maintenance is low, therefore, it can be fully operated using solar energy. These signs provide warnings on tunnel sections, upcoming construction, detours, and road closures. Rotapanel in The Netherlands installed prism-method signs to provide information on congestion, accidents and appropriate routes. These signs provide more information according to various road situations, which is very convenient for drivers.. [5].

Figure 4. ROTAPANEL's (Netherlands) Prism Variable Message Sign [5]

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Figure 5. Safe Road's (Finland) Variable Message Sign [6]

IB FOOR in Estonia developed a prism sign composed of 3 panels, which can provide 3 types of information. Prism signs have limited information compared to existing LEDs, but they have the advantage of low installation costs [7].

Figure 6. IB FOOR's Variable Message Sign [7]

As a result of a study on current variable message signs, LED is mostly used domestically, and prism signs were shown to be more popular in Europe. LED signs are possible for various displays but have low display resolution, and prism signs have low installation costs, but the number of display screens is limited to 3.

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2. Technological Trend of Current Variable Message Signs

During this study , a lightly colored display with high resolution was reviewed, and technology and patent trends on the transparent display and the flexible display were identified.

2.1 Technological Trend of the Transparent Display

The transparent display allows the back side of the screen to be visible through the transmittance of the screen, and there are many other functions that can also be realized this way. A few different types of transparent display include transparent TFEL, transparent OLED, and transparent LED displays. In the transparent TFEL, the electron that is accelerated in the inorganic fluorescent substance activates the fluorescence as it passes to generate light. The transparent TFEL is composed of transparent electrodes and inorganic fluorescent substance and insulator film, and the inorganic fluorescent substance and the insulator film have transparent characteristics which enable transparent display. The transparent TFEL has a long lifespan, and it also has high resistance against temperature and physical impact [8].

Figure 7. Transparent TFEL Form [8]

In the transparent OLED, electrons and positive holes are inserted in both sides of the inorganic luminous layer and are then combined inside to emit light. Generally, if both sides of the electrodes are transparent, the transparent inorganic luminous layer can work as a transparent display [8].

Figure 8. Transparent OLED Keypad [8]

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A transparent LED display is installed to the outer wall of buildings and applied as a media facade to be used as a screen, and as a small and simple sign board.

2.2 Technological Trend of the Flexible Display

Flexible displays are composed of plastic or thin glass to give added flexibility to the basic display of the LCD and the organic EL. The flexible display has the advantages of being thin, light and being durable. Also, the display is produced on top of plastic boards in order to be light and durable , and it can be produced in various shapes if necessary [9].

Figure 9. Flexible Display [9]

The flexible display requires a great amount of R&D on the development of the material. Proper process and equipment technology have better, more diverse functionality than current technology, and must maintain distinct display characteristic of their own . Regarding the flexible display industry in Korea, the module field is highly advanced, but is behind in the originality of technology and applications, therefore, more R&D is required to make these products more competitive [9].

3. Comparison of Technology

During this study, 4 displays of the LED (light emitting diode), prism method, transparent display and the flexible display were tested on outdoor visibility, cost and informativeness and scored either good, fair or poor. The existing LED (light emitting diode) and the prism method were excellent in outdoor visibility and had low costs, but these also have limits in how much information they provide. On the other hand, the transparent display and flexible display still had limits in outdoor visibility and also had high costs, but scored highly in how much information they provide, due to high resolution.

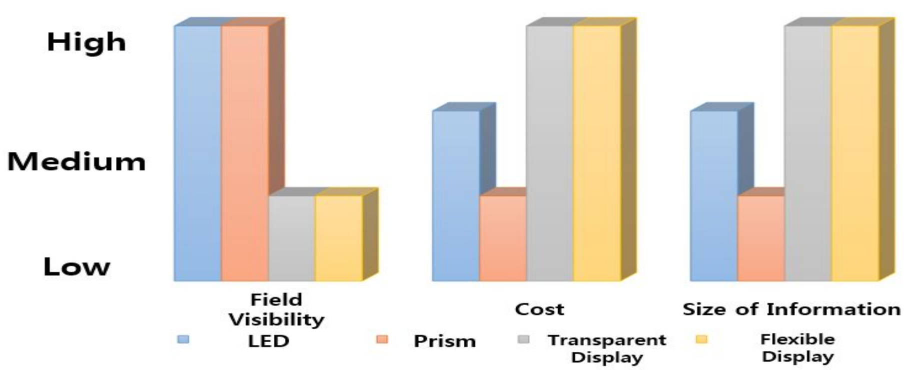

Figure 10. Analysis of Variable Message Sign Technology Trend

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4. Luminance Contrast Test on OLED and Message Sign

During this study, among the transparent displays reviewed through the literature review , a luminance contrast test was conducted on the OLED display and on general road signs. Compared to the general LCD, the OLED display does not require a back light, as it has a self-luminous function, and it can display thin and pure color. In this test, a nighttime environment was applied to the OLED display and the general road sign model to verify the visibility through luminance contrast. For the OLED display used in the test, a current OLED TV was used, and the message sign image was displayed on the screen through the computer.

Figure 12. OLED Display

The dot luminance meter (CS-100 Model) by MINOLTA was used for measuring the luminance. The test was conducted in a lightless darkroom, and the light source was projected on the OLED display and the message sign model to demonstrate the head lamp light of the vehicle in the nighttime. To find out the statistical difference of the luminance contrast between OLED displays and message sign models, the test was conducted 5 times for each display.

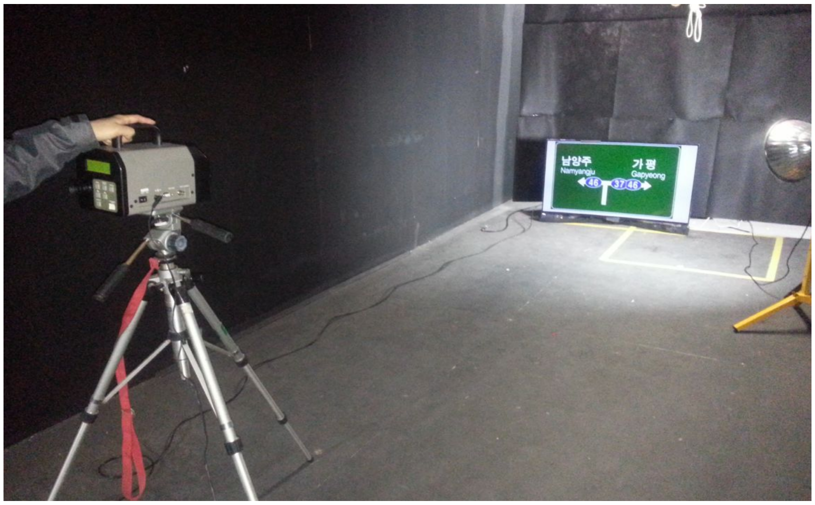

Figure 13. Luminance Measurement using the Dot Luminance Meter

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Generally, the driver can distinguish an object better when the luminance ratio is low and when the luminance contrast is high. As a result of the test, the average luminance ratio of the OLED showed approximately 5% less result than the luminance ratio of the message sign. Also, the luminance contrast of the OLED showed an approximately 5% higher result than the luminance contrast of the message sign model. This test verified that the luminance contrast of the OLED display is slightly higher than the luminance contrast of the message sign model.

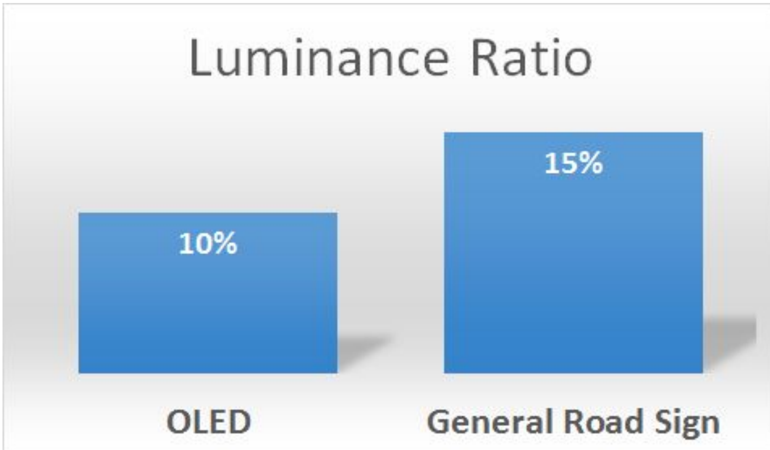

Figure 14. Luminance ratio result

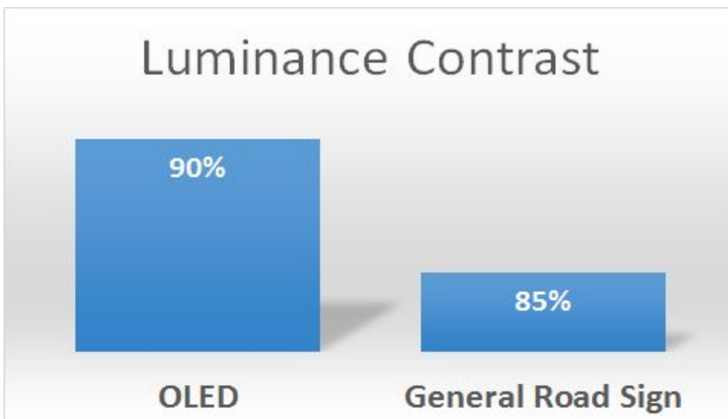

Figure 15. Luminance Contrast Result

During this study, an independent sample T-test was performed to verify the statistical difference of luminance contrast between the OLED display and the road sign model, and a widely used statistical analysis program (SPSS) was used. As a result of the test the significance probability was higher than 0.05, therefore, an independent sample T-test was conducted.

As a result of the equal variance test, the significance probability was 0.889 and thus higher than 0.05, therefore, the equal variance was satisfied, and as an independent sample T-test result, the significance probability showed 0.000 to be less than 0.05, therefore, the luminance contrast between the OLED display and the road sign model showed statistical difference. This test also verified that the road sign displayed in the new technology as part of the OLED display had a statistically significant effect in terms of luminance contrast. However, this test was conducted in a limited circumstance, and to demonstrate the actual situation, additional tests and verification are required. Also, when the display sign is applied to an outdoor space, the biggest problem is the Sun-Phantom, and additional tests are needed to verify whether this can be overcome.

Figure 16. VMS Visibility Degradation due to Sunlight [10]

※ Sun-Phantom [10]

Sun-Phantom is a phenomenon where the message and symbols that must be displayed are difficult to read due to sunlight. This affects all road facilities exposed to sunlight, and it is especially important to facilities that induce visibility.

III. CONCLUSION

During this study, a new display was provided to increase the ability to provide more information than current variable message signs, and a comparative study was performed. Also, a luminance contrast test was conducted on the next generation display proposed in this study and existing road signs in order to verify whether to replace these road signs.

During this study, the technological trend of the current variable message sign method, LED, and the prism-type sign were initially identified. As a result, the LED method was mostly used in Korea, and in Europe, prism-type signs were mostly used.

Also, for the next generation display to be utilized in the variable message sign, the OLED display was proposed, and a technical comparison was performed with the existing LED. As a result of the technical comparison, the OLED display showed excellence in providing various information and was significantly better than the existing LED, but it was still insufficient when applied outdoors. However, this weakness can be overcome through future technological developments.

During this study, a luminance contrast test was performed between the common OLED display and road signs in order to examine the road sign applicability of the OLED display. As a result, the OLED showed an approximately 5% higher luminance contrast than the general road sign, which concludes that the statistical difference is valid.

The economic feasibility comparison and luminance contrast test performed in this study were conducted in a limited situation, therefore, further studies considering various variables must be performed in the future.

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