P2.21

Analysis on LGP of LCD Backlight/Frontlight

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Abstract

LGP (Light-Guide Panel) of TFT-LCD Backlight/Frontlight is one of the major components which affect on the product quality of LCD. Since the brightness distribution of LGP is sensitive to the process error in manufacturing, the optical characteristics such as reflection and absorption of LGP pattern should be modeled including the process error. LGP is developed by using the fast and reliable design technology, which uses the concept of the inverse-design, makes the model on the characteristics of uncertainty in the manufacturing process, and designs the dispersion pattern analytically without try-and-error by using an artificial intelligence. The PEA(Process-Error-Adaptive) design gives the best solution in handling the process error. The offset of target in feedback system makes such the best pattern design possible that the brightness distribution is nearly same (more than 90%) with target in regardless of the miscellaneous errors in mass production. The present design method has been also applied to frontlight and multi-side-lamp(eg., four-side-four-lamp) backlight.

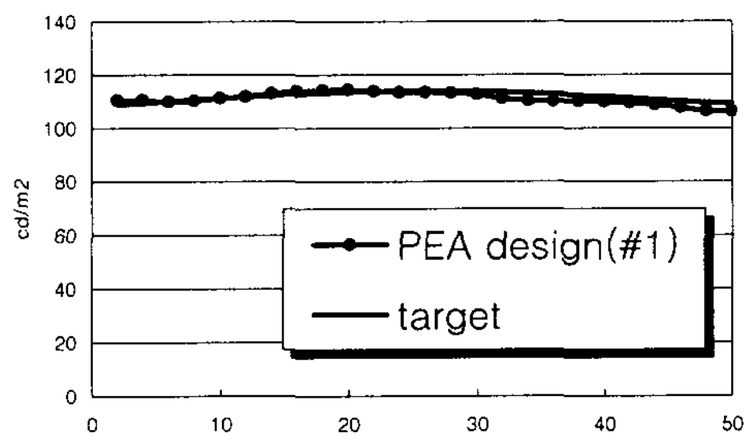
1. Objective and Background

The LGP of LCD backlight/frontlight which uses the principles of TIR(Total Internal Reflection) has been classified as edge-lighting type. The light source located either at one side or at two sides propagates into the LGP in terms of TIR. When the light hit at dispersion pattern, the diffused light emits upward. The TIR and diffusion of light are very sensitive to the shape of dispersion pattern as well as the roughness of patterned and unpatterned surfaces. The iterative method is inevitably used with know-how in order to overcome the uncertainty of manufacturing process. The characteristics of manufacturing process is modeled analytically and the inverse design is applied for the proper dispersion pattern. This algorithm not only gives the fast (less than three iterations) and reliable(more than 90% accuracy) result but also is applicable identically to any LGP of side-lighting type such as FLU LGP, print-typed LGP, printless v-cutting LGP, printless injection molding LGP, etc..

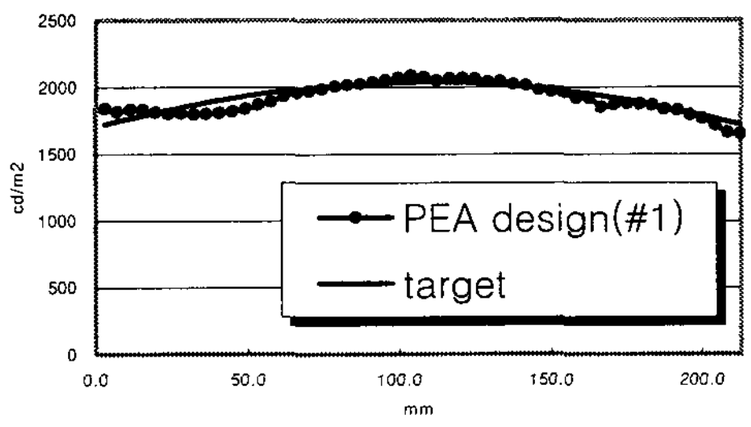
2. Design Algorithms

2. 1 Process-Error-Adaptive Design

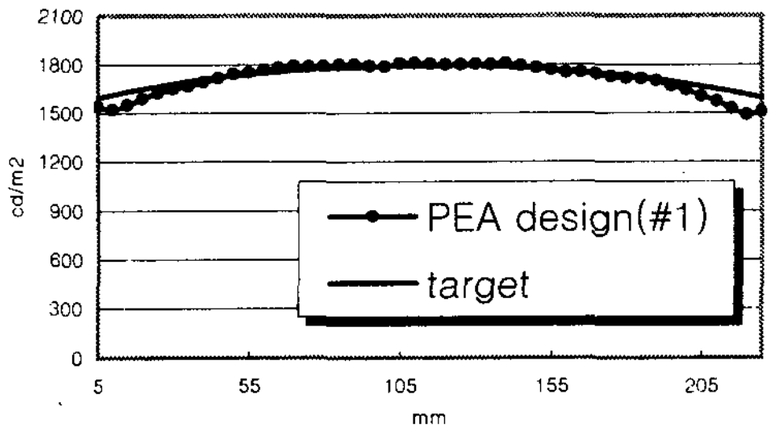
The brightness distribution of LGP is sensitive to various errors in processes of manufacturing, molding, and assembling. To overcome erroneous distribution due to the uncertainty of the process-error, the optical characteristics of reflection and absorption are adapted to the process-errors as design parameters. Fig.1 shows the excellent accuracy of this PEA design technique.



(a) frontlight of 3.5" PDA



(b) backlight of 14" notebook



(c) backlight of 15" LCD moniter

Figure 1 Examples of PEA design

2.2. Feedback Design

The offset of target in feedback system makes the correction of erroneous brightness distribution due to the miscellaneous errors in mass production. Fig. 2 shows the result of feedback design applied to PEA design of Fig. 1(c).

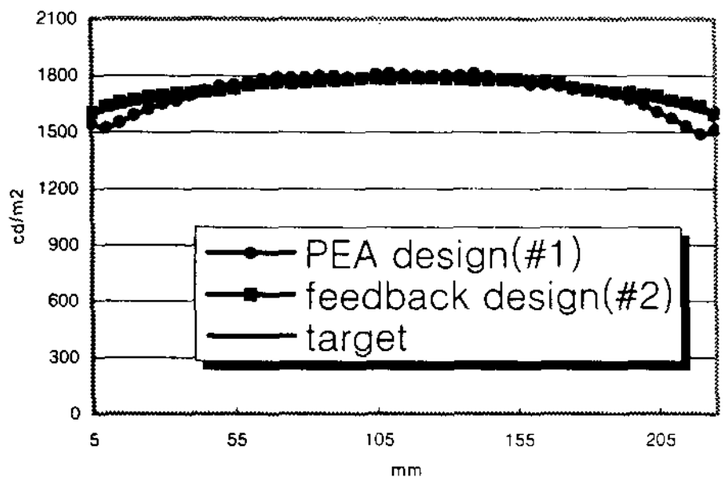
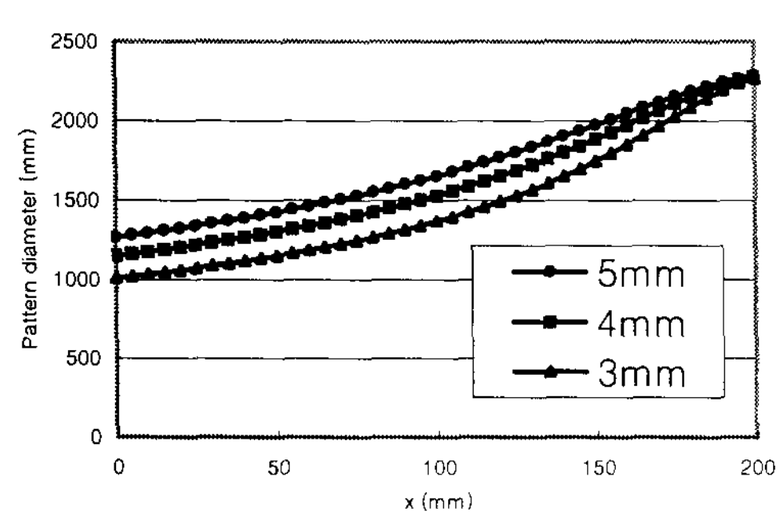


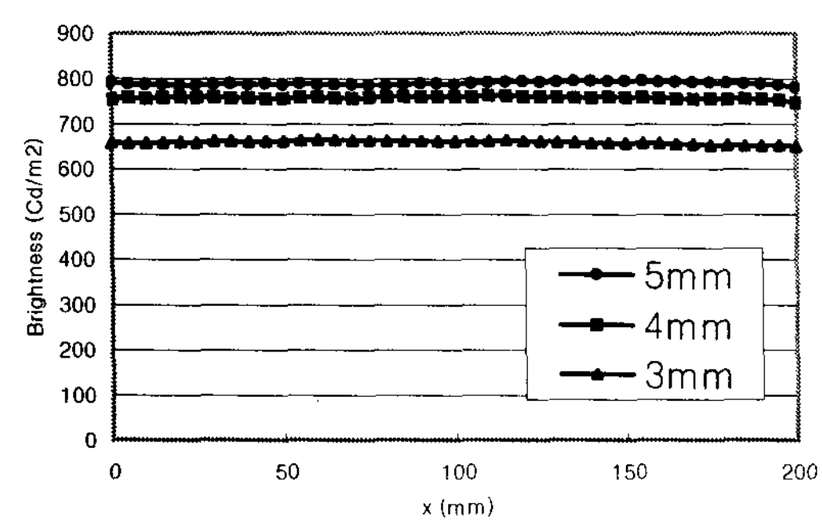
Figure 2 Example of feedback design

3. Optical Characteristics of LGP

The LGP pattern design is under the influence of LGP thickness. The uniform distribution has been given as target. Fig. 3. shows the distribution of designed dot pattern diameter and measured brightness.



(a) distribution of designed dot pattern diameter



(b) distribution of measured brightbess

Figure 3 Examples of design for various LGP thickness

4. LGP with Multi-Side Lamp

When given the uniform distribution of brightness as target, pattern disptribution of LGP with multi-side lamps has been analyzed by using two-dimensional PEA and feedback designs. Fig. 4 and 5 shows the excellent brightness distribution for LGP with four-side-four-lamp.

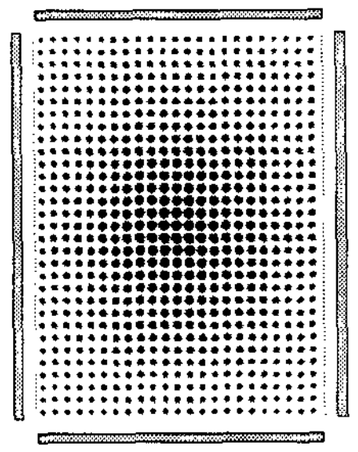
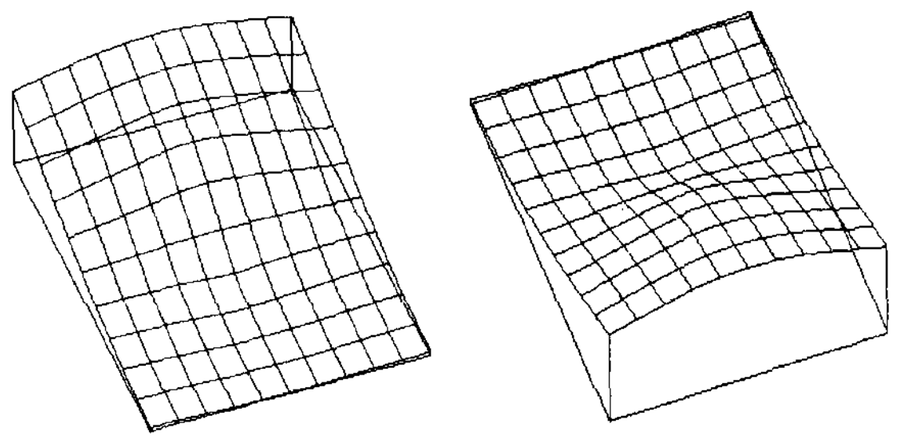
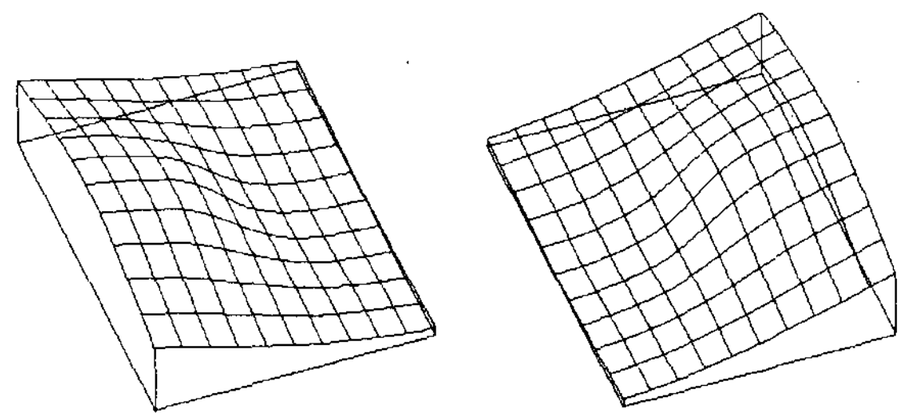


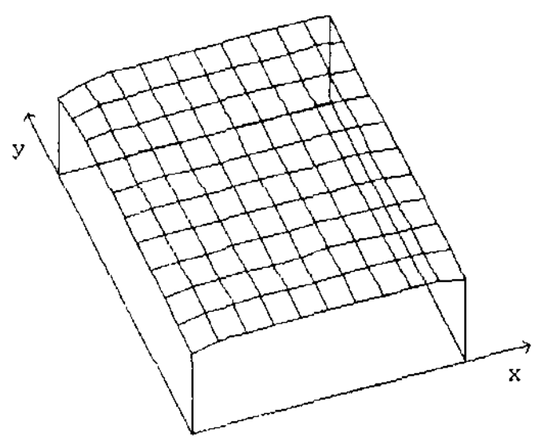
Figure 4 pattern distribution of LGP with four-side-four-lamp



(a) top lamp is on (b) bottom lamp is on



(c) left lamp is on (d) right lamp is on



(e) all lamp is on

Figure 5. brightness distribution of LGP with four-side-four-lamp

5. LGP of Frontlight

The frontlight for transive LCD consists of guide and reflect regions as shown in Fig. 6. When given the uniform brightness distribution as target, the PEA design gives various profile of frontlight LGP. Designer of frontlight should select the proper guide angle as shown in Fig. 7. Fig. 8 shows that the profile of frontlight LGP as result of final design is under influence of LGP thickness.

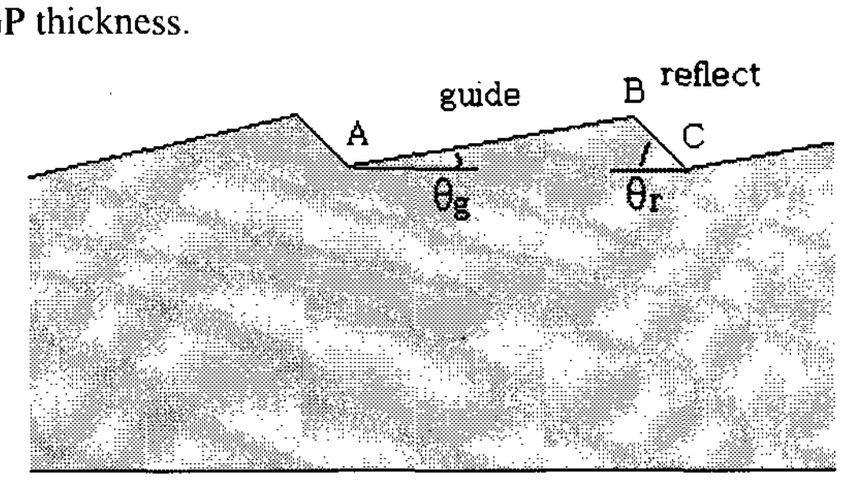
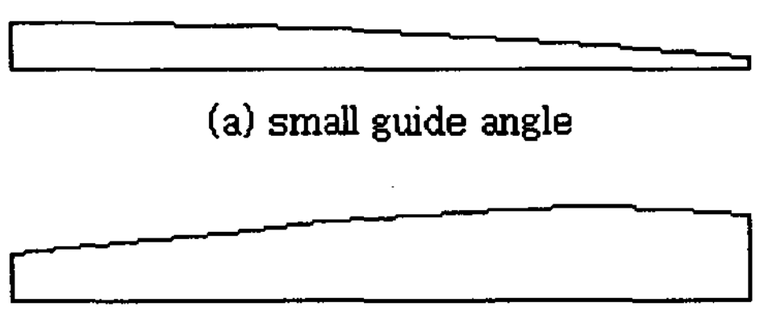
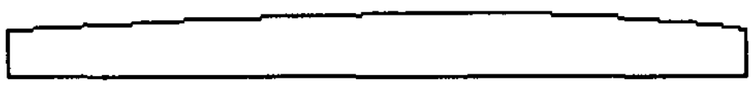


Figure 6 Geometry of LGP of frontlight



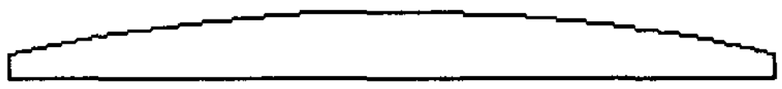
(a) small guide angle

(b) large guide angle

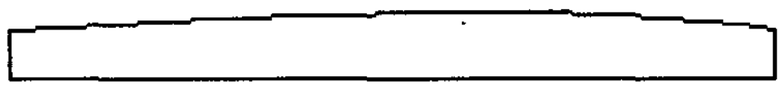


(c) adequate guide angle

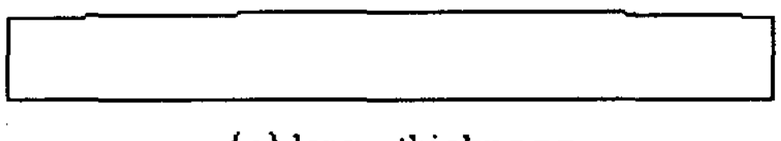
Figure 7 Influence of guide angle, θ_g



(a) small thickness



(b) adequate thickness



(c) large thickness

Figure 8 Influence of LGP thickness

6. Acknowledgement

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7. References

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