Design of 1 panel LCD system without color filter For projection color television

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Abstract

In this paper, we study the performances of optical system design using the 1 panel LCD without color filter for projection color television. We analyze the optical efficiency compare this system with 1 panel LCD system using the color filter, and work out a constraint condition of 1 panel LCD without color filter for optical design. We design a high brightness 1 panel optical system using a complex reflection mirror and suggest a method of the optical system design.

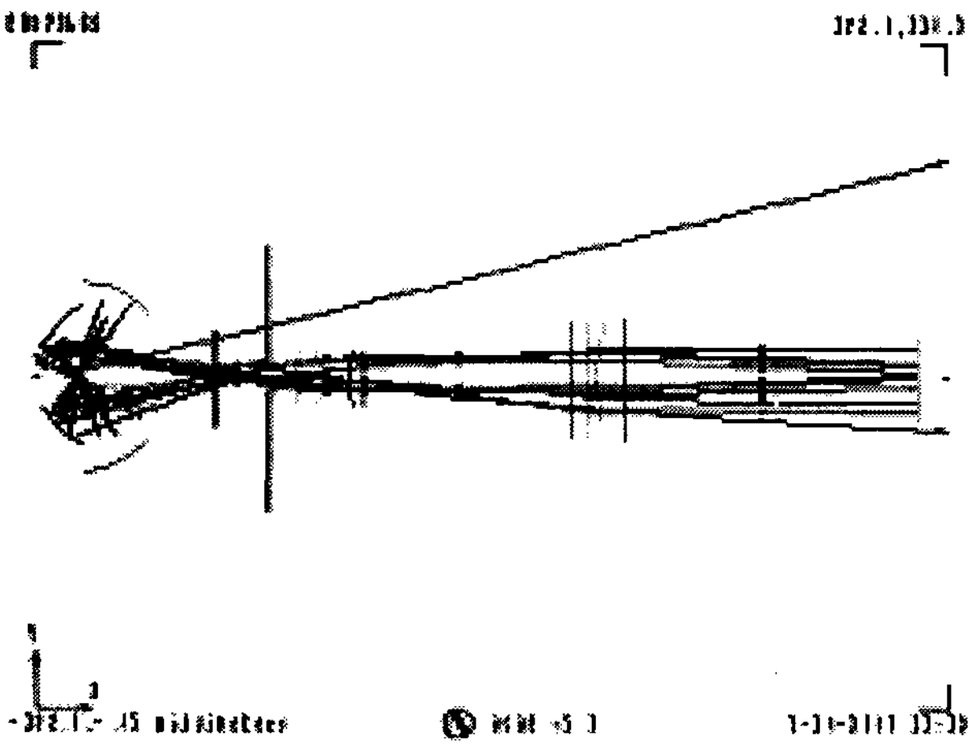
1. Introduction

LCD Projection TV is possible to offer thin and light type compared with CRT projection TV. Generally speaking, there are two types LCD projection TV, one of them makes use of 3 LCD panels and the other use 1 LCD panel with color filter for color display. The optical system for 3 LCD panels may be separated a white light dart out of a lamp into R, G, and B by dichroic mirrors and recombined them into a white light by a X-cube prism. A picture is magnified to the size of screen through the projection lens. In this 3 panel LCD system, we can get a bright picture, because of using the 3 panel LCD and dichroic mirror filter or dichroic prism. But, the optical system of 3 panel LCD is a complicated and very expensive.

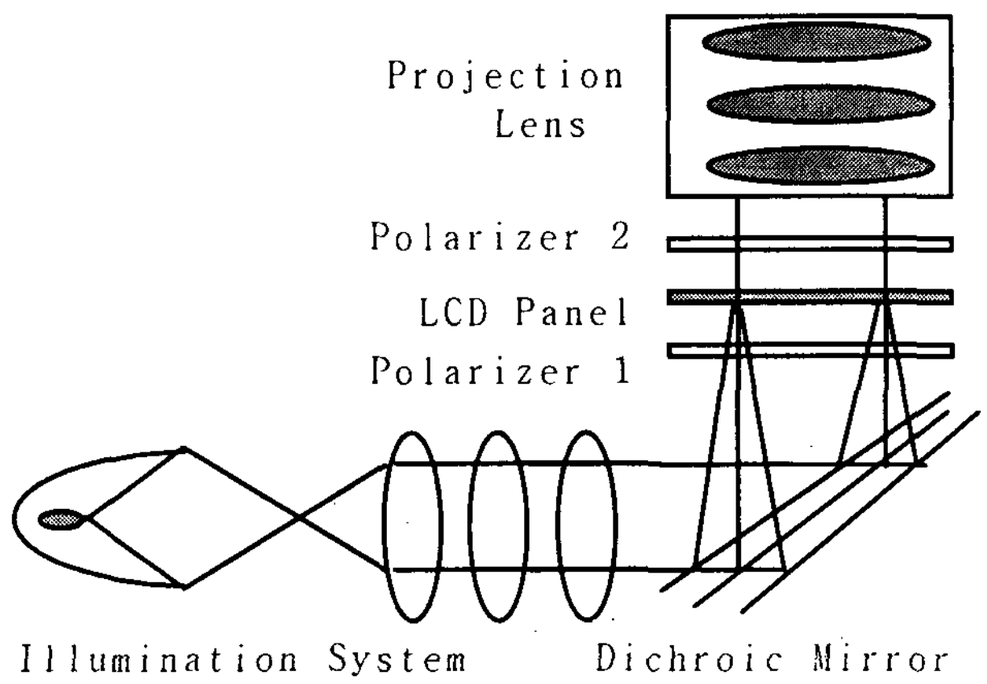
In the conventional 1 panel optical system, white light is separated into three colors by color filter on LCD, and then separated colors are incident onto the pixels of LCD corresponding to each color filter. Finally, full color images are generated on the screen by projection lens.

Full color images in the 1 panel optical system are generated by one LCD and color filters (absorption efficiency 80%). So it is attractive to be able to make large scale image on the screen at a low price. Due to low brightness, however, it is still included into a group of a low priced production (the front projection type).

Optical system using the 1 panel LCD in LCD projection color television, In this paper, we intend to develop one panel optical system without color filter for LCD projection TV of a high efficiency and a low price as Fig. 2.



[Fig. 1] Layout of a light source optical system using a complex reflection



[Fig. 2] Layout of 1 panel optical system

2. Design

We can get the about 4 times of light efficiency in the one-panel optical system realized as without color filter than the conventional one – the 2.5 times of optical transmittance with dichroic mirrors and the 1.5 times with micro lens.

There are three constraints.

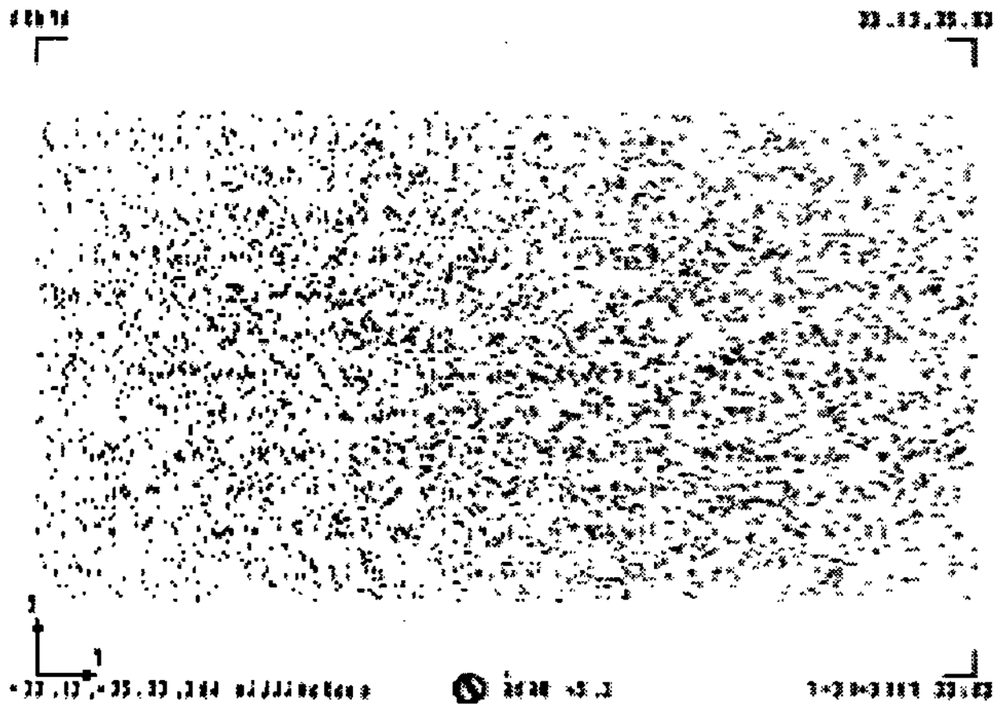
Constraint 1: Since the incident angle into micro lens makes the color, if the incident angle of red chief ray is 0 degree then the angles of blue and green should be +7.62 degree and –7.62 degree.

Constraint 2: For the color purity, the horizontal deviation angles of R, G and B's rays from their respective chief rays should be smaller than ±3.82 degrees.

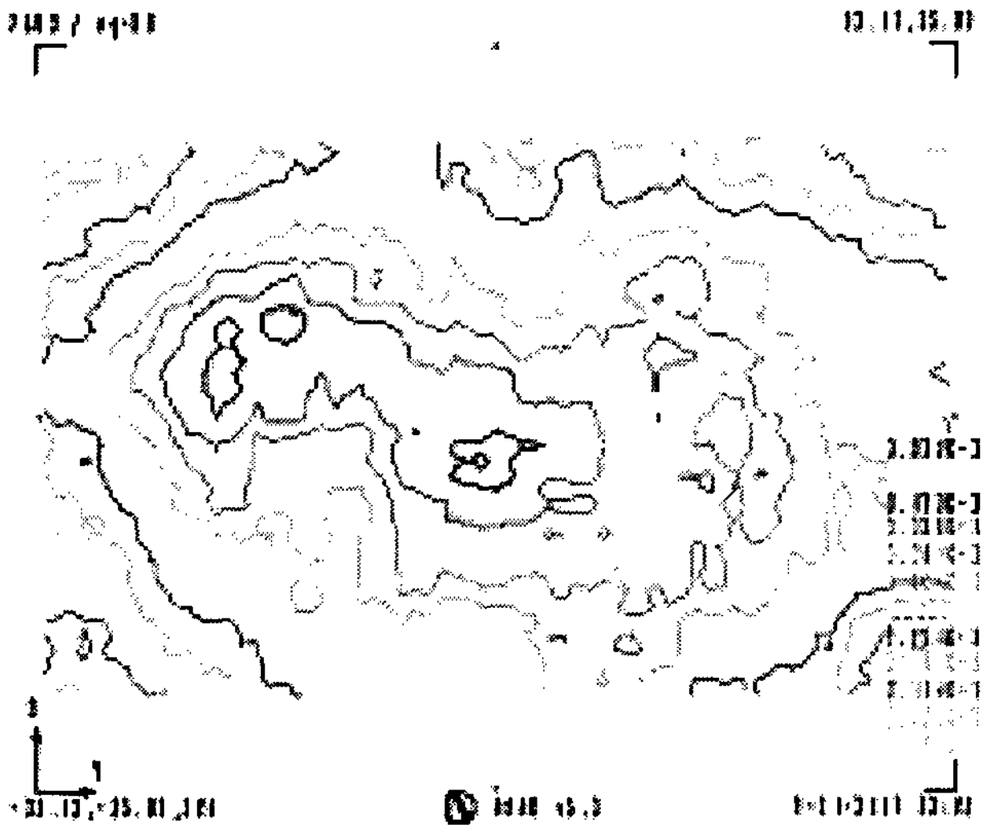
Constraint 3: For the color purity, the vertical deviation angle of R, G and B's rays from their respective chief rays should be smaller than ±7.1 degrees.

The rays from the first focal point of an elliptic reflector converge into the second focal point. But the arc lamp is not a point source, so at the second focal point the bundle of light is formed. Since the optical system can use only a part of the bundle in a certain size under the above constraints, the reflector to converge many rays into a stop size is necessary.

In this paper, to satisfy the above conditions we use an elliptic reflector as a main reflector and a spherical as a subsidiary, and can converge the 1.5 times of light into the stop.



[Fig. 3] Spot diagram on LCD plate using a complex reflection



[Fig. 4] Contour plot on LCD

3. Results

The following results are drawn from the study.

Fig. 1 and Fig.2 show layout of a light source optical system using a complex reflection mirror and layout of optical engine using the conventional lamp. Fig. 3 and Fig. 4 show spot diagram and contour plot of beam intensity on the LCD plate using a complex reflection mirror. Table 1 shows comparative data between the optical system of Sony and LGE.

1) We find a solution and method of design for 1 panel LCD system without color filter.

2) In large size display, we approach a high brightness system for rear LCD projection TV as Table 1.

Also, the development of optical system as listed below are necessary to expand the market of one-panel LCD Projection.

(1) Realization of projection color TV over 40"

(2) Brightness over 200cd/㎡

(3) Life time of system over 10,000 hours.

(Lamp exchange after 5 years when 6 hours/day use)

4. Conclusion

LCD Projection color TV has possibility to display text information more vividly than CRT projection

TV, and because of its small and thin type, it is expected to use in various fields as multimedia display device.

	S Company DATA	Paper DATA
LCD	LCX011AM	LCX011AM
Screen Size	40"	40"
Brightness	70 fL	100 fL
Uniformity	60%	60%
Reflector	Single Reflector	Complex Reflector
Screen Gain	2.5	2.5
Lamp	100W	100W
ARC GAP	1.4 mm	1.3 mm
Life Time	6,000hours	10,000hours
Color (C.I.E)	Rx=0.590 Ry=0.340 Gx=0.340 Gy=0.620 Bx=0.155 By=0.070	Rx=0.610 Ry=0.320 Gx=0.290 Gy=0.640 Bx=0.125 By=0.090

[Table 1] Specification of Sony & LGE

So, the method which is suggested in this paper will contribute to low priced, high bright system, and an expansion of LCD projection color TV market.

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