Illumination System using Two Lamps for the Projector

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Abstract

In this paper, an illumination system design using two lamps was proposed to improve the brightness of the projector. The proposal is based on the results from optical simulation.

The prism array was applied to maintain the same optical properties, such as brightness distribution for the divergence angle and the composed beam size of the system. These were compared to those of the one UHP lamp system. The brightness of the two-lamp system, having a panel size of 0.74" and an f/2.9, increased by a factor of 1.7 when compared to the brightness of one UHP lamp system.

1. Introduction

Most of the front projector users think that the most important factor is brightness, but many of the projectors have insufficient brightness. This is due to the fact that a front projector maker uses a small display device for decreasing the cost of the optical system. For making a bright front projector, the makers use the high power lamp instead of a large panel. But this high power lamp's life time is very short, and the cost of replacing the lamp is increased.

The purpose of this article is suggesting the optical system of a front projector for making a brighter and more affordable front projector. For achieving this purpose, we designed the illumination system, having two lamps, for the front projector.

In the illumination system, the system has almost all the same parts of the one lamp system except for the light source. We also use a prism array for combining the spatial light distribution from each lamp. These prism arrays spatially slice and re-arrange the light distribution, and the light distribution of the two lamps were changed without emitting size and angular distribution change. We simulated the brightness of the two-lamp system, having a micro device size of 0.74" and an f/2.9, and we have found that brightness of our two-lamp system increased 1.7 times compared to a one lamp system.

2. Simulation

In this paper, we simulated the brightness of the two lamp system, having a prism array, for making a brighter illumination system. In general, the spatial light distribution is not uniform. Fig 1 shows the spatial light distribution by one UHP lamp and two UHP lamp. Fig 1(b) is the light distribution of two lamps when placing the lamps parallel to each other.

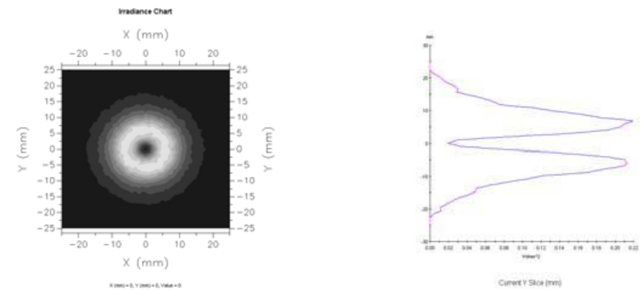

Fig. 1(a). Spatial light distribution of one UHP lamp.

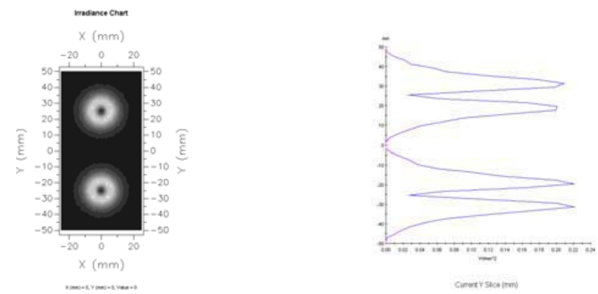

Fig. 1(b). Spatial light distribution of two UHP lamp when placed parallel to each other.

Our basic idea of combining two lamps is slicing and re-arranging the spatial light distribution in order to increase the light flux in an effective area of the light source. Fig 2 shows how to increase the light flux in an effective area of the light source. If the light source distribution is not uniform, we can get more light flux on the center of the sources by slicing and re-arranging the light distribution. If the light source distribution is almost uniform spatially, the light flux is not changed by these methods.

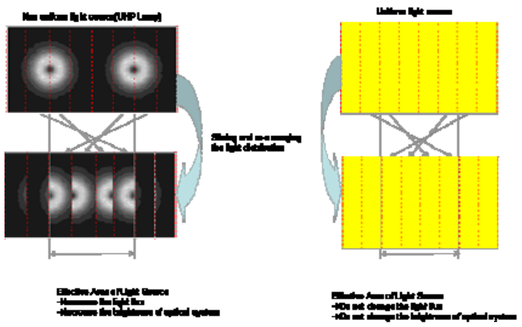

Fig. 2. In case of uniform and non-uniform light source, increase of light flux by the slicing and re-arranging method.

Fortunately, the spatial light distribution of the UHP lamp is not uniform.

In this paper, we use multiple prisms for slicing and changing the position of the light. On a prism, the lights emitted from each UHP lamp incident to the prism surface normally and reflect by total internal reflection. The direction and position of the light emitting from each UHP lamp can be mixed by multiple prisms. Fig 3 (a) and (b) show how to mix the position and direction of light.

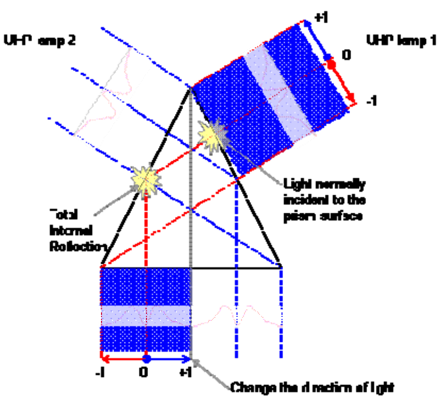

Fig. 3(a). Light distribution is changed spatially by a prism.

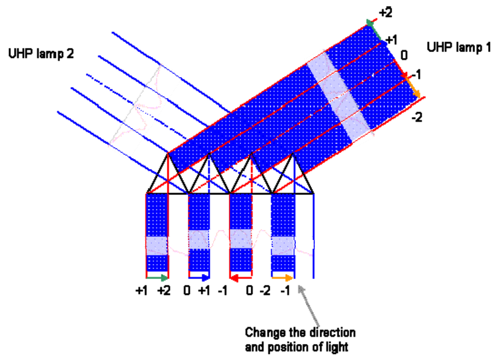

Fig. 3(b). With multiple prisms, spatial light distribution is sliced and re-arranged.

Fig 4 shows the result of the simulated light distribution on the bottom surface of multiple prisms. We can obtain the concentrated light distribution at the center of the prism array.

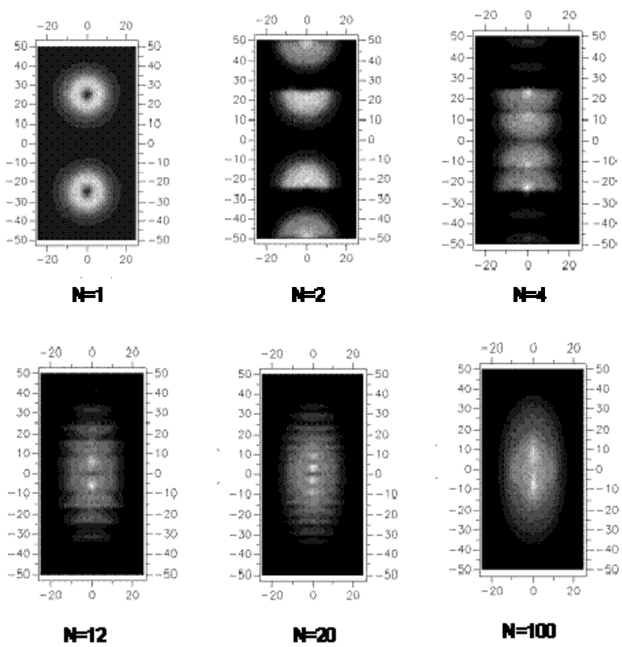

Fig. 4. The simulated result of the light distribution in related to the number of prisms.(N is the number of prisms)

As the number of prism increase, we can see the light distribution is similar to that of the one lamp. We can optimize the light distribution by changing the distance of each lamp and the number of prisms. Fig 5 is the optimized result.

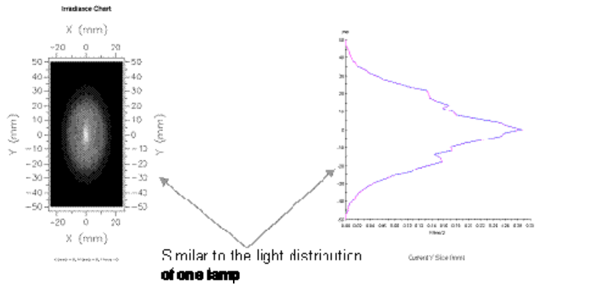

Fig. 5. The light distribution of the optimized result.

3. Results and discussion

We simulated the light flux of the two lamp system, having a 0.74” LCoS imager and illumination F/2.9, in relation to the number of prisms. We were able to get the light flux to increase by a factor of 1.7 when compared to the one UHP lamp system. Fig 6 shows the two lamp system layout and the simulated result.

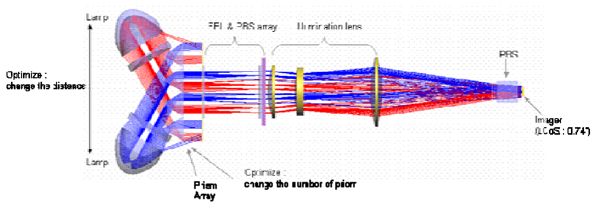

Fig. 6(a). Illumination system layout of the two lamp.

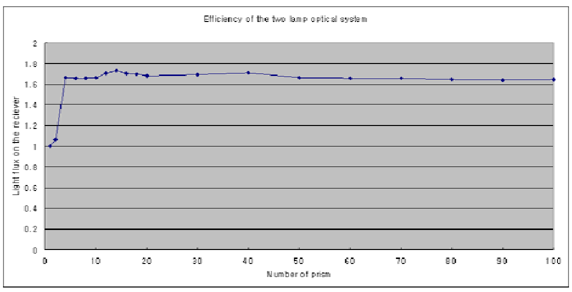

Fig. 6(b). The optical efficiency of the two lamp system compared to the one lamp system.

In this simulated result, if the number of prism is over 4, the light flux increased about 1.7 times compare to the one lamp system.

4. Summary

In the two lamp system, we used multiple prisms for slicing and re-arranging the spatial light distribution. We were able to get the simulated result where the light flux increased about 1.7 times compared to the one UHP lamp system.

5. References

1. Robert W. Boyd, Radiometry and the detection of optical radiation, John Wiley & Sons, p69-93 (1983)