Novel Chromakey Technology with Polarizer and Retardation Film

Yoshiaki Asanoi[1], Muneo Kaneko[2], Kazuya Yoshimura[1], Katsunori Takada[1], Akinori Izaki[1]

[1]Nitto Denko Corporation, 455-6, Hongo, Minogo-cho, Onomichi, Hiroshima, 722-0212, Japan
[2]Kansai Television Co.Ltd, 2-1-7, Ogimachi, Kitaku, Osaka, Japan
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ABSTRACT

We have developed a novel chromakey technology with polarizer and retardation film. A fine greenish color which is required for image composing of chromakey can be produced by optimizing the retardation. It is superior with conventional method at a point that light can be illuminated from the rear, it is easy to change the background color and anti-reflection treatment can be applied on a background polarizer.

1 INTRODUCTION

Chromakey is a visual effect technology for synthesizing two images or video streams together based on color hues. Generally, a greenish cloth is used as a background color. The reason why the greenish color is preferred is that this color is not included in the human body. We have promoted the development of novel chromakey technology using a background polarizer and a filter polarizer with some retardation films.

Novel chromakey technology is superior at three points as follows. Anti-reflection treatment on the surface of the background polarizer improves the appearance of subject. In addition, it is easy to change background color by exchanging to other filter polarizer with different retardation. Furthermore, Illuminated light can be irradiated from the rear of polarizer, therefore it is possible to take a photograph in various situation.

2 PRINCIPLE AND EXPERIMENT

The principle of the novel chromakey system composed of a filter polarizer and a background polarizer is shown in Figure 1. Retardation films are laminated to filter polarizer. The absorption axis of two polarizers are orthogonal to each other. Natural lights which include red, green and blue are transmitted to the background polarizer and are changed to p-wave polarizer. These lights are transmitted to retardation films and green light is changed to s-wave although blue lights are not changed to s-wave. P-waves are absorbed in the filter polarizer. As mentioned above, only green light is transmitted to the filter polarizer, and chromakey synthesis is accomplished by use of these films.

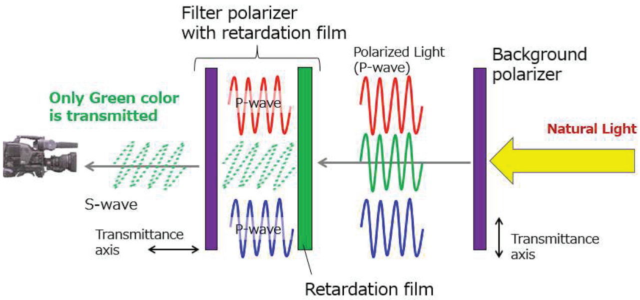

Figure 1. Novel chromakey system with polarizer and retardation film

A fine greenish color which is required for image composing of chromakey can be produced by optimizing the retardation. For the purpose of fixing the best retardation, we tried to simulate a transmitted hue of two polarizers which were orthogonal to each. As shown in Figure 2, some retardation films were arranged between two polarizers. The transmittances in each wavelength (I) were calculated by the following expression.

$$I = \cos 2(\varphi a - \varphi i)\cos 2(\sigma/2) + \cos 2(\varphi a - 2\varphi i + \varphi p)\sin 2(\sigma/2) \quad (1)$$

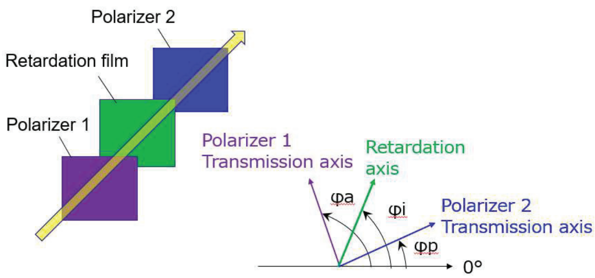

Figure 2. Axis alignment of polarizers and retardation film.

When the transmission axis of two polarizers were arranged to 0 degree and 90 degree, and retardation axis were arranged 45 degree respectively, transmittance (I) was calculated by the following equation.

$$I = \sin 2((ne-no)d*\pi/2) \qquad (2)$$

(ne-no)*d represents the retardation value. Retardation values in each wavelength (R_0) were calculated by the Sellmeier's dispersion formula.

$$R_0 = a + b/\lambda^2 + c/\lambda^4 + d/\lambda^6 \qquad (3)$$

Positive and flat dispersion films were used for the simulation.

3 RESULTS AND DISCUSSION

Transmittance spectrum calculated by optical simulation are shown in figure 3. Based on the transmittance spectrum, hue a* in each retardation values were calculated (Figure 4). It is revealed that a fine greenish color is accomplished by use of approximately 1250nm of positive dispersion film and approximately 1300nm of flat dispersion film. We adopted the five pieces of flat dispersion film which has 270 nm of retardation.

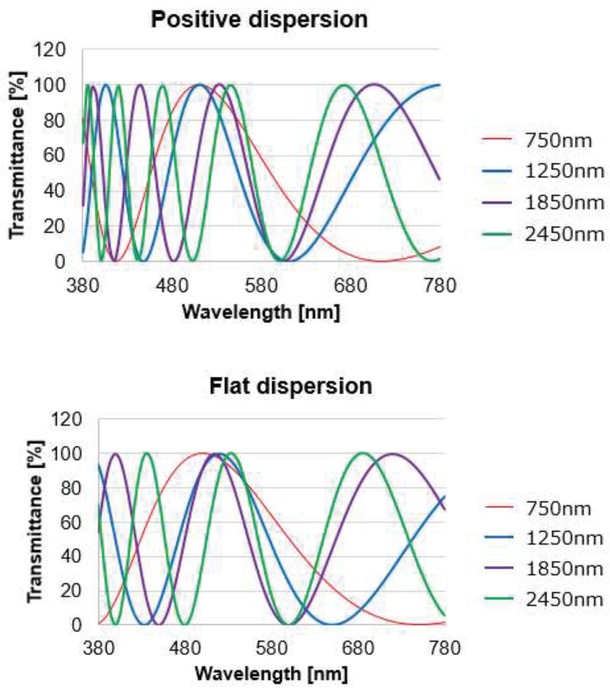

Figure 3. Transmittance spectrum in each retardation calculated by optical simulation

We prepared the background polarizer and filter polarizer with retardation films which were calculated as a best greenish color, and synthesized two movies together. Synthesized image of novel chromakey technology is shown in Figure 5.

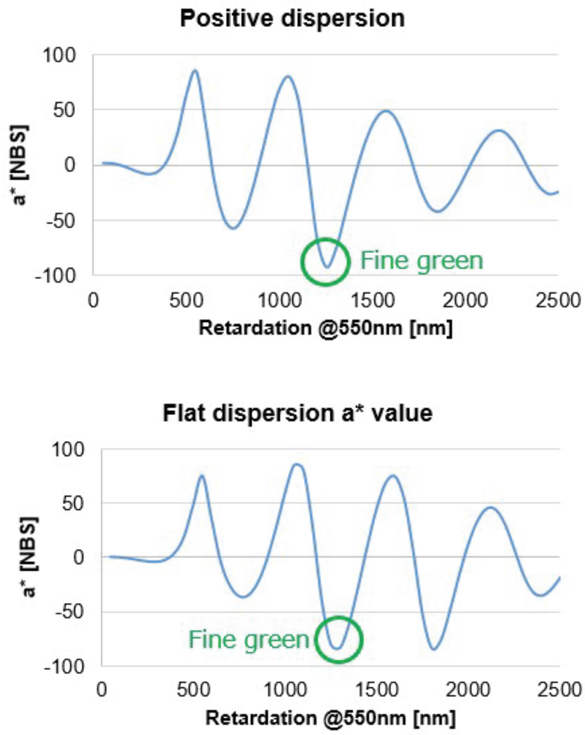

Figure 4. Transmittance hue a* in each retardation

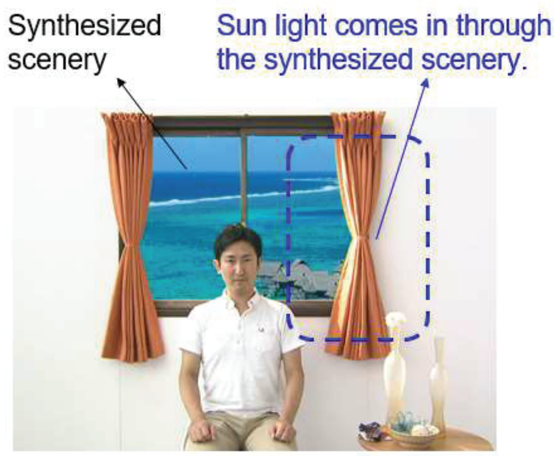

Figure 5. Synthesized image of novel chromakey technology

It is clear that an object and a scenery are synthesized without big issues. The illumination light can be irradiated from the rear of background polarizer because light is transmitted the polarizer. Therefore, we can photograph a scene that sun light comes in through the synthesized scenery by putting a background polarizing on the window.

4 IMPROVEMENT

When the light was illuminated from top of the subject, the reflection light turned into magenta color (Figure 6).

Figure 6. Magenta colored reflected light

The reason why this color change occurred is assumed that the reflecting light includes a lot of s-wave at oblique incidence. Reflectance of polarized light based on Fresnel equation is shown in Figure 7.

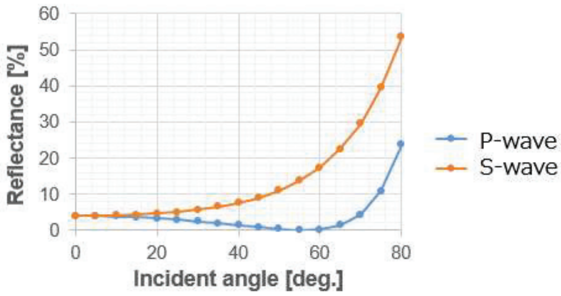

Figure 7. Reflectance based on Fresnel equation

S-wave is rich in the large incident angle region. After having transmitted to retardation films, reflected green light is turned into p-wave, and it is absorbed by the filter polarizer. Because the blue and red lights are pass through the filter polarizer, reflected light turned into magenta color (Figure 8a).

To improve this color change, retardation films are laminated to both background polarizer and filter polarizer (Figure 8b). The light through the both polarizer turns greenish color because these retardations become 1350 nm in total. On the other hand, the reflected light through only the filter polarizer doesn't change the color because the retardation of filter polarizer is designed so that hue a*b* become low (Figure 9).

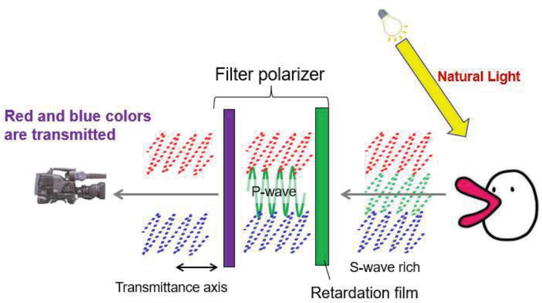

Figure 8a. Mechanism of reflected light turning magenta color

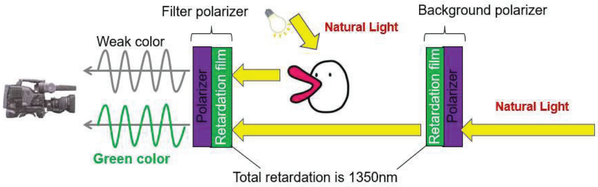

Figure 8b. Improved structure for magenta coloring

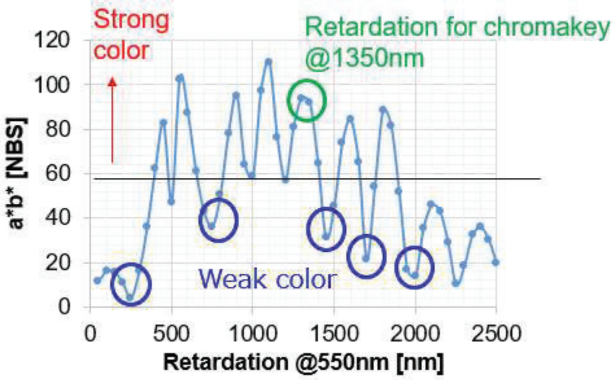

Figure 9. Transmittance hue in each retardation

Thus, the magenta coloring is improved by dividing the retardation into the background and filter polarizer.

5 CONCLUSION

We have developed a novel chromakey technology with polarizer and retardation film. It is superior with conventional method at various points. A fine greenish color which is required for image composing of chromakey can be produced by optimizing the retardation. Magenta coloring of reflected light is improved by the laminating retardation films on both background polarizer and filter polarizer. In this technology, illumination light can be irradiated from the rear of background polarizer. Therefore, we can photograph a scene that sun light comes in through the synthesized scenery by putting a background polarizing on the window. By these advantages, novel chromakey technology has a possibility to synthesize a various situation.

6 REFERENCES

[1] Max Born and Emil Wolf, "Principles of Optics," Tokai University Press, 1974.

[2] Application number: JP2017-248781