A Simulation of Pearl Optical Phenomena for Cosmetic Preproduction

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1 Introduction

In the area of materials development, preproduction using visual simulation has come to be considered essential. In this paper, we propose a simulation of pearl optical phenomena for cosmetic preproduction. Pearls manifest a very specific optical phenomenon caused by their multilayered thin-film structure, and most people have a common sense that pearls have a unique beauty. Therefore, the expected merits of the simulation for cosmetic preproduction are not negligible.

2 Computational Model of A Pearl based on Physics

The co-authors of this research succeeded in achieving a realistic representation of a pearl by means of three principal factors, namely, the interference component, mirroring component, and texture component, using physics-based modeling (called an "illuminant model") [Nagata et al. 1997]. Furthermore, Dobashi et al. indicated the importance of the blurring of light, as a fourth factor, to improve the representation of a delicate appearance, and proposed its computational model and calculation algorithm. In these studies, they succeeded in a generating high-quality perfect sphere pearl CG image which consists of four components: interference of incoherent light, blurring, diffusion and interference of coherent light components. It is, however, necessary to apply the visualizing method to a free-form surface for our purpose.

3 Expansion of Blurring Model

3.1 BRDF simulation using Monte Carlo method

The pearl visual simulation method described in Section 2 utilized the Cook-Torrance reflection model to represent the blurring of a pearl. In this research, we simulate the BRDF of a pearl using the Monte Carlo method for more detailed representation of the blurring. Figure 1(a) shows a simulation result which represents transition of the BRDF by changing the incident angle at intervals of 10 degrees. As shown in Figure 1(a), the asymmetricity shifts left side to right side of the distribution with increase the incident angle, and the BRDF finally has a large peak value from the influence of Fresnel reflection. We measured the BRDF of the underside of a pearl oyster shell as shown in Figure 1(b). Although the pearl shell was not a perfectly flat surface, the measured BRDF indicates a similar tendency of the BRDF simulation. Therefore, it is reasonable to support that the blurring phenomenon is properly simulated by the method.

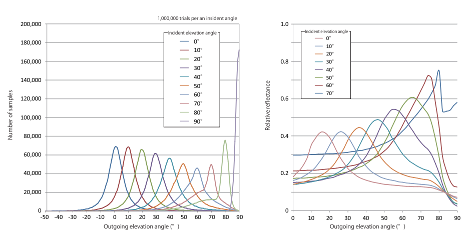

Figure 1: *Simulated BRDF and BRDF of pearl oyster shell.*

3.2 Generation of free-form surface and 3D face model CG Image

We implement the BRDF as look-up table in a plug-in material shader of the 3DCG software MAYA to apply the blurring model to a free-form surface and generate 3D images of the free-form surface and face model applied pearl optical phenomena. Figure 2 shows the synthesized free-form surface image with diffusion, interference of incoherent light, blurring, and interference of the coherent light component images. Figure 3 shows the synthesized 3D face model.

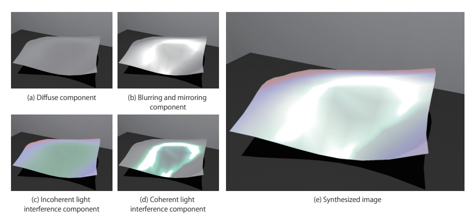

Figure 2: *Synthesized free-form surface with four components.*

Figure 3: *Synthesized face image.*

4 Conclusion

For cosmetic preproduction, we simulated pearl optical phenomena on a free-form surface by expansion of the blurring model, and confirmed that this simulation was successful In the future, we plan to introduce natural fluctuations and irregularities to build a model much closer to the actual phenomena of a pearl.

References

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