Investigation of ambiguity in measuring of skin parameters from spectral reflectance curves

○Kaustav Das, Yuta Kobori, Tomoki Hashisaka, Takehiro Ohya, Tomonori Yuasa, Hideki Funamizu, Yoshihisa Aizu
Muroran Institute of Technology, Muroran, Hokkaido 050-8585, Japan
email: 18096009@mmm.muroran-it.ac.jp

1. Introduction

When light rays fall on the skin, there are two mechanisms can be seen, one is absorption where light energy is being transferred to human skin tissue and the other is scattering which means reflection or transmission. Now by exploring these mechanisms many important characteristics about human skin tissue have been found. Monte Carlo simulation (MCS) [1] takes all of these in account to replicate this process as realistically as possible. In our laboratory, we have developed a technique to estimate human skin parameters from spectral reflectance, but sometimes estimating such parameters as melanin and hemoglobin content becomes difficult due to ambiguity.

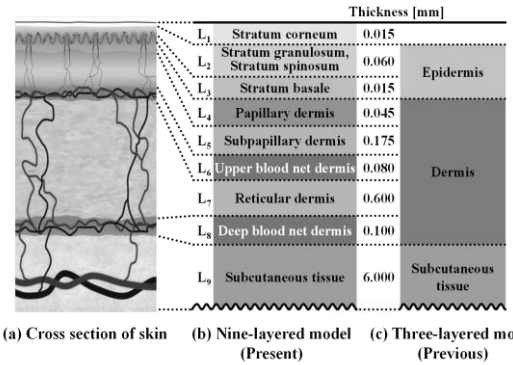

Fig. 1 Schematic structure of skin tissue, nine-layered model, and three-layered model.

2. Nine-layered model and MCS

Human skin has inhomogeneous and complicated structure that can be justified with the Figure 1. As can be seen, it has nine parallel layers [2] with their own different thickness and optical properties. The working of the MCS is being conceptualized by Figure 2. There are five parameters of each layer required to execute the codes; scattering coefficient μ_s, absorption coefficient μ_a, anisotropy parameter g, refractive index n and thickness t.

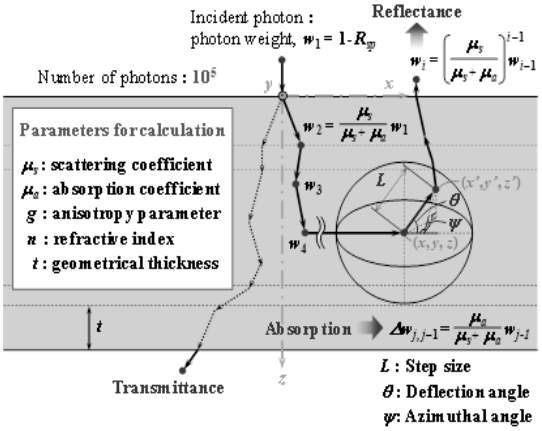

Fig. 2 Light propagation in a multi-layered skin tissue by Monte Carlo simulation.

3. Simulated results with explanation

Skin parameters having different set of values produce spectral reflectance curves of similar kind, but point spread functions (PSF) with some difference, as can be seen in Figs. 3 and 4. A possible way to look forward is to do quantitative analysis by checking the root mean square error (RMSE) and colour difference (ΔE) values of spectral reflectance curves and also by finding the relationship between the full width at half maximum (FWHM) value of those PSFs with respect to the magnification values of μ_a and μ_s of each layer.

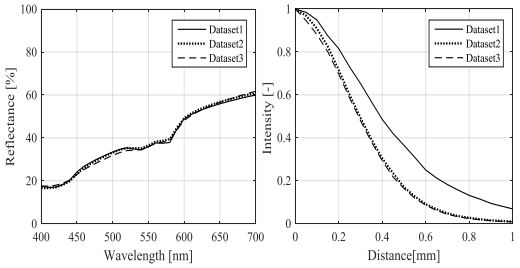

Fig. 3 Similar spectral reflectance curves.

Fig.4 Different point spread functions.

4. Conclusion

The quantitative analysis of PSFs and spectral reflectance curves may help in finding the reason behind the inexactness of estimating internal condition from spectral reflectance. So, furthermore investigation is required to understand this problem.

References

1) L. Wang *et al*., "MCML-Monte Carlo modeling of photon transport in multi-layered tissues", Comput. Methods Programs Biomed. Vol.47 (1995) pp.131-146.
2) T. Maeda *et al*., "Monte Carlo simulation of spectral reflectance using a multilayered skin tissue model," Opt. Rev. Vol.17 (2010) pp.223-229.