Complex Monte Carlo ray tracing simulation in human skin

Youngjin Jeon and Hwi kim.
Department of Electronics and Information Engineering, Korea University, 2511 Sejong-ro Sejong 339-700, Korea
E-mail: hwikim@korea.ac.kr

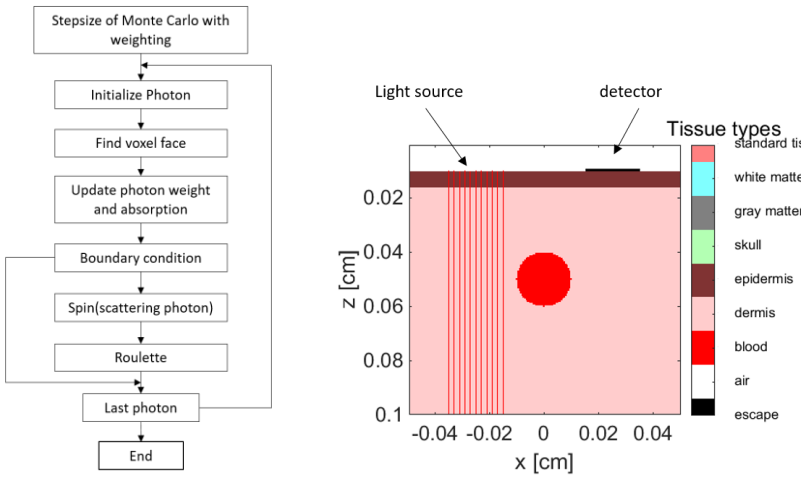
Abstract: With considering smart health care technology as next generation technology, human skin optic field has been actively researched over recent years. In this paper, to analyze human skin, we will introduce complex Monte Carlo ray tracing method based on classical Monte Carlo method and diffractive wave optic theory.

1. Introduction

With advancements in smart health care considered as next generation technology, skin optic field has actively researched over recent years. Therefore, we develop optical simulation tool to analyze and measure human skin and disordered media. This optical simulation tool can predict migration effect of photon from light source based on Monte Carlo method and calculate diffraction optical field from complex field of detector. Generally, Monte Carlo simulation to predict migration effect of photon can calculate just amplitude profile. However, to obtain specific underneath skin data, we need complex field of detector through the skin. In this presentation, therefore, we represent specific skin optic simulation method and complex ray tracing method to predict information of human skin/tissue by using information of complex field of detector.

2. Complex Monte Carlo ray tracing method

Fig.1 (b) is simulation skin model and it is based on Cartesian coordinate. Photon from light source enters the skin/tissue model and migrate. Moving path of photon is decided by Monte Carlo method with absorbance coefficient and scattering coefficient as shown in Fig.1 (a) [1]. Photon transfer in skin until killed by boundary, roulette and detected by detector. When photon is moving in the skin, weight of photon is losing by absorbance and scattering of numerical skin model and absorption of skin is recording on the voxel.



(a) (b)

Figure.1 (a) Schematic of simulation (b) Simulation skin model.

Fig.2 (a) is the result of simulation. Simulation parameters are as in the following. Number of photons is 50000, wave number is 532nm, number of bins are 200*200*200 and size of each bin is 0.00025cm. We can observe absorbance of photons from light source to detector in Fig.2 (a). Left graph in Fig. 2 (b) shows length of photon path from source and right graph shows length of photon path from source to detector.

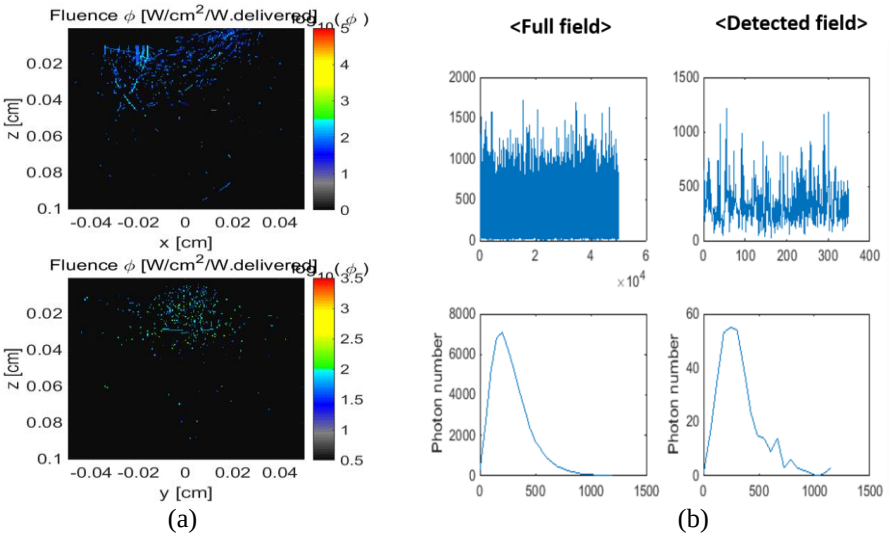


Figure. 2. (a) results of simulation (b) spectrum of photon length.

In the previous simulation step, we can obtain weight of photon on the detector. In other word, only amplitude profile of detector field is calculated by classical Mote Carlo method. To analyze specific underneath skin data, we need complex field of detector. Therefore, we propose complex ray tracing method by using path length of photon. When detector detects photons that passed skin from light source, we can obtain spectrum data of path length of photons. Phase profile can be obtain by $l_D \times (2\pi/\lambda) = \phi_D$. l_D is path length from light source to detector, λ is wave length and ϕ_D is phase of detector field. Combining of amplitude and phase profile of detector, we can get a complex field of detector. After that, to analyze skin state, we can reconstruct diffractive distribution from complex field of detector by using wave optics such as Fourier transform and angular spectrum method.

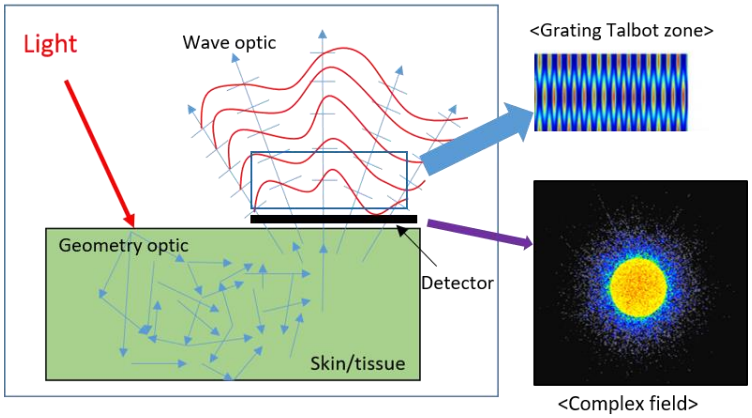


Figure. 3. Schematic of complex Monte Carlo ray tracing simulation

In this paper, we will introduce detail complex Monte Carlo ray tracing simulation method to analyze human skin combining geometry optic and wave optic theories.

3. References

[1] S. A. Prahl, M. Keijzer, S. L. Jacques, A. J. Welch, “A Monte Carlo Model of Light Propagation in Tissue” SPIE Institute Series Vol. IS 5 (1989)

[2]