# Raman Spectroscopic Analysis of Human Skin by Monte Carlo simulation


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## 1. Introduction

Recently, interest in health has greatly increased. so interest in smart healthcare, which combines smart devices with healthcare, has also increased. Smart healthcare refers to the provision of healthcare services for prevention, diagnosis, treatment, and follow-up management at anytime and anywhere by connecting information and communication technology and healthcare. It can be broadly divided into mobile healthcare, IoT(Internet of Things) healthcare, and wearable health care. This field is also part of the 4th industrial revolution. Therefore, the market size is growing greatly and governments and businesses are investing in a variety of research activities. In this paper, we introduce smart healthcare technology that optically analyzes human skin based on Monte Carlo methodology and diffractive optics theory and Raman spectroscopy

## 2. Monte Carlo Algorithm

The following figure is a Monte Carlo simulation algorithm and example result image. [1]

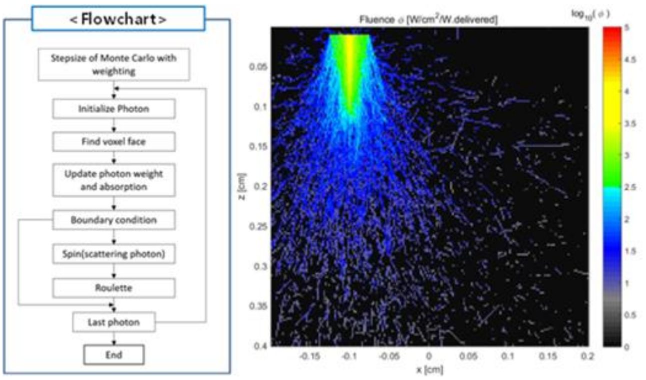


Fig. 1 Monte Carlo simulation (a) Algorithm (b) Simulation result image

The optical parameters of human skin consist $\mu_a$(Absorption coefficient), $\mu_s$(Scattering coefficient), g (Anisotropy factor), n (Refractive index). The Monte Carlo random method by these four parameters predicts the unit stepsize, direction vector and energy of the photon packet. The parameters are completely different depending on the skin layer, and all calculation processes are performed randomly by Monte Carlo method. However, when many enough of photon packets are simulated, they converge to some accurate results. Fig. 1(b) shows the simulation results for 200*200*200 cells, 20um cell size, 100,000 photon packets, and 1000nm wavelengths. When the photon packet is randomly moved by the Monte Carlo method, the amount of energy absorbed by each cell in the photon packet by $\mu_a$ is recorded as an image.

## 3. Raman Spectroscopic Analysis

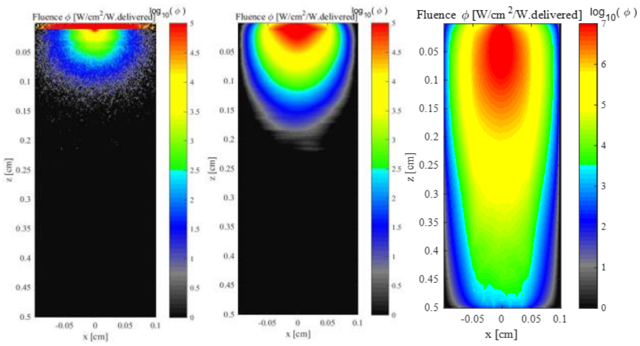

Fig. 2 Raman convolution simulation (a) single point source (b) single layer convolution field (c) full layer convolution result

Fig. 2 is a Raman convolution simulation performed with 840nm wavelength, 400 * 400 * 250 cells, 5um * 5um * 20um cell size, and 100,000 point source photon packets. [2] For the speed of calculation, we simulate single point light source per layer, and then shift it to the xy axis to calculate the convolution. The pathlength and the weight data of the photon packets entering the detector can be obtained. Also, it is possible to obtain data by analyzing the talbot pattern of the detected phase field using the diffractive optics. [3]

## 3. Conclusions

Monte Carlo simulation, Raman spectroscopy, and Talbot pattern analysis suggest to optical analyze the inside of the skin. In the future, we will try to match the experimental data and make accurate simulation.


## Acknowledgements

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## References


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