Monte Carlo Microscopy: a random-walk scanning microscopy for efficient image acquisition

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Compared to conventional uniform illumination microscopy, laser scanning microscopy, in general, takes much longer time for image acquisition, because a beam scans a sample in 2D or even in 3D by pixel by pixel. In this presentation, I will discuss a new scan method that extremely reduces the time of imaging in scanning microscopy. The method is beneficial to the methods that image weakly scattering and sparsely distributed molecules or nano-materials, for example, Raman scattering microscopy, dark-field microscopy, and phase-contrast microscopy. The proposed method of scanning is based on statistics and stochastic process theory [1]. The method mimics the human's behavior of finding unknown places in a large map and animal's hunting their prey from a large area. In the method, starting points of searching are given by a given random distribution (the first layer), and the scanning starts to diffuse the search area based on a given stochastic process (the second layer). The diffusion area of scanning is limited by the entropy of local information of the sample. The method is effective to samples that scatter or emit extremely weak signals from a large scale and require fast image detection. One of the typical examples is Raman scattering microscopy. Figure 1 shows a diagram of the typical walk of laser beam on a sample based on the proposed method. Figure 2 shows Raman scattering images obtained by the Monte Carlo Raman microscope and a conventional laser-scanning Raman microscope. In the presentation, I will show experimental results of a variety of Raman scattering images in a limited exposure time with the proposed method and will discuss the effectiveness of the method compared with the conventional scanning method of laser scanning microscope.

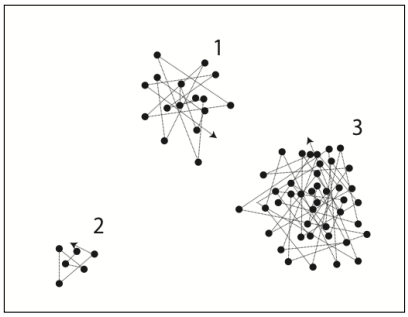

Figure 1: An example trajectory of beam scanning in Monte Carlo microscope

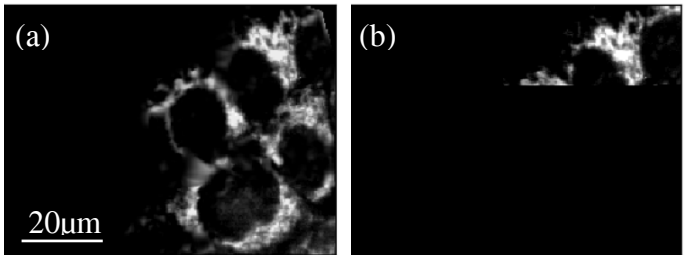

Figure 2: Raman scattering images of HeLa cells at 1590 cm-1 obtained by (a) Monte Carlo microscope, and (b) conventional laser-scanning microscope in a fixed experimental time (150 seconds).

References:
[1] Patent pending.