The modified method based on radial reference point in non-invasive blood glucose sensing by near infrared spectroscopy

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Introduction

The technology of non-invasive blood glucose sensing by NIR is an advancing subject in the field of biomedical engineering. However, it has not proved to be successful up to the present, due to interferences from the physiological background, and the low sensitivity of glucose monitoring. In order to solve the background interference problem the floating-reference method was proposed. This study introduces a spectrum-modified method, based on the radial reference point.

Materials and methods

The variation of blood glucose content, which changes tissue optical properties such as absorption and scattering, can influence the diffusely reflected light. In the actual measurement, the reflected light information includes the influences of both blood glucose and physiological background changes caused by several sources of interference. To by-pass the counteractive effects of absorption and scattering, the spectrum measured in a location where the reflected light intensity is insensitive to the variation of glucose concentration can be used as a reference spectrum. Solving the steady-state diffusion equation for the infinite solution with a single point-source light, the distribution of diffuse reflected light was obtained for different source-detector separations. According to the floating-reference method, the variation of diffuse reflectance at a reference point can be used to calculate the real-time variation of $I_{\Delta\text{Background}}$, which is considered as the internal reference, to counteract noise disturbance. In this study, a Monte Carlo simulation and *in vitro* experiment were combined to evaluate the effectiveness of this method. Solutions of glucose in 10% intralipid were used tissue-simulated media. A laser diode (QDFBLD-1300-20, Qphotonics, LLS, USA), working at wavelength of 1310 nm and power of 20 mW, was used to provide near-infrared light energy. The light was introduced through incident fibres, and

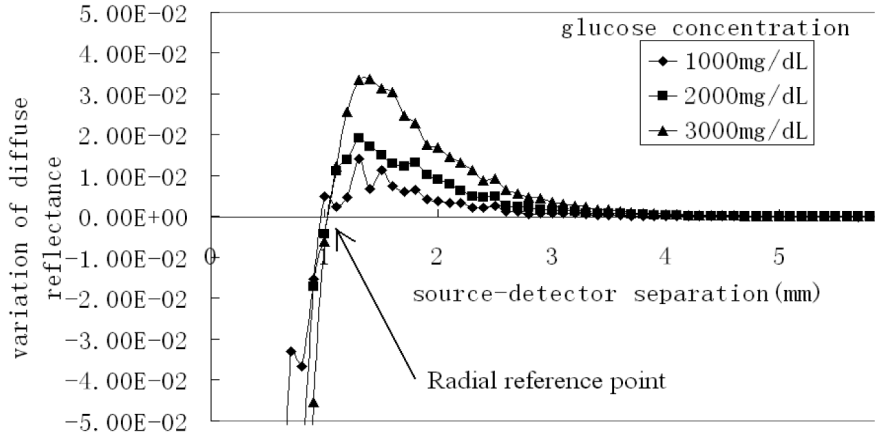

Figure 1. The reference point of glucose in 10% intralipid at 1310 nm (by simulation).

the diffusely reflected light was detected by an InGaAs photodiode (G5853-203, Hamamatsu Photonics K.K, Japan) through collecting fibers.

Results and discussion

The optical probe was designed according to the simulated results obtained by using 10% intralipid at the wavelength of 1310 nm (Figure 1), based on the characteristics of the radial reference point (Figure 2).

The experimental results showed that in the case of single variable linear regression models, both data precision and prediction ability were clearly improved. The values of *RMSEC* and *RMSEP* were reduced by 77.7 % and 59.5 % respectively, by means of the modified method.

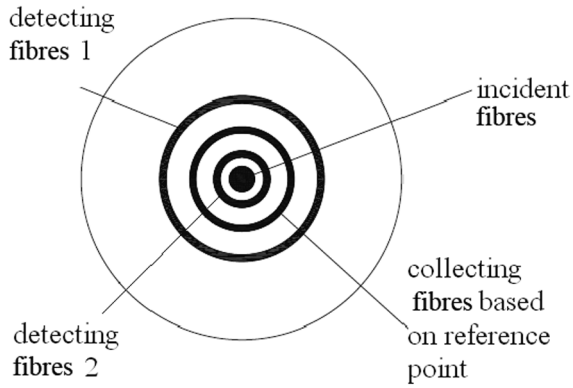

Figure 2. The end face of optical probe using for the in vitro reflectance experiment.