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In vivo imaging of the absorption and scattering properties of exposed rat brain by using multi-spectral diffuse reflectance images

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Determining optical properties of brain tissue is important for application of light in clinical diagnosis, surgery, and therapeutic procedure in brain disorders. Diffuse reflectance spectroscopy (DRS) is one of most promising technique for evaluating cortical hemodynamics [1] and assessment of tissue viability [2]. In this study, we investigate a method to estimate the spectral images of reduced scattering coefficients $\mu_s'(\lambda)$ and the absorption coefficients $\mu_a(\lambda)$ of *in vivo* exposed brain tissues in the range from visible to near-infrared wavelength (500-760 nm) based on DRS using a multi-spectral imaging system.

In the proposed method, the spectral reflectance images of *in vivo* exposed brain are converted into the spectral absorbance images. The Monte Carlo simulation-based multiple regression analysis for the absorbance spectra is then used to specify the absorption and scattering parameters of brain tissue. In this analysis, the concentration of oxygenated hemoglobin C_{hbo} and that of deoxygenated hemoglobin C_{hb} are estimated as the absorption parameters whereas the scattering amplitude a and the scattering power b in the expression of $\mu_s'(\lambda)=a\lambda^{-b}$ as the scattering parameters, respectively. The spectra of $\mu_a(\lambda)$ and $\mu_s'(\lambda)$ are reconstructed from the absorption and scattering parameters, and finally, the spectral images of μ_a and μ_s' are estimated. A white light emitted diode illuminated the cortical surface via a light guide with a ring-shaped illuminator.

The spectral reflectance images of the exposed cortex were acquired at 9 wavelengths (500, 520, 540, 560, 570, 580, 600, 730 and 760 nm) by a 16-bit cooled CCD camera with motorized filter wheel system. The estimated images of absorption coefficients were dominated by the spectral characteristics of hemoglobin [3]. The estimated spectral images of reduced scattering coefficients showed a broad scattering spectrum, exhibiting larger magnitude at shorter wavelengths, corresponding to the typical spectrum of brain tissue published in the literature [4]. Experiments with optical phantoms validated the proposed method. *In vivo* experiments with exposed brain of rats during normoxia, hyperoxia, and anoxia, confirmed the possibility of the method to evaluate both hemodynamics and changes in tissue morphology due to loss of tissue viability.

References

[1] P. B. Jones *et al., J. Biomed. Opt.* **13**, (2008) 044007.
[2] S. Kawauchi *et al., J. Biomed. Opt.* **18**, (2013) 015003.
[3] M. Friebel *et al., J. Biomed. Opt.* **14**, (2009) 034001.
[4] V. Tuchin, *Tissue Optics: Light Scattering Methods and Instruments for Medical Diagnosis*, 2nd ed., SPIE Press, Bellingham, WA (2007).