In-vivo High-resolution High-speed Spectral Domain Optical Coherence Tomography

Cheol Song, MyoungKi Ahn and DaeGab Gweon

School of Mechanical, Aerospace & Systems Engineering
Korea Advanced Institute of Science and Technology (KAIST)
Daejeon, Republic of Korea
E-mail: feloveyou@kaist.ac.kr

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1. Introduction

Optical coherence tomography (OCT) has researched as a promising modality for high-resolution, high-speed measurement of turbid or even non-transparent samples since 1991. This technique is similar to ultrasound imaging, except that it utilized different optical source as near-infrared light. Unlike ultrasound imaging, optical coherence tomography does not need a contact with the tissue directly. In optical coherence tomography, the backscattered or back-reflected lights from different depths of the sample are interfered with known delay light in the reference arm based on the principle of the Michelson interferometer. Spectral domain optical coherence tomography (SD-OCT) has recently focused much interests in biomedical imaging groups, because imaging speed and signal sensitivity are higher than time domain optical coherence tomography (TD-OCT) which needs optical delay scanning through the depth range [1]. The cross-sectional 2D image of SD-OCT can be obtained by analyzing the spectral interference pattern on the detector of the spectrometer.

2. Experiments

SD-OCT was manufactured in the form of microscopy in order to achieve easy measurement. Ensemble average of all axial scan data was subtracted from each axial scan data before Fourier transform to reduce severe DC and autocorrelation noises. The axial scan data acquired on the line CCD were evenly sampled in wavelength domain, thus becomes evenly sampled by linear interpolation and re-sampling in wave-number domain. Also, dispersion mismatch between the sample arm and reference arm was compensated by iterative numerical process to obtain the optimal axial resolution [1]. After dispersion compensation, $5\mu m$ axial resolution near optical path difference $250\mu m$ in air was obtained. The 2D image data were acquired at a rate of 30 frames per second (2048 x 512 pixels/frame, camera exposure time 65 $\mu \sec$) by high-speed frame grabber with camera link type. The signal to noise ratio (SNR) was evaluated by about 51.2 dB near a depth of $250\mu m$; the peak signal was dropped by 23.7 dB over optical path difference of 2.45 mm. *In-vivo* images of human fingerprint skin and nail were measured with high-speed. *Ex-vivo* image of mouse eye was also measured by proposed system. 3D visualization of mouse eye was reconstructed by commercial software.

References

[1] Maciej Wojtkowski, Vivek J. Srinivasan, Tony H.Ko, et al., "Ultrahigh-resolution, high-speed, Fourier domain optical coherence tomography and methods for dispersion compensation", *Optics Express*, Vol. 12, No.11, 2404-2422 (2004)