In vivo dynamic optical coherence tomography with hardware- and software-based motion correction methods

○Yu Guo[1], Rion Morishita[1], Ibrahim Abd El-Sadek[1,2], Pradipta Mukherjee[1], Yiqiang Zhu[1], and Yoshiaki Yasuno[1]

Computational Optics Group, Univ. of Tsukuba[1], Faculty of Science, Damietta Univ.[2]

E-mail: yu.guo@cog-labs.org

1. Introduction:

Optical coherence tomography (OCT) is a non-invasive imaging modality that can provide three-dimensional (3D), high resolution, and few mm depth imaging of biological tissues. Recently, dynamic optical coherence tomography (D-OCT) has been developed to visualize and quantitatively assess the intracellular motility by statically analyzing the temporal characteristics of a-few-second sequentially captured OCT frames at the same location in the tissue [1]. However, *in vivo* D-OCT imaging is challenging due to the involuntary motions, which cause motion artifacts in D-OCT images.

In this study, we demonstrated in vivo D-OCT by employing hardware and software methods for motion correction. Using the proposed approach, *in vivo* D-OCT imaging of human skin was successfully obtained.

2. Method:

In *in vivo* sample measurement, we implemented two methods to capture a motion-suppressed D-OCT data. First is a fixation spacer to reduce involuntary motion during measurement. The fixation spacer is shown in Fig. 1 and was designed by us and printed by 3-D printer to press the sample. Second is a software-based motion correction to remove bulk motions from acquired data before D-OCT computation. The bulk motion correction algorithm registers the time sequential frames measured at the same location, then detects and corrects the bulk motion among frames along the depth- and slow-scan-direction [2].

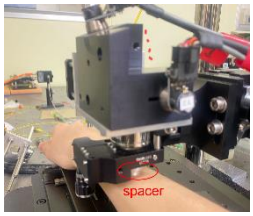

Figure 1: The photo of the fixation spacer

We measured skin of human outer forearm for *in vivo* D-OCT imaging. As D-OCT contrast, logarithmic intensity variance (LIV) was used to visualize the tissue dynamics. LIV is defined as time variance of the time sequential logarithmic OCT intensity signals [3].

To calculate the LIV, we applied the 3D dynamic scanning protocol [1] using a polarization-sensitive Jones matrix swept-source OCT system. The 3 × 3 mm2 scanning area was divided into 8 blocks and each block consist of 16 locations. Each block is imaged by a rapid raster scanning pattern and it is repeated 32 times in 6.55 s. So, 32 frames were obtained at each location with a frame repeating time of 204.8 s. The OCT volume was measured in 52.4 s.

3. Result

Figure 2 shows the LIV images of the *in vivo* human outer forearm skin. Overall, a significant reduction of the LIV signal in the entire field of view (FOV) after using the fixation spacer [Fig.2 (b)] and several vessels-like structures with high LIV were clearly observed. We believe that the high LIV signals without the spacer [Fig. 2 (a)] are a motion artifact and it is suppressed after the fixation. After applying motion correction, a better LIV image with a reduction of high LIV artifacts was observed [Fig. 2 (d)] (See the zoomed up images at the insets).

The 30 × 30-pixels area [squares, Fig. 2] below the skin surface was selected as the region of interests (ROIs). The mean LIV of the ROIs in Fig. 1(a-d) were 15.04, 5.55, 10.91, 4.98, respectively.

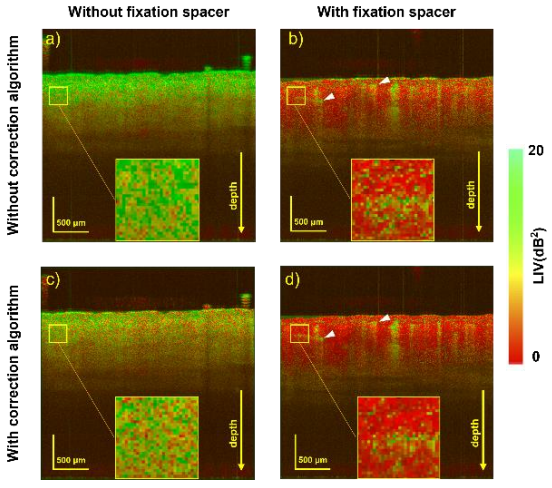

Figure 2 : B-scan LIV image of outer forearm skin. FOV is 3 × 3 mm^2.

4. Summary and conclusion:

We proposed *in vivo* D-OCT imaging of human skin using a combination of hardware- and software-based motion correction methods. A significant improvement of the D-OCT contrast was obtained and serval vessel-like structures [triangles, Fig. 2 (b), (d)], which were muddled in high LIV artifacts without using our methods, has been clearly visualized. The results indicate that our proposed methods are promising methods for *in vivo* D-OCT imaging.

References:

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