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METHOD FOR REAL TIME COLOUR DOPPLER OPTICAL COHERENCE TOMOGRAPHY

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Colour Doppler optical coherence tomography (CDOT) has recently shown great promise in two-dimensional, high-spatial-resolution (15 to 20 microns) tomographic velocity mapping of blood in living tissues. CDOT is based on optical interference in a scattering medium with a wide bandwidth. When a scattering object is in motion, it generates a signal in the detector channel, interfering with the envelope of light, which gives the spatial coherency. The Doppler frequency is proportional to the square of the object's velocity and the square of the reference arm speed. Conventional, phase-sensitive processing of the interferometric signal is performed, requiring a large amount of computation. This phase-sensitive operation of CDOT is necessary to produce multispectral false images in vivo. However, a unique feature of the conventional approach concerns the bandwidth of the Doppler encoding. The high dynamic range of a channel (1000:1) for high dynamic range (100:1), the channel bandwidth should be as narrow as the available system permits. However, this leads to narrow and sensitive flows, and the flow profile of the object's velocity is obtained. The signal of the object's velocity is obtained, and the channel bandwidth must be increased.

In this paper, we present a novel detection scheme, based on an electronic phase-lock loop (PLL), that circumvents these problems. The key property of the PLL is its ability to obtain phase-locked PLL, phase-locked to the interferometric signal over a wide range of spatial and temporal variations. Importantly, our PLL design is real-time both the interferometric frequency (velocity) and the turbulent nature of the observed flows. Moreover, the PLL detects the reference signal at the interferometric frequency (velocity), and through frequency doubling, selects an optimal narrow channel bandwidth.

Furthermore, for a given sample period, only the signal of the object's velocity is obtained. The key property of the PLL is its ability to obtain phase-locking PLL, phase-locking to the interferometric signal over a wide range of spatial and temporal variations. Importantly, our PLL design is real-time both the interferometric frequency (velocity) and the turbulent nature of the observed flows. Moreover, the PLL detects the reference signal at the interferometric frequency (velocity), and through frequency doubling, selects an optimal narrow channel bandwidth.

To test our detection scheme, we implemented a CDOT system in both optical and ultrasound. Using this system, we performed a cross-sectional imaging of blood flow using a fiber laser, and a wide-angle wide-field detection technique. This technique exhibits high dynamic range, 10 dB, in the presence of large vessel diameter. Figure 1 shows the velocity profile across the artery's vessel (solid line, with the point measured). Figure 1 shows the velocity profile across the artery's vessel (solid line, with the point measured). The point is in a region of shear stress, which is optimal for blood flow studies.

The application of a PLL detection technique to CDOT provides the best prospects to date for real-time, in vivo tomographic imaging of blood flow velocity and, simultaneously, tissue morphology in the absence of motion artefacts.


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