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Coherence Domain Optical Methods and Optical Coherence Tomography in Biomedicine XII

**Joseph A. Izatt
James G. Fujimoto
Valery V. Tuchin**
Editors

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Introduction

These proceedings are from the Coherence Domain Optical Methods and Optical Coherence Tomography in Biomedicine XII Conference, held January 21–23, 2008 at the SPIE Photonics West Symposium in San Jose, California. This year's conference featured 111 oral and poster presentations from leading national and international research groups.

The conference was organized into several sessions including: Fourier Domain OCT: New Technology; Fourier Domain Swept Source OCT; Fourier-Domain OCT: Image Enhancement; Full-Field, Phase, and Extended Focus Imaging; Doppler and Polarization-Sensitive OCT; Novel Techniques; Novel Contrast Mechanisms; OCT Signal and Image Processing; Catheter/Endoscopic OCT; Ophthalmic/Dental OCT; Retinal Functional Imaging; *In Vivo* Imaging Applications; and a poster session with 32 presentations. As usual, a predominant fraction of the papers focused on optical coherence tomography – basic research, instrumentation, and applications.

This year, there were significant advances in Fourier Domain OCT Imaging (three sessions, New Technology, Swept Source OCT, and Image Enhancement, with 20 oral and six poster presentations) with discussion of 60 MHz A-line rate ultra-high speed FD OCT, multi-channel system with superior lateral resolution, K-space linear Fourier domain and programmable high-speed (~1MHz) Vernier mode-locked frequency-swept lasers, single-mode 140 nm swept light source realized by using SSG-DBR lasers, as well as techniques for full-range complex spectral domain OCT.

Extended focus Fourier domain optical coherence microscopy and fluorescence lifetime imaging, dispersion free low coherence interferometry, depth-encoded spectral domain phase microscopy for simultaneous multi-site nanoscale displacement measurements, real-time high-resolution optical coherence microscopy with binary-phase spatial filters, single-shot full-field OCT based on four quadrature phase-stepped interferometer, and dynamic focusing OCT with radial gratings for *in vivo* high-resolution imaging were presented and discussed in six papers in the session on Full-Field, Phase, and Extended Focus Imaging.

Six oral presentations in the session on Doppler and Polarization-Sensitive OCT reported advanced technologies for *in vivo* quantification of volumetric cerebrovascular blood perfusion in mice through intact skin by optical microangiography, for enhanced performance in phase-resolved Doppler OCT, for flow velocity analysis and calibration. New approaches in polarization-sensitive OCT, such as polarization-sensitive swept-source OCT with continuous polarization modulation, were also discussed in this and the poster session.

The session on Novel Techniques contained six oral papers and was devoted to further development of OCT components and whole systems, such as a miniature OCT system based on silicon photonics, Fourier domain low coherence transillumination computed tomography, OCT systems based on unique source providing several spectral wavebands, superconducting single-photon detectors, and hybrid interferometer.

The Novel Contrast Mechanisms session contained eight oral presentations and discussed OCT imaging of distribution of magnetic nanoparticles, pump-probe OCT for hemoglobin imaging at 830 nm, measurement of the hemoglobin oxygen saturation and microvascular oximetry, thermoelastic optical Doppler tomography of tissues, quantifying permeability of glucose in skin *in vivo*, motility contrast imaging of tumor response to anti-mitotic cancer drugs, and usage of gold nanoshells for increasing contrast and functional information in OCT imaging.

Various OCT processing modalities were discussed in eight papers in the session on OCT Signal and Image Processing, including clustering of spectroscopic OCT images for contrast enhancement, segmentation, and diagnosis, automated calculation of fiber orientation from 3-D cardiac OCT volumes, alignment of intravascular OCT movies affected by non-uniform rotation distortion, denoising of OCT images, real-time signal processing using field programmable gate arrays, speckle size quantification, a comparison of OCT versus x-ray micro CT, and defining of Gouy phase shift in FD OCT.

The Catheter/Endoscopic OCT session contained six papers and discussed recent achievements in *in vivo* OCT endomicroscopy, 3-D comprehensive microscopy and design of balloon catheter optics for OCT imaging of the human esophagus, catheter-based high-speed polarization sensitive frequency domain imaging, design of imaging fiber bundles for Fizeau based OCT, and subsurface and Doppler spectrally encoded endoscopy.

Three sessions, Ophthalmic/Dental OCT, Retinal Functional Imaging, and *In Vivo* Imaging Applications, with 18 papers were devoted to biomedical studies using various OCT technologies. These studies included *in vivo* high-speed OCT and motion corrected simultaneous SLO/OCT imaging of the human retina, keratometry and cornea topography, segmentation of the retinal pigment epithelium by PS OCT, modeling of light scattering from retinal photoreceptors and their *in vivo* optical probing. A few papers presented advanced researches of human retinal blood flow. One paper described non-invasive optical detection of functionally stimulated neural activity in the limulus compound eye. Two papers were devoted to embryonic developmental imaging, including a high-throughput longitudinal imaging of the embryonic heart. One paper has shown an *in vivo* imaging and vibration measurement of guinea pig cochlea. Real-time OCT for the intraoperative microscopic assessment of surgical margins in breast cancer and successful monitoring of the evolution of oral cancerous tissue were

also demonstrated. Dynamic analysis of eccrine sweat glands of human fingertips was also presented in this session.

The poster session contained 32 papers on the major above-mentioned topics.

A short course for engineers, scientists, and clinicians, SC312 - Principles and Applications of Optical Coherence Tomography by James Fujimoto, accompanied the conference.

All submissions were fully peer reviewed. Authors were requested to submit a three-page summary of their paper. The program committee evaluated the submissions for technical content and assigned a numerical score to each paper. The selection of the papers as oral presentations, posters, or non-acceptance was based upon the program committee score. Although this process was time consuming, we felt that it was important for the conference. Many participants felt that the technical quality and novelty of the papers had increased as the result of peer review. The peer review also provided a fairer assessment of the submitted papers. We have had very positive feedback and a record number of submissions and attendees (see photo) this year.

The conference chairs would like to thank the members of the technical program committee for their help in organizing the conference. We sincerely appreciate the support of SPIE and the conference staff. Finally, we would like to thank all of the conference attendees and manuscript authors for their contributions and participation that helped to make this meeting a success.

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