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Introduction

This proceedings volume is from the conference, Dynamics and Fluctuations in Biomedical Photonics XV, held Sunday through Monday, 28–29 January 2018, at the SPIE Photonics West Symposium in San Francisco, California, (United States). It was a two-day meeting featuring one keynote, nine invited presentations, 22 oral presentations, and 31 poster presentations from leading international research groups. The goal of the conference was to gather essentially different groups of researchers such as biophysicists, medical doctors, physicians, and optical and laser engineers, together with students to discuss the current state of the art and to facilitate future progress in the development of biomedical optical and laser technologies based on dynamics and fluctuations approaches. The laser-speckle, speckle-based coherence imaging, microcirculation analysis and angiography using OCT and other optical techniques, dynamics of molecular diffusion, including nanoparticles, and tissue optical clearing in context of their application to biomedical science and clinics are always included in this annual meeting. These approaches should be useful for diagnosis and therapy of devastating life-threatening diseases such as those of the heart, cancer, vascular, mental illness, and many others that manifest as a breach of the living organism's immune systems at the level of molecule, cell, organ, or organism as a whole. We hope that the proceedings of this conference will contribute to the development of such interdisciplinary fields of science and applications as dynamics and structures of living systems, biomedical optics and laser medicine, and that it will be useful to researchers, medical doctors, engineers, and students.

Several biophotonics techniques including Optical Coherence Tomography (OCT) and Photoacoustic Imaging (PAI) are rapidly impacting research, discovery, and clinical applications. The rapid development of functional extensions to these techniques is perhaps nowhere better illustrated than in angiography. Following a keynote lecture by one of the leaders of this field, we discussed what can, and should, be done by our community to provide and promote the necessary tools. Malfunction of blood flow is associated with diseases including diabetes, cancer, psoriasis, neurodegeneration and many others. Biophotonics is well placed to fill this need and many of our colleagues have already demonstrated techniques for this purpose. These include: Optical Coherence Tomography Angiography (OCTA), Intra-vital Microscopy, Photoacoustics and Multiphoton Microscopy. The panel discussion reviewed the state of the art and discussed what can and should be done by our community to provide the necessary tools to advance discovery, diagnosis, and therapy.

The panel discussion followed several related talks in the Dynamics and Fluctuations conference, including a wonderful keynote lecture by Prof. Ruikang Wang, University of Washington, (United States) on "Optical coherence tomography based angiography: principles and applications." Prof. Wang described the rapid advances of OCTA in ophthalmology, neuroscience,

dermatology and the oral cavity. He provided an overview of the principles behind several of the OCTA techniques. Prof. Gereon Hüttmann and others had an interesting debate about the pulse wave velocity (PWV) in the retinal vessels. This is an indication of the stiffness of the vessels with correlation to several diseases. Until a recent paper by Prof. Hüttmann's group, there had been some uncertainty and even controversy surrounding the typical PWV ranging from sub mm/s to 600 mm/s. It appears the real typical PWV is of the order of 50 mm/s. Bernard Choi emphasized the need for monitoring equipment that was informative, affordable, and unobtrusive in the clinic, and laser speckle techniques have advantages in these areas. Peter H. Tomlins, Queen Mary University of London (United Kingdom), outlined the use of high speed, 4D micro-angiography to aid discovery and diagnosis in traumatic brain injury and related diseases. He also discussed the need for a compact low-cost OCT system for periodontal investigations. Rainer Leitgeb, Medizinische Universität Wien (Austria), brought up the importance of high-speed imaging to support large field of view angiography as well as to support high resolution. The combination with adaptive optics allows for unprecedented vascular details and suppression of shadow artifacts. He also demonstrated the combination with photoacoustics to obtain a complete picture of tissue perfusion starting from superficial capillaries down to larger vessel networks over several millimeters in depth.

Perhaps the most exciting images and videos were those developed in Irina V. Larina's, Baylor College of Medicine (United States) lab, showing the extraordinarily rapid development of the mammalian fetus, which in 9.5 days post-coitus has a fully formed beating heart with four chambers. These details were described by Kirill V. Larin, University of Houston (United States), whose group obtained and rendered the images and videos obtained from the mammalian mouse model in Prof. Larina's lab at Baylor College of Medicine. Several challenges were overcome for longitudinal monitoring of the fetuses and to obtain clear images, such as cardiac gating so that the heart would be in a similar position for several scans. Not only is the blood flow visible, but the typically hyperbolic velocity profile can also be seen using OCTA. The model provides a much needed resource to study diseases and disorders of early developmental origin. Many of the details of mammalian development can be studied, including the blood supply to the crystalline lens of the eye, which is only present during development, defects in limb or heart development, development and remodeling of yolk sac and embryonic brain vasculature etc. The ability of speckle variance OCT to monitor fetal brain vasculature was shown as equal to that of Doppler OCT for vessels horizontal to the beam and superior when the vessels approached the axial direction. In a further demonstration of the power of this technique and model, Prof. Larin revealed that alcohol exposure caused the arteries to constrict and reduced fetal brain flow by approximately 50%. In addition to the selected panel of experts, others contributed their opinions, insights and questions to make this a lively and informative discussion.

Most of the conference sessions featured invited presentations. These presentations drew significant attention from the audience and resulted in wide

coffee break discussions. They provided a nice overview of recent advances in multiple fields of biomedical optics and biophotonics related to dynamic and fluctuation research. The oral sessions and corresponding poster session featured many presentations that described different methods and techniques developed and applied to study complex problems of dynamics and fluctuations in biological systems on the scale ranging from cell to the whole body. The reader is encouraged to browse the table of contents for this issue to learn the full scope of the conference.

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 conference staff. Finally, we would like to thank all of the conference attendees and manuscript authors for their contributions and participation, especially invited and keynote speakers, and panelists who helped to make this meeting a success.

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Kirill V. Larin
Martin J. Leahy
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