Photoacoustic Tomography: Omniscale Imaging from Organelles to Patients by Ultrasonically Beating Optical Diffusion

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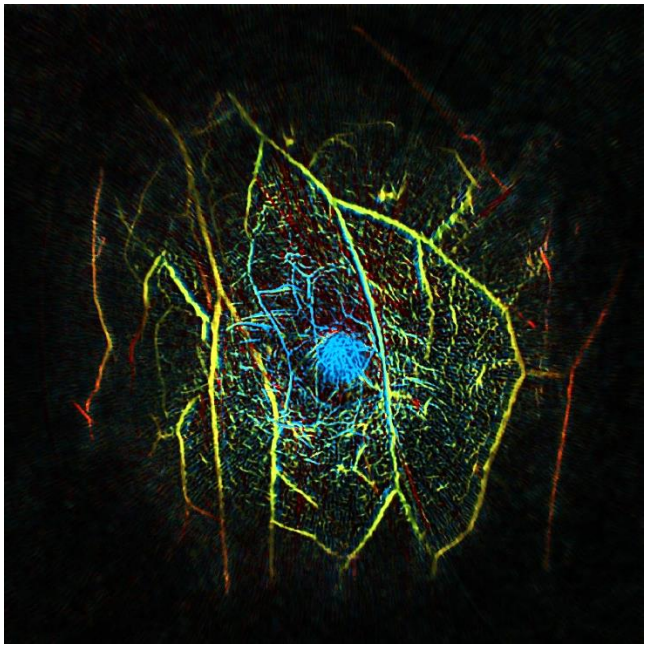
Photoacoustic tomography (PAT) has been developed for in vivo functional, metabolic, molecular, and histologic imaging by physically combining optical and ultrasonic waves. Broad applications include early-cancer detection and brain imaging. High-resolution pure optical imaging—such as confocal microscopy, two-photon microscopy, and optical coherence tomography—is limited to superficial imaging within the optical diffusion limit (~1 mm in the skin) in scattering tissue. By synergistically combining optical contrast of molecules and ultrasonic transparency of tissue, PAT in the form of either photoacoustic computed tomography or photoacoustic microscopy provides deep penetration with high contrast and high resolution. PAT is the only modality capable of imaging across the length scales of organelles, cells, tissues, and organs (or small-animal organisms) with consistent contrast. The annual conference on PAT has become the largest in SPIE's 20,000-attendee Photonics West since 2010. Also, wavefront engineering and compressed ultrafast photography (world's fastest camera) will be touched upon.

Selected publications

1. Nature Biotechnology 21, 803 (2003).
2. PRL 92, 033902 (2004).
3. PRL 96, 163902 (2006).
4. Nature Biotechnology 24, 848 (2006).
5. Nature Protocols 2, 797 (2007).
6. PRL 99, 184501 (2007).
7. Nature Photonics 3, 503 (2009).
8. Nature Materials 8, 935 (2009).
9. Nature Photonics 5, 154 (2011).
10. Nature Materials 10, 324 (2011).
11. Science 335, 1458 (2012).
12. Nature Medicine 18, 1297 (2012).
13. PNAS 110, 5759 (2013).
14. PRL 111, 204301 (2013).
15. PNAS 111, 21 (2014).
16. PRL 112, 014302 (2014).
17. PRL 113, 174301 (2014).
18. Nature 516, 74 (2014).
19. Nature Photonics 8, 931 (2014).
20. Nature Photonics 9, 126 (2015).
21. Nature Communications 6, 5904 (2015).
22. Nature Methods 12, 407 (2015).
23. Nature Methods 13, 67 (2016).
24. Nature Methods 13, 627 (2016).
25. Science Advances 3, e1601814 (2017).
26. Nature Biomedical Engineering 1, 0071 (2017).
27. Science Advances 3, e1602168 (2017).



In vivo photoacoustic image of a human breast.