What Life Scientists Should Know About Molecular Imaging

Optical Imaging, Ultrasound, Photoacoustics

Photoacoustic Imaging
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Learning Objectives:

- Understand the fundamental principles of photoacoustic imaging
- Knowing major components of photoacoustic imaging system
- Knowing how photoacoustic images are from and how to interpret photoacoustic images
- Understand how imaging contrast agents assist contrast and penetration depth in photoacoustic imaging
- Understand the ability of photoacoustic imaging system to visualize anatomical, functional and molecular properties of imaged tissue
- Identify the role of photoacoustic imaging in basic science and clinical applications

Photoacoustic (also known as optoacoustic and, more generally, thermoacoustic) imaging or tomography – a nonionizing, non-invasive. real-time imaging technique capable of visualizing optical absorption properties of tissue at reasonable depth and high spatial resolution, is a rapidly emerging biomedical and clinical imaging modality. Photo acoustic imaging is regarded for its ability to provide in-vivo morphological and functional information about the tissue. With the recent advent of targeted contrast agents, photoacoustics is capable of in-vivo molecular imaging, thus facilitating further molecular and cellular characterization of tissue.

This presentation is designed to provide both a broad overview and a comprehensive understanding of photoacoustic imaging, sensing, and spectroscopy. With a brief historical introduction, we will examine the foundations of photo acoustics, including discussion of governing equations. We will also review relevant optical/acoustic properties of the tissues and the related topics of laser-tissue interaction. The experimental aspects of photoacoustic imaging will then be discussed with emphasis on instrumentation, i.e., system hardware and signal/image processing algorithms. Specifically, penetration depth and spatial/temporal resolution of photoacoustic imaging will be analyzed in relationship to a laser source, an ultrasound transducer and other components of the photoacoustic imaging system. Integration of photoacoustic and ultrasound imaging systems will be discussed. Techniques to increase contrast and to differentiate various tissues in photoacoustic imaging will be presented including image reconstruction algorithms. Furthermore, design, synthesis and optimization of imaging contrast nanoagents to enable molecular/cellular photoacoustic imaging will be presented. Special emphasis will be placed on contrast agents capable of multiplexed imaging, multi-modal imaging and image-guided therapy including drug delivery and release. The presentation will continue with an overview of several commercially available and experimental systems capable of photoacoustic imaging. Regulatory aspects of photoacoustic imaging systems and imaging contrast agents will be presented. Finally, current and potential biomedical and clinical applications of photoacoustics will be discussed.