Deep-tissue, High-resolution Imaging for Intact Biological Organisms
Technology #17590

Applications

This combined hyperspectral and NIR-II imaging platform provides cellular-level detection of deep-tissue biological features in vivo. This allows for the detection of small numbers of cells at early stages of disease, rendering the system applicable for early diagnostics (e.g., of cancers or infectious disease), leading to better patient response to therapy and increased chances of remission. The system is also capable as a real-time surgical assistance tool that can minimize residual disease, thus improving patient prognosis and long-term survival rates. Patient response to therapy can be monitored at the cellular level. Furthermore, the system provides the capability to phenotype cancers with increased sensitivity, promoting the creation of personalized treatment plans to maximize efficiency.

Problem Addressed

Imaging is a critical component of clinical care, with applications that include screening, diagnosis, therapy-planning, and monitoring of treatment. The limits of detection of most common imaging modalities (e.g., X-ray, magnetic resonance imaging (MRI), positron emission tomography (PET), and computer tomography (CT)) prevent the visualization of deep-tissue structures at the cellular level with sufficient sensitivity and resolution. Fluorescence microscopy techniques enable high-resolution imaging, but they are not suited for diagnostics at the macroscopic scale. Optical imaging, which uses visible, ultraviolet, or infrared light, is a promising technique that is relatively safe and low-cost. It can be used with near infrared (NIR) probes, which penetrate through deep tissue. Imaging in the second near-infrared (NIR-II) window provides a 100-fold improvement in the signal-to-noise ratio, further improving the method. Combining NIR-II-emitting probes with hyperspectral imaging allows for in vivo imaging at depths of up to ~9 cm in biological tissues with single-cell resolution.

Technology

NIR-II hyperspectral imaging is a method for deep-tissue, high-resolution optical imaging in biological samples. The use of in vivo optical imaging with NIR-II probes is made feasible using upconverting nanoparticles (UCNPs) as fluorescent probes that emit in this range. UCNPs are lanthanide-doped fluoride nanoparticles that are better suited than conventional fluorophores for biomedical imaging purposes. Whereas the prior maximum reported depth of penetration of UCNPs was 3.2 cm, combining these probes with hyperspectral imaging allows for depths of up to ~9 cm in biological tissues. Hyperspectral imaging collects electromagnetic spectral information for each pixel in a 2D image. By obtaining the spatial coordinates and the wavelength of each pixel, the system can be used to generate 3D anatomical information from 2D scans. It can image at a range of scales from cells (tens of microns) to tumor microenvironments, organs, and the whole body. The system is a promising alternative to existing methods of clinical imaging modalities that suffer from limited ranges of detection and sensitivity.
Advantages

- High-resolution imaging at the cellular level
- Obtain information from surrounding tissues
- Image at depths of up to ~9 cm in tissue
- Obtain 3D information (e.g., location; depth) from 2D scans

Categories For This Invention:

- Photonics
- Sensors (Photonics)
- Imagers
- Life Sciences
- Clinical Applications
- Imaging

Intellectual Property:

Systems and methods for hyperspectral imaging
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